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AgriGate

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An International Multidisciplinary Monthly e-Magazine

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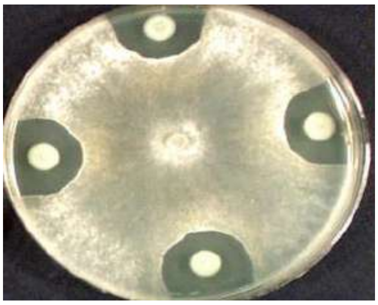

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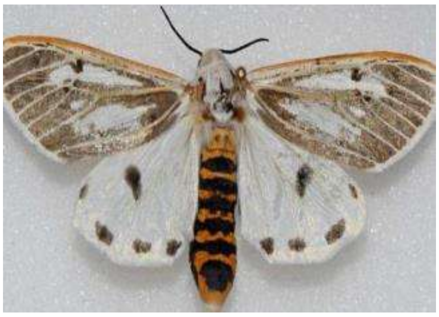

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From the Desk of Editor-in-chief

August 2024| Vol. 04 | Issue No. 08

I would like to introduce the launch of **“AgriGate - An International Multidisciplinary Monthly e-Magazine Volume 04 Issue No. 08 – August 2024”** with immense pleasure. Ourteam is privileged to dedicate this issue to the freedom fighters and farmers of India. India celebrates **Independence Day** on 15th, August of every year. As of this day, India got freedom. It makes us remind about a new beginning, the beginning of a new era and freedom to write.

The main objective of the magazine is to provide a publishing platform to young researchers and scientists as well as an information hub for the enthusiast, progressive farmer and also common readers. We envisage providing an online platform that appreciates illuminating articles on various topics related to agriculture and allied sciences monthly that will appraise and update the students, farming community and the whole society at large on the updates in agriculture.

Last but not the least, I wholeheartedly thank the editorial team, authors as well as anonymous reviewers for contributing to the release of this issue.

Our team welcomes your constructive feedback and suggestions to improve delivering fruitful content to hungry minds.

Dr R Shiv Ramakrishnan
Editor-in-chief
AgriGate Magazine

Volume: 04 Issue No: 08

INNOVATIVE BIOTECHNOLOGICAL APPLICATIONS OF MUSHROOMS

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Introduction

Mushroom is a global delicacy with proven nutritional value and health benefits. Consumption of mushrooms dates back to ancient Greece, where they have been used in religious ceremonies and were believed to provide vigor to soldiers during wars. Similarly, Romans, who saw them as the “Food of the Gods” and people of China have valued mushrooms as "elixir of life" for ages. Mushrooms fall under the category of kingdom “Fungi” which possesses more than 1.4 lakh known species including mushrooms, yeasts, molds, smuts, rusts and mildews. Mushrooms are the fast-growing fruiting bodies of fungi, characterized by heterotrophic mode of nutrition. They are different from plants by lacking green chlorophyll pigment, which limit them from utilizing atmospheric carbon dioxide for synthesizing their own food. Mushroom can be categorized based on the differences in their shapes, colors, national values, surfaces, and activities. White button mushrooms, Portobello mushrooms, Shiitake Mushrooms, Oyster mushrooms, Enoki mushrooms, Shimeji mushrooms, Porcini Mushrooms and Paddy Straw Mushrooms are some of the most edible mushrooms found across the globe.

Nutritional Value of Mushroom

Mushrooms are the rich source of carbohydrates, proteins and vitamins, with carbohydrates alone contributing 50-65 % of the total dry weight of the fruiting body (Table 1).

Monosaccharides together with their derivates, oligosaccharides and some amounts of alcoholic sugars like mannitol and trehalose are the part of this carbohydrates group. Additionally, mushrooms also possess sufficient amounts of macro and macronutrients including phosphorus, potassium, calcium, and magnesium.

Table:1 Approx. amounts of nutritional factors in edible mushroom (on dry weight basis)

Mushroom Species	Ash	Energy (Kcal/100g)	Sugars	Proteins	Fibers	Fat
Agaricus spp.	8.4 – 9.3	335-1424	48-53	25-29	2.9-6.0	1.4-1.6
Amanita sp.	14.4	300-1276	32	24	14.9	5.6
Craterellus spp.	8.9 – 13.3	317-1387	45-49	19.5-23.1	7.7-12.3	5.5-5.9
Cantharellus cibarius	13.2	298-1257	43.5	19	12.4	2.2
Ganoderma lucidum	2.8	360-1553	58	19	11.3	2.1
Pleurotus citrinopileatus	7.9	330-1395	36.3	38	7.0	2.2
Lentinula edodes	6.1	340-1443	59.5	21	3.8	1.3
Hericium erinaceus	7.1	355-1502	59.2	20	3.3	3.6
Cordyceps militaris	4.4	317-1417	49.3	23	11.9	0.4

Apart from macro-molecules, and nutrients, mushrooms also have an innate ability to accumulate wide range of vitamins including retinol, thiamine, pyridoxine, folic acid, niacin, pantothenic acid, cyno-cobalamin, biotin, ascorbic acid and ergo-calciferol. The highest concentration of niacin was reported in mushrooms like Pleurotus (109 mg/ 100 g DM), Ganoderma lucidum (61.9 mg /100 g DM) Agaricus bisporus (57 mg / 100 g DM), Agaricus Blazei (39.9 mg /100 g DM). Similarly, highest concentration of ascorbic acid reported in Amanita bisporus (207 mg / 100 g DM), retinol in Cordyceps militaris (96 mg / 100 g DM), pantothenic acid in Agaricus Blazei (39.4 mg /100 g DM) and riboflavin in Ganoderma lucidum (17.10 mg /100 g DM).

Biotechnological Applications of Mushrooms

A) Myco-remediation: Mushrooms are also referred as mycoremediation tools, due to their widespread application in the removal of various contaminants or remediation. Mushrooms produce different kinds of enzymes which help in efficient degradation of various pollutants and substrates. Mushrooms adopt multiple strategies in the process of bioremediation like

(i) Bioconversion (ii) Biosorption (iii) Biodegradation

i) **Bioconversion**: Currently most of the researchers are focusing on bioconversion particularly for the conversion of industrial and agro-industrial wastes into some useful products using mushrooms. Many industrial wastes (paper and pulp industry, cotton industry) can be used as a substrate for mushrooms cultivation which is specific to that particular geographical location. Lignocellulosic waste is one of the industrial wastes used as a substrate for the mushroom cultivation and can be further use as a product. Mushrooms like *Volvariella volvacea*, *Lentinula tigrinus, Pleurotus eous and Lentinus connotus* uses banana leaves, wheat straw, paddy straw, sorghum stalk, and banana pseudostem as substrate. Similarly, Pleurotus uses cotton waste, rice straw, cocoyam peels and sawdusts of some other plants

ii) **Biosorption:** Another way of removing pollutants from environment using mushrooms is biosorption. The process involves the sorption of industrial effluents or xenobiotics or metallic ions from live or dried mushroom biomass having good tolerance to these metal ion effluents**.** *Agaricus bisporus, Lactarius piperatus* are efficient in biosorption of cadmium (II) ions. Live *Fomes fasciatus* and compost of *Flammulina velutipes* are used as absorbant of copper. Similarly, *Pleurotus tuber- regium, Pleurotus sajor-caju* used in biosorption of heavy metals.

iii) **Biodegradation:** It involves the final breakdown and recycling of complex molecules to their mineral elements (NO_3, CO_2, H_2O). Mushroom spp. Like *Pleurotus ostreatus, Lentinula edodes, Pleurotus pulmonarius* successfully degraded 2,4-dichlorophenol (DCP), radioactive cellulosic-based waste and crude oil respectively.

B) Bioactive compounds: Bioactive compounds derived from mushrooms have lot of medicinal applications, proteins, peptides, polysaccharides, terpenes and terpenoids, phenols, phenolic compounds are some of the most studies bioactive compounds from mushrooms. These compounds can provide wide range of medicinal properties including, anticarcinogenic, anti-inflammatory, antiangiogenic, antioxidant, immunomodulatory, hepatoprotective, antibacterial, antiviral, antifungal, anti-neurodegenerative, antidiabetic, and hypoglycemic. *Agaricus bisporus, Agaricus macrosporus Agaricus subrufescens, Antrodia camphorate, Boletus edulis, Cantharellus cibarius Calvatia gigantea, Clitocybe maxima, Cordyceps militaris, Cordyceps sinensis, Craterellus cornucopioides, Daldinia concentric, Flammulina velutipes and*

Ganoderma lucidum, are some of the mushroom's species most frequently used for the production of bioactive compounds with immense medicinal properties (Figure. 1)

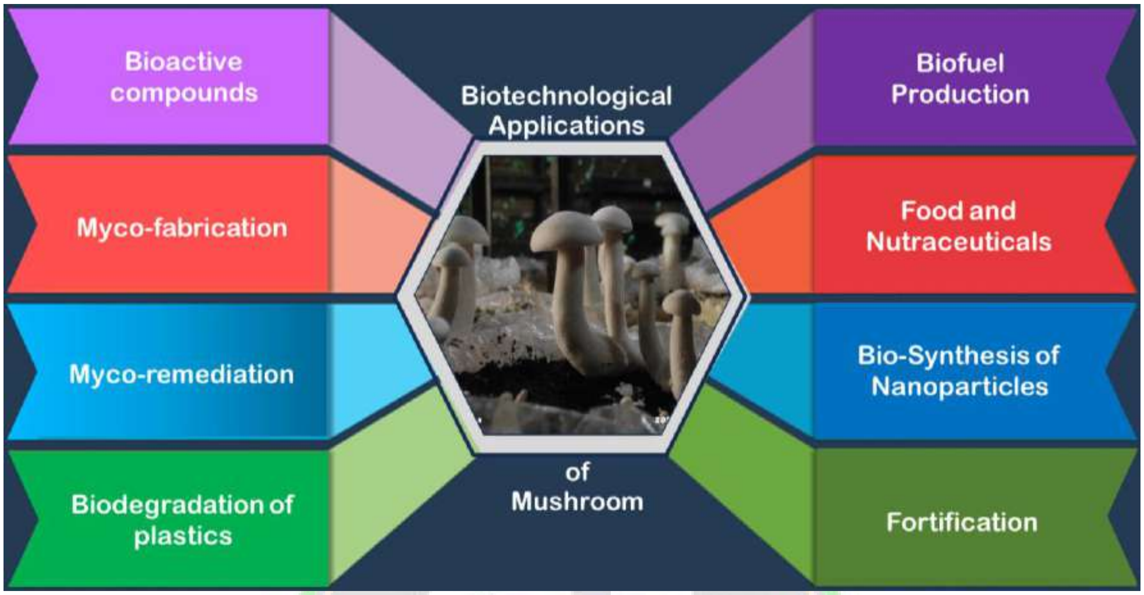

Figure. 1. Biotechnological Applications of Mushrooms

C). Myco-fabrication and Biosynthesis of Nanoparticles: Myco-fabrication offers straightforward and reliable method to produce stable biological nanoparticles (NPs). Most of the mushrooms offer additional advantages by producing significant metabolites including carbohydrates, proteins, and lipids. These are highly efficient in molecules accumulation and can easily be cultured, making them more suitable for low-cost production of nanoparticles. Since the years, mushrooms have been using to synthesis both metallic and non-metallic NPs such as gold, ferrous platinum, silver, zinc, palladium and selenium. Oyster mushrooms are the most explored mushroom in nanobiotechnology. *Pleurotus sajor caju, P. florida P. cornucopiae, P. platypus P. salmoneostramineus, P. djamor* and many more Pleurotus species group fungi are most frequently used in NPs biosynthesis. These fungi-based NPs are most effective against several harmful pathogenic bacterias like Salmonella typhii, Proteus alcalifaciens, Proteus mirabilis, and Staphylococcus aureus. Even mushroom species like Ganoderma, is often associated with greater medicinal applications like hypocholesterolemic, anti-HIV, hepatoprotective, anticancer, antioxidant, antibacterial, antitumour and antidiabetic properties. Similarly, *Agaricus bisporus* used in the biosynthesis of silver NPs which are highly effective against foodborne bacterial pathogens.

D). Food and Nutraceuticals: Mushrooms also refereed as "the new superfood", because of its huge therapeutic potentials and medicinal applications. Mushrooms are popular since prehistoric eras as a food supplement which played significant role in enhancing fitness and good health. Additionally, they are excellent choice as a low calorie diets with high protein, fiber and low-fat content. Mushrooms have been used by many food industries in preparing numerous food products. Mushroom powder is a functional food ingredient directly used in food industry for the preparation of baked goods like mushroom cookies, bread, biscuits, cakes as well as breakfast cereals. Oyster mushrooms known for their high nutritional value and sensory flavour, making them more suitable for sauces and puree soups. Similarly, *Lentinus edodes* and *Pleurotus ostreatus* used in the seasoning as flavoring agent. Mushrooms like, *A. blazei, F. velutipes and P. ostreatus* are used in beer and wine industrial fermentation as an alternative to *saccharomyces cerevisiae*. Different bioactive compounds such as proteins, peptides, polypeptides, carbohydrates, terpenoids and phenolic compounds have been reported in many mushrooms. Bioactive compounds act as nutritive nutraceuticals. In generally, mushroom nutraceuticals are the purified, refined and incompletely defined extractives that have been consumed in the form of capsules as dietary supplement. These mushrooms derived dietary supplements have significant ability to enhance physical and mental health status of the eater.

E. Biofuel Production: The wet byproducts generated from fresh mushroom is known as spent mushroom substrate (SMS), which is nothing but lignocellulosic waste. SMS acts as a cheap and most reliable substrate for the production of wide range of biofuels like, bio-oil, biohydrogen, solid-biofuels, biogas and bioethanol. Agaricus bisporus, Coprinopsis cinerea, Coprinus scinereus, Gymnopilus pampeanus, Flammulina velutipes, Pleurotus eryngii, Flammulina velutipes Lentinula edodes, Pleurotus pulmonarius and many more mushroom species are used in the biosynthesis of biohydrogen, solid-biofuels, biogas and bioethanol.

Conclusion

The applications of mushrooms are vast and highly promising. Mushrooms abilities like bioremediation, myco-fabrication, biofuel production, nutraceuticals can provide solutions for several environmental challenges. Further research into mushroom biology will undoubtedly unlock further potential for sustainable innovation.

References

Dimopoulou, M., Kolonas, A., Mourtakos, S., Androutsos, O. and Gortzi, O., 2022. Nutritional composition and biological properties of sixteen edible mushroom species. *Applied Sciences*, *12*(16), p.8074.

H. Kumar, K. Bhardwaj, R. Sharma, E. Nepovimova, N. Cruz-Martins, D.S. Dhanjal, R. Singh, C. Chopra, R. Verma, K.A. Abd-Elsalam 2021. Potential usage of edible mushrooms and their residues to retrieve valuable Supplies for industrial applications. Journal of Fungi, 7 (6):427

Kour, H., Kour, D., Kour, S., Singh, S., Hashmi, S.A.J., Yadav, A.N., Kumar, K., Sharma, Y.P. and Ahluwalia, A.S., 2022. Bioactive compounds from mushrooms: Emerging bioresources of food and nutraceuticals. *Food Bioscience*, *50*, p.102124.

Kulshreshtha, S., Mathur, N. and Bhatnagar, P., 2014. Mushroom as a product and their role in mycoremediation. *AMB express*, *4*, pp.1-7.

Leong, Y.K., Varjani, S., Lee, D.J. and Chang, J.S., 2022. Valorization of spent mushroom substrate for low-carbon biofuel production: Recent advances and developments. *Bioresource technology*, *363*, p.128012.

Rathore, H., Prasad, S. and Sharma, S., 2017. Mushroom nutraceuticals for improved nutrition and better human health: A review. *PharmaNutrition*, *5*(2), pp.35-46.

Shaheen, T.I., Salem, S.S. and Fouda, A., 2021. Microbial Nanobiotechnology: Principles and Applications.

Valverde, M.E., Hernández-Pérez, T. and Paredes-López, O., 2015. Edible mushrooms: improving human health and promoting quality life. *International journal of microbiology*, *2015*(1), p.376387.

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AROMATHERAPY: THE SCIENCE AND ART OF HEALING WITH ESSENTIAL OILS

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Introduction

Aromatherapy, a holistic healing modality that harnesses the therapeutic properties of essential oils, has experienced a resurgence in popularity in recent years. This ancient practice, with roots tracing back thousands of years to early civilizations in China, India, and Egypt, has evolved into a recognized complementary therapy in modern times. As individuals increasingly seek natural alternatives to conventional medicine, aromatherapy offers a bridge between traditional wisdom and contemporary wellness practices. This article explores the principles of aromatherapy, its scientific foundations, applications, benefits, and considerations for safe use.

Historical Context

The use of aromatic plant materials for healing and religious purposes dates back to ancient civilizations. The Egyptians, renowned for their advanced knowledge of aromatics, used essential oils in religious ceremonies, cosmetics, and embalming processes. The Greeks and Romans further developed these practices, with famous physicians like Hippocrates and Galen documenting the medicinal properties of various plants (Worwood, 2016). In the Middle Ages, Persian polymath Avicenna invented the process of distillation, which revolutionized the extraction of essential oils. This technology spread to Europe during the Crusades, leading to a flourishing trade in exotic oils and spices. The term "aromatherapy" was coined in the 1920s by French chemist René-Maurice Gattefossé, who discovered the healing properties of lavender oil after a laboratory accident (Tisserand, 2016).

Figure 1. Temple of Edfu, Egypt

- **Origin traced back to about 265 B.C. to ancient Egypt**
- **Incense and unguents (soothing or healing ointments)**

The Science Behind Aromatherapy

Aromatherapy works primarily through two pathways: olfaction (the sense of smell) and dermal absorption. When inhaled, the volatile organic compounds (VOCs) in essential oils interact with olfactory receptors in the nasal cavity. These receptors are connected to the olfactory bulb, which communicates directly with areas of the brain that are involved in emotion and memory, including the amygdala and hippocampus. This direct connection explains why scents can have such a powerful and immediate effect on mood and emotional state (Herz, 2009). When applied topically, essential oils are absorbed through the skin and enter the bloodstream. The lipophilic nature of essential oils allows them to easily penetrate cell membranes. Once in the bloodstream, the components of essential oils can interact with various physiological systems, potentially influencing hormone production, enzyme activity, and neurotransmitter function (Buckle, 2015). Essential oils, the cornerstone of aromatherapy, are complex mixtures of volatile organic compounds extracted from plant materials. These oils can contain hundreds of different chemical components, including terpenes, alcohols, esters, aldehydes, and phenols. Each of these compounds may contribute to the oil's therapeutic effects. For example, linalool, a component found in lavender oil, has been shown to have sedative and anxiolytic properties (Koulivand *et al.,* 2013).

Applications and Methods

Aromatherapy can be applied through various methods, each with its own advantages:

1. **Inhalation:** This method is particularly effective for emotional and respiratory issues. It can be achieved through direct inhalation from a bottle or tissue, diffusion using a specialized device, or steam inhalation.
2. **Topical Application:** Essential oils can be applied to the skin through massage oils, baths.

This method is often used for localized issues such as muscle pain or skin conditions. Essential oils are typically diluted in a carrier oil to prevent skin irritation.

3. **Internal Use:** Some practitioners advocate for the internal use of essential oils, such as adding them to water or taking them in capsules. However, this method is controversial and should only be done under the guidance of a qualified professional due to potential risks.

Common essential oils used in aromatherapy include lavender (*Lavandula angustifolia*), peppermint (*Mentha piperita*), eucalyptus (Eucalyptus globulus), tea tree (*Melaleuca alternifolia*), and rosemary (*Rosmarinus officinalis*). Each oil has its unique properties and potential benefits.

Chemical Family	Properties	Common Oils	Examples of Components
Terpenes	Antiseptic, anti-inflammatory	Pine, Cypress	Pinene, Limonene
Alcohols	Antimicrobial, antiviral	Tea, Geranium	Terpinen-4-ol, Geraniol
Aldehydes	Sedative, anti-infectious	Lemongrass, Cinnamon	Citral, Cinnamaldehyde
Esters	Calming, antispasmodic	lavender, Roman Chamomile	Linalyl acetate, Roman chamomile
Ketones	Mucolytic, cell regenerating	Rosemary, Sage	Camphor, Thujone

Table 1. Chemical Families of Essential Oil Components

Benefits and Therapeutic Uses

Aromatherapy is used to address a wide range of physical and emotional conditions:

1. **Stress and Anxiety Reduction**: Lavender, chamomile, and bergamot oils are known for their calming properties. A systematic review by Sánchez-Vidaña *et al.,* (2017) found evidence supporting the use of aromatherapy for stress and anxiety reduction in various populations.
2. **Sleep Improvement:** Essential oils like lavender, valerian, and sandalwood may help with insomnia. A randomized controlled trial by Lillehei *et al.*, (2015) indicated that inhaled lavender essential oil might improve sleep quality in college students.
3. **Pain Management:** Eucalyptus, peppermint, and ginger oils are often used for their analgesic properties. A meta-analysis by Lakhan *et al.*, (2016) suggested that aromatherapy

can be effective in treating various types of pain.

4. **Mood Enhancement:** Citrus oils like lemon and orange are associated with uplifting effects. A study by Kiecolt-Glaser *et al.,* (2008) found that lemon oil enhanced mood in healthy volunteers.
5. **Immune System Support:** Tea tree and eucalyptus oils are believed to have antimicrobial properties. While in vitro studies have demonstrated these effects, more research is needed to confirm their efficacy in vivo.
6. **Digestive Issues:** Peppermint oil is commonly used for nausea and digestive discomfort. A review by Chumpitazi *et al.,* (2018) found evidence supporting the use of peppermint oil in treating irritable bowel syndrome.

Research in Aromatherapy

While anecdotal evidence supports many benefits of aromatherapy, scientific research is ongoing. The field faces several challenges, including the complexity of essential oils, variability in product quality, and difficulties in designing placebo-controlled trials for olfactory interventions.

Despite these challenges, several high-quality studies have been conducted:

- A systematic review and meta-analysis by Sánchez-Vidaña *et al,.* (2017) examined 65 randomized controlled trials on aromatherapy for stress and anxiety. The authors concluded that aromatherapy could be an effective therapeutic option for rcing stress and anxiety levels.
- Lakhan *et al.,* (2016) conducted a meta-analysis of 12 studies on aromatherapy for pain management. They found that aromatherapy, particularly when combined with massage, could effectively reduce pain.
- A randomized controlled trial by Karadag *et al.,* (2017) investigated the effects of lavender oil inhalation on sleep quality and anxiety in patients undergoing coronary artery bypass surgery. The study found significant improvements in sleep quality and reduced anxiety levels in the aromatherapy group.

While these studies show promising results, more rigorous clinical trials are needed to firmly establish the efficacy of aromatherapy for various conditions. Future research should focus on standardizing essential oil compositions, optimizing delivery methods, and investigating potential interactions with conventional treatments.

Safety and Considerations

While generally considered safe when used correctly, aromatherapy carries some risks:

1. **Skin Irritation**: Some essential oils can cause allergic reactions or skin irritation, especially if used undiluted. A patch test should always be performed before applying a new oil topically.
2. **Photosensitivity**: Certain oils, particularly citrus oils, can increase skin sensitivity to sunlight, potentially leading to burns or skin damage.
3. **Interactions**: Essential oils may interact with medications or exacerbate certain health conditions. For example, some oils can interfere with blood clotting or affect blood sugar levels.
4. **Quality Control**: The lack of regulation in the essential oil industry can lead to variability in product quality. It's important to source oils from reputable suppliers who provide detailed information about their products, including botanical names and extraction methods.
5. **Toxicity**: Some essential oils can be toxic if ingested or used improperly. For instance, wintergreen oil contains high levels of methyl salicylate, which can be dangerous if consumed in large quantities.

It's crucial to consult with a qualified aromatherapist or healthcare provider before starting aromatherapy, especially for individuals with health conditions, pregnant women, and children. Essential oils should always be diluted appropriately and used as directed.

Conclusion

Aromatherapy offers a natural, non-invasive approach to promoting physical and emotional well-being. While more research is needed to fully understand its mechanisms and efficacy, its growing popularity and integration into various healthcare settings underscore its potential as a complementary therapy. As with any health practice, it's essential to approach aromatherapy with an informed perspective, considering both its benefits and limitations. The future of aromatherapy lies in bridging traditional wisdom with modern scientific understanding. By combining rigorous research with centuries of practical knowledge, aromatherapy has the potential to play an increasingly significant role in integrative healthcare. As we continue to unravel the complex relationships between scent, physiology, and well-being, aromatherapy stands poised to offer new insights into the power of plant-based healing.

References

Buckle, J. (2015). Clinical Aromatherapy: Essential Oils in Healthcare (3rd ed.). Elsevier Health Sciences.

Chumpitazi, B. P., Kearns, G. L., & Shulman, R. J. (2018). Review article: the physiological effects and safety of peppermint oil and its efficacy in irritable bowel syndrome and other functional disorders. Alimentary Pharmacology & Therapeutics, 47(6), 738-752.

Herz, R. S. (2009). Aromatherapy facts and fictions: a scientific analysis of olfactory effects on mood, physiology and behavior. International Journal of Neuroscience, 119(2), 263-290.

Karadag, E., Samancioglu, S., Ozden, D., & Bakir, E. (2017). Effects of aromatherapy on sleep quality and anxiety of patients. Nursing in Critical Care, 22(2), 105-112.

Kiecolt-Glaser, J. K., Graham, J. E., Malarkey, W. B., Porter, K., Lemeshow, S., & Glaser, R. (2008). Olfactory influences on mood and autonomic, endocrine, and immune function. Psychoneuroendocrinology, 33(3), 328-339.

Koulivand, P. H., Khaleghi Ghadiri, M., & Gorji, A. (2013). Lavender and the nervous system. Evidence-Based Complementary and Alternative Medicine, 2013, 681304.

Lakhan, S. E., Sheafer, H., & Tepper, D. (2016). The Effectiveness of Aromatherapy in Reducing Pain: A Systematic Review and Meta-Analysis. Pain Research and Treatment, 2016, 8158693.

Lillehei, A. S., Halcón, L. L., Savik, K., & Reis, R. (2015). Effect of Inhaled Lavender and Sleep Hygiene on Self-Reported Sleep Issues: A Randomized Controlled Trial. Journal of Alternative and Complementary Medicine, 21(7), 430–438.

Sánchez-Vidaña, D. I., Ngai, S. P., He, W., Chow, J. K., Lau, B. W., & Tsang, H. W. (2017). The Effectiveness of Aromatherapy for Depressive Symptoms: A Systematic Review. Evidence-Based Complementary and Alternative Medicine, 2017, 5869315.

Tisserand, R. (2016). Essential Oil Safety: A Guide for Health Care Professionals (2nd ed.). Churchill Livingstone.

Worwood, V. A. (2016). The Complete Book of Essential Oils and Aromatherapy, Revised and Expanded: Over 800 Natural, Nontoxic, and Fragrant Recipes to Create Health, Beauty, and Safe Home and Work Environments. New World Library.

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THE RISE OF BLOCKCHAIN TECHNOLOGY IN AGRICULTURE AND FOOD SUPPLY CHAINS

Article ID: AG-V04-I08-03

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Introduction

Blockchain technology, originally developed to support cryptocurrencies like Bitcoin, has transcended its initial use and found applications across various industries. In agriculture, blockchain is emerging as a revolutionary tool that promises to enhance transparency, traceability, and efficiency throughout the supply chain. This article explores the potential of blockchain technology in agriculture and its transformative impact on the industry. Blockchain technology in agriculture involves using a decentralized and secure digital ledger to record and verify transactions and data related to farming and supply chain activities.

Core principles

- **Decentralization:** Information is distributed across a network of computers, reducing therisk of a single point of failure and enhancing transparency.
- **Transparency:** All participants in the agricultural ecosystem have access to a shared,immutable ledger, ensuring transparency and traceability of transactions and data.
- **Immutability:** Once data is added to the blockchain, it cannot be altered or deleted,providing a tamper-resistant record of all activities.
- **Smart Contracts:** Self-executing contracts with predefined rules can automate various processes in agriculture, such as payments, ensuring trust and efficiency.
- **Security:** Cryptography secures transactions, protecting sensitive information and preventing unauthorized access to the blockchain.

- **Traceability:** The ability to trace the origin and journey of agricultural products, promoting accountability and reducing fraud in the supply chain.
- **Tokenization:** Assets and values in agriculture can be represented as digital tokens on the blockchain, facilitating easier and more efficient transactions.
- **Consensus Mechanism:** Participants agree on the validity of transactions through a consensus mechanism, ensuring the integrity of the data on the blockchain.

Applications & benefits of blockchain technology in agriculture and food supply

1. **Supply Chain Transparency:** Blockchain ensures transparency by recording every transaction and movement of goods on a decentralized ledger. In agriculture and food supply, this can help trace the origin of products, monitor their journey through the supply chain, and verify the authenticity of organic or fair-trade claims.
2. **Reducing Fraud and Counterfeiting:** Blockchain's immutability makes it difficult for fraudulent activities. In agriculture, it can prevent the falsification of origin or quality certificates, ensuring consumers receive authentic products.
3. **Smart Contracts for Agreements:** Smart contracts on blockchain enable automated execution of predefined agreements. In agriculture, this could streamline and automate contracts between farmers, distributors, and retailers, ensuring fair compensation and timely delivery.
4. **Provenance Tracking:** Blockchain can be used to track the entire history of a product, from seed to shelf. This is crucial in the food industry, allowing consumers to verify the authenticity and quality of the products they purchase.
5. **Efficient Payments and Transactions:** Blockchain facilitates faster and more secure financial transactions, reducing the delays and uncertainties often faced by farmers. This ensures prompt payment for their produce.
6. **Data Security for Farm Records:** Storing agricultural data, such as crop yields, on a blockchain ensures data integrity and security. Farmers can have control over who accesses their data, preventing unauthorized modifications.
7. **Supply Chain Optimization:** Blockchain can streamline processes by providing real-time visibility into the supply chain. This helps in optimizing routes for transportation, reducing wastage, and improving overall efficiency.
8. **Decentralized Marketplaces:** Blockchain can support decentralized marketplaces, allowing

farmers to directly connect with consumers or retailers without the need for intermediaries. This can lead to fairer pricing for farmers and fresher produce for consumers.

9. **Sustainable and Ethical Practices:** Blockchain can certify and track adherence to sustainable and ethical practices in agriculture. This transparency can appeal to consumers who prioritize environmentally friendly and socially responsible products.
10. **Emergency Response and Food Safety:** In the case of outbreaks or contamination, blockchain can swiftly trace the origin of the affected products, helping authorities and businesses take immediate action to ensure public safety.

Challenges and concerns of blockchain technology inagriculture and food supply

- **Data Privacy and Security:** Blockchain technology relies on decentralization and transparency, but ensuring the privacy and security of sensitive agricultural and food supply data is a challenge. Protecting information about crop yields, supply chain transactions, and other critical data points is crucial to prevent unauthorized access andtampering.
- **Scalability Issues:** As the volume of transactions and data in the agriculture and food supply chain grows, scalability becomes a concern. Blockchain networks may face challenges in handling the increasing number of transactions efficiently, leading to potential delays and increased costs.
- **Interoperability:** Different stakeholders in the agriculture and food supply chain may use different systems and platforms. Achieving seamless integration and interoperability among these diverse systems is essential for the successful implementation of blockchaintechnology, but it poses a significant challenge.
- **Costs and Infrastructure:** Implementing blockchain technology requires a robust infrastructure and can involve substantial initial costs. Small-scale farmers or businessesmay find it challenging to afford the necessary technology and infrastructure, hindering widespread adoption.
- **Education and Adoption:** Lack of awareness and understanding about blockchaintechnology among stakeholders in the agriculture and food industry is a barrier. Promoting education and facilitating the adoption of blockchain solutions require concerted efforts to bridge the knowledge gap.

Regulatory Uncertainty: The regulatory landscape for blockchain technology in agriculture is still evolving. Uncertainty regarding how governments will regulate and oversee blockchain applications can create hesitation among industry participants,impacting adoption.

- **Smart Contract Reliability:** The use of smart contracts in blockchain technology introduces automation into the supply chain. Ensuring the reliability and security of smart contracts is crucial to prevent potential vulnerabilities that could compromise the integrity of transactions and agreements.
- **Environmental Concerns:** Some blockchain networks, particularly those using Proof of Work (PoW) consensus mechanisms, have been criticized for their environmental impact due to high energy consumption. Addressing these concerns is essential, especially in an industry focused on sustainability like agriculture.
- **Resistance to Change:** Traditional agricultural and food supply chain practices may face resistance to change. Convincing stakeholders to transition to a blockchain-based system requires overcoming inertia and demonstrating the tangible benefits of the technology.
- **Fraud Prevention:** While blockchain enhances transparency, it does not eliminate the possibility of fraud entirely. Ensuring that data entered into the blockchain is accurate and truthful remains a concern, emphasizing the importance of combining blockchain with other technologies for comprehensive security.

Barriers to adopting blockchain technology inagriculture and food supply chain

Cost: Implementing blockchain systems can be expensive, especially for small and medium-sized enterprises in the agriculture sector.

Complexity: Integrating blockchain requires a level of technical expertise that may be challenging for some stakeholders in the industry.

Interoperability: Lack of standardized protocols and interoperability issues between different blockchain platforms can hinder seamless collaboration among participants in the supply chain.

Regulatory Uncertainty: The regulatory environment for blockchain in agriculture is still evolving, creating uncertainty for businesses about compliance and legal aspects.

Data Privacy Concerns: Farmers and other stakeholders may be hesitant to share sensitive data on a decentralized ledger due to concerns about privacy and data security.

Education and Awareness: Limited understanding of blockchain technology among stakeholders can impede its adoption, as education about the benefits and functionality of blockchain is crucial.

Infrastructure Challenges: In some regions, inadequate internet connectivity and technological infrastructure can hinder the effective implementation of blockchain solutions.

Resistance to Change: Traditional systems in agriculture may resist adopting blockchain due toa reluctance to change established processes and practices.

Conclusion

In conclusion, the integration of blockchain technology in agriculture and the food supply chain holds tremendous promise for enhancing transparency, traceability, and efficiency. By providing a decentralized and secure ledger, blockchain ensures the authenticity of information at every stage, from farm to table. This not only mitigates the risk of fraud and contamination but also fosters trust among consumers. Additionally, smart contracts and real-time data tracking empower stakeholders to make informed decisions, optimize processes, and reduce wastage.

While challenges remain, the transformative potential of blockchain in revolutionizing the agricultural and food sectors is undeniable, paving the way for a more resilient, sustainable, and interconnected future.This article demonstrates that blockchain technology is already being used by many projects and initiatives, aiming to establish a proven and trusted environment to build a transparent and more sustainable food production and distribution, integrating key stakeholders into the supply chain. Yet, there are still many issues and challenges that need to be solved, beyond those at technical level. To reduce barriers of use, governments must lead by example and foster the digitalization of the public administration. They should also invest more in research and innovation, as well as in education and training, in order to produce and demonstrate evidence for the potential benefits of this technology. Gupta (Gupta 2017) discusses the possible transition of Governments towards the use of the blockchain, noting the fact that governments and their relevant departments should observe and understand the particular "pain points", addressing them accordingly.

From a policy perspective, various actions can be taken, such as encouraging the growth of Blockchain-minded ecosystems in agri-food chains, supporting the technology as part of the general goals of optimizing the competitiveness and ensuring the sustainability of the agri-food supply chain, as well as designing a clear regulatory framework for blockchain implementations. The economic sustainability of the existing initiatives, as they have been presented in this paper, still needs to be assessed and the outcomes of these economic studies are expected to influence the popularity of the blockchain technology in the near future, applied in the food supply chain domain. Summing up, blockchain is a promising technology towards a transparent supply chain of food, but many barriers and challenges still exist, which hinder its wider popularity among farmers and food supply systems.The near future will show if and how these challenges could be addressed by governmental and private efforts, in order to establish blockchain technology as a secure, reliable and transparent way to ensure food safety and integrity. It is very interest to see how blockchain will be combined with other emerging technologies (big data, robotics, IoT, RFID, NFC, hyper spectral imaging etc.), towards higher automation of the food supply processes, enhanced with fulltransparency and traceability.

References

1000EcoFarms. 2017. https://www.1000ecofarms.com/.

Abelseth, B. 2018. "Blockchain Tracking and Cannabis Regulation: Developing a permissioned blockchain network to track Canada's cannabis supply chain." Dalhousie Journal of Interdisciplinary Management 14.

Caro, M.P., M.S. Ali, M. Vecchio, and R., Giaffreda. 2018. "Blockchain-based traceability in Agri-Food supply chain management: A practical implementation." IoT Vertical and Topical Summit on Agriculture-Tuscany (IOT Tuscany). Tuscany, Italy: IEEE. 1-4.66

Grass Roots Farmers' Cooperative. 2017. How we 're using blockchain tech for total Transparency. https://grassrootscoop.com/blog/how-we-use-blockchain-technology-to-give-you-total-transparency

Tripoli, M, and J. Schmidhuber. 2018. "Emerging Opportunities for the Application of Blockchain in the Agri-food Industry." FAO and ICTSD: Rome and Geneva Licence: CC BY-NC-SA 3 .

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CARBON SEQUESTRATION

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Introduction

It is widely recognized that soil carbon (C) sequestration is win-win strategy. This is especially true in developing countries and emerging economies where soil resources are often degraded, land-use change and agricultural intensification are imminent, and the need to sequester carbon in soil is more important than ever before because of the necessity to restore degraded soils and ecosystem, improve water quality, enhance biodiversity, and increase agronomic productivity to achieve food security. Yet reliable information on the attainable and potential rate of soil carbon sequestration in relation appropriate land used and recommended management practices (RMPS) is not known.

TERRESRTIAL CARBON POOL

There are five large global C pool;(1) an oceanic pool estimated at 38000Pg (1Pg=pentagram=1015g=1bilion metric tones or 1billion Mg),(2) ecologic pool estimated at about 5000 Pg comprising 4000 Pg of coal and 500 Pg of each of oil and gas ,(3) a pedologic or soil see pool comprising 1550 Pg of soil organic C(SOC) and 950 Pg of soil inorganic C (SIC) ,(4) an atmospheric pool estimated at 750 Pg and increasing annually at rate of 3.3 Pg C per year, and (5) a biotic pool of 620 Pg including 60 Pg of detritus material. These five pools are interconnected. The atmospheric pool increasing due to three anthropogenic activities: fossil fuel combustion deforestation and soil cultivation and cement production.

The terrestrial C pool has two principle components are interconnected, depend on each other, and are influenced by atmospheric condition. Together the terrestrial C pool of 3120 Pg is

4.1 times the atmospheric pool .The soil C pool by itself (2500Pg) is 3.3 times the atmospheric pool. The residence times of C in terrestrial pool is longer than that in atmospheric pool. Therefore, transfer of fraction of C from atmospheric to terrestrial C pools is a prudent strategy of minimizing the CO2 related effect on climate change.

Geologic Sequestration

Geologic sequestration is putting CO2 into long-term storage in geologic zones deep underground. Geologic sequestration is the method of storage that is generally considered for carbon capture and storage (C C S) projects. C C S is the practice of capturing CO2 at anthropogenic sources before it is released to the atmosphere and then transporting the CO2 gas to a site where it can be put into long-term storage.Before geologic sequestration can be widely used, two issues need to be addressed:

1. Only a handful of specialized facilities like natural gas-processing plants, coal gasification plants, and ethanol plants currently have processes that separate C O2 and make it available for geologic sequestration. Actions are under way now to develop economical methods of separating and capturing CO2 at other large-scale systems like power plants that produce relatively large quantities of anthropogenic CO2.
2. Although pure CO2 has been stored as a gas in natural underground deposits for millions of years and oil field operators have safely pumped millions of tons of CO2 underground into oil-producing formations to increase production (CO2 flooding), we need validation demonstrations in geologic environments to ensure that we understand the best ways to site the systems as well as monitor the C O2 in storage over the long term.

SOIL CARBON SEQUESTRATION

The process of transferring atmospheric C in to a pedologic/ soil C pool is called soil C sequestration. Soil C sequestration is natural process and involves transfer of atmospheric CO2 in to biomass C via photosynthesis. Transfer of biomass C in to SOC occurs through humification of the biomass returned to the soil.

Carbon sequestration refers to the storage of carbon in a stable solid form. It occurstrough direct and indirect fixation of of atmospheric co2. Direct soil Carbon sequestration occurs by inorganic chemical reactions that converts CO2 into soil inorganic Carbon (SIC) compounds such as calcium and magnesium carbonates. Direct plant carbon sequestration occurs such as plants photosynthesize atmospheric CO2 into plant biomass.

Carbon sequestration is one of the important mitigation strategy to cope with the impact of climate change by reducing the atmospheric concentration of carbon dioxide emission. Carbon sequestration is necessity to restore degraded soils and ecosystem, improve water quality, enhance biodiversity and increase agronomic productivity to achieve food security and reducing poverty in countries.(Bhattacharya 2008).

As nation has progressed we have been emitting carbon or gases which results in warming globe. This climate change has emerged as the leading environmental threat facing the world today. Green revolution not with standing the alarming depletion in soil organic C and increasing the production of major green house gases and enhancing the contamination of ground water. Under such situation carbon sequestration plays a key role to conserve natural resources and achieve sustainability in agricultural production.

Scope and importance of carbon sequestration

1. Carbon sequestration is one of the important mitigation strategy to cope with the impact of climate change by reducing the atmospheric concentration of carbon dioxide emission.
2. Carbon sequestration is necessity to restore degraded soils and ecosystem, improve water quality, enhance biodiversity and increase agronomic productivity to achieve food security.
3. Soil are the third largest terrestrial sink for carbon on the planet.
4. The potential of soil organic sequestration through restoration of degraded and desertified soils in India is about 10-14 Tg C per year (Lal, 2004).
5. The present attempt is made to estimate carbon (both SOC and SIC) in Indian soils and there application to focus issue and priorities on carbon sequestration in soil.

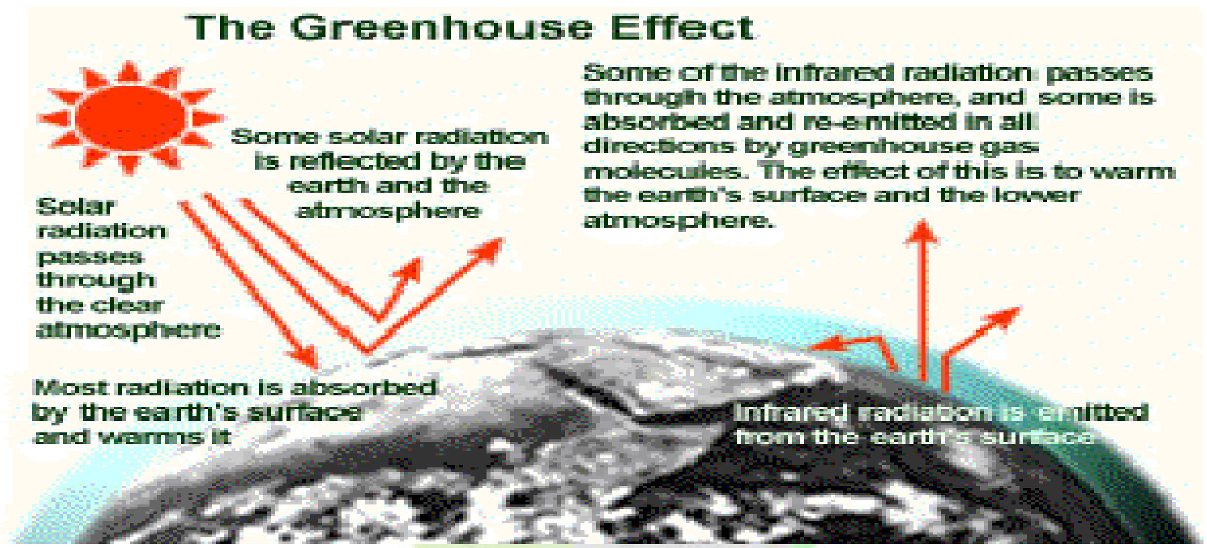
Greenhouse Effect

The phenomenon whereby the earth's atmosphere traps solar radiation, caused by the presence in the atmosphere of gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through but absorb heat radiated back from the earth's surface**.**

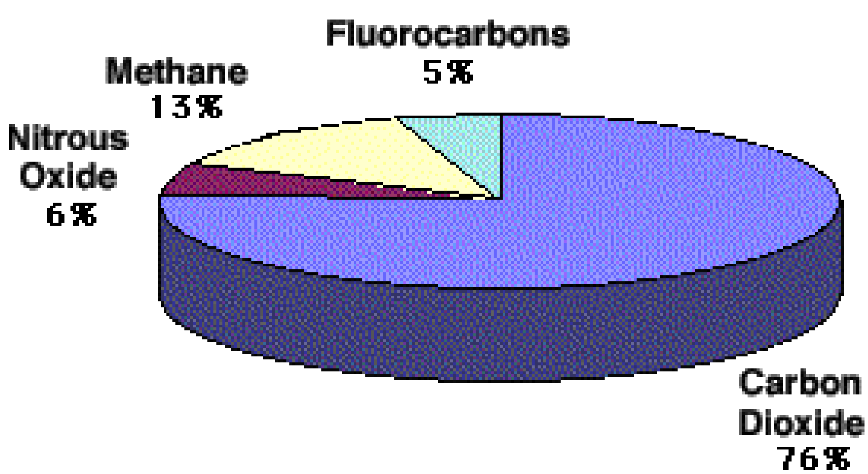
Short waves from the sun enters the atmosphere and heats the atmosphere and earth surface. Earth and it’s atmosphere re-radiates long waves which are not allowed to escape from the atmosphere. This effect maintain the temperature or worm of the earth and is called greenhouse effect.

The recent trend of an increase in the concentration of greenhouse gases (GHGs) in the atmosphere has led to an elevated concern and urgency to adopt measure for carbon (C) sequestration to mitigate the climate change

Carbon dioxide (CO_2), one of the major components of greenhouse gases, is of major concern in terms of the global warming phenomenon. To mitigate the effect of atmospheric CO_2, carbon capture and storage (CCS) has been found to be an important tool. The present study aims at explaining the role soils as one of the most important natural resources in enhancing natural resources CCS. Soils capture and store both organic and inorganic forms o f carbon and thus act both as source and sink for atmospheric CO_2.



Major Greenhouse Gases

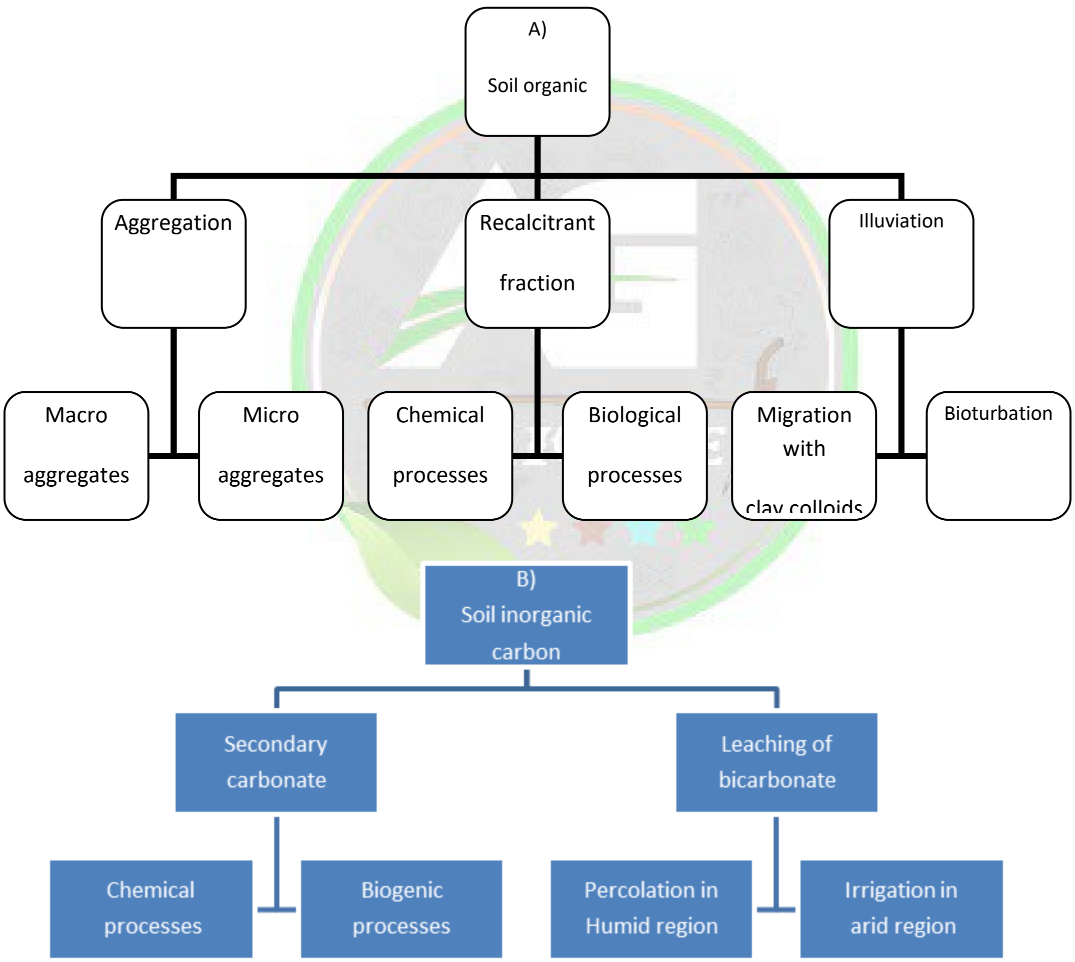


Carbon Sequestration : definition and its type

Definition

1) "Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into soil through crop residues and other organic solids and in a form that is not immediately remitted".
2) "The process of transferring atmospheric C into a pedologic/ soil C pool is called as soil C sequestration". (R. Lal)
3) "Carbon sequestration refers to the storage of carbon in a stable solid form".

Soil carbon sequestration:



Methods of Carbon Sequestration in Organic Agriculture:-

- Conservation agriculture
- Cropping sequences
- Agro forestry

- Forest management practices
- C-sequestration through plant

Develop Agricultural Management Programs that:

Enhance C Input- 1.Crop selection 2. Crop management 3. Crop rotation

Reduce C losses - 1. Tillage 2. Fallow management

Conservation Agriculture

Conservation Agriculture aimed at little or no soil disturbance , no burning ofcrop residue, direct seeding in to untilled soil, crop rotation and permanent soilcover by retaining crop residue.

This are the Four principle of Conservation Agriculture

- Minimal soil disturbance
- Residue retention
- Crop rotation
- Minimal soil compaction

Various management practices adopted for sequestration in soil and also lead to mitigation of atmospheric CO_2 load. These management practices are :-Conservation agriculture, Cropping sequences, Agro forestry, Forest management practices, C sequestration through plant .

Residue management

Residue management as surface mulch provides a congenial environment for biodiversity, which significantly improves on SOC (Tomar et el 1992)

Carbon trading

- Carbon sequestration is one of the important mitigation strategies to cope with the impact of climate change.
- The kyoto protocol brought the mechanism of trading carbon unit as a global mechanism to address the issue of reducing emission by various countries to meet the mandatory requirement.

What is kyoto protocol?

- The kyoto protocol is an international agreement which lays down targets for industrialize countries to cut their green house emission which include CO_2, CH_4, N2O, HFCs.
- Accepted by several developed and developing countries in 1997.

- Australia the latest signatory (late 2007)
- USA refuse to sign the convention (world biggest green house emitter).

Carbon credit

- ✓ Carbon credit is a concept that a incentivizes countries which reduce their GHG emission and disincentivises those who do not reduce their GHG emission.
- ✓ Under the kyoto protocol each company that shifts to cleaner technologies obtains to it account one credit per tone of CO_2 emission reduction. This credit to the company obtain is called carbon credit.
- ✓ The protocol imposes target commitment upon a countries who in turn set emission quota on companies in their country. In order to fulfill their quota.

Benefits of Soil Carbon Sequestration

- Improved soil structure.
- Better water use and storage.
- Increased soil fertility.
- Improved biodiversity.
- Healthier ecology.
- Importantly soil carbon represents the ONLY AVAILABLE buffer against the impacts of climate change already being experienced.

Future Research Thrust Areas:

- Increase the research focus on identifying the management practices that enhance the carbon sequestration potential of soil under different agro-ecological region of country.
- Increase the research and development support for innovative technologies to accelerate total C sequestration in cropping system.
- Develop and promote regional and state specific approach to enhance soil C stock.
- Policy on minimum tillage and conservation agriculture is needed to be developed for major soil groups of india and promoted to adopt.

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INTEGRATED FARMING SYSTEM MODELS IN IRRIGATED UPLAND

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Abstract

Farming system research is considered as a powerful tool for natural and human resource management in developing countries such as India. This is a multidisciplinary whole-farm approach and very effective in solving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holdings by integrating various farm enterprises and recycling crop residues and by-products to sustain the soil productivity under varied agro-ecological situations. Studies on integrated farming system involving various components were carried out at different agro-climatic zones of India. This study includes about the viable components for irrigated uplands.

Introduction

Indian agriculture is characterized by small farm holdings and the average farm size is only 1.57 ha. Around 93% of farmers have land holdings smaller than 4 ha and they cultivate nearly 55% of the arable land. Majority of Indian farmlands can be classified under low land ecosystem, irrigated dry land and rainfed ecosystem. One of the most credited ways of achieving resilience in these areas is through adapting practices such as IFS and also the most recognized practice among various researchers as well. Therefore, even a small change in the production system could jeopardize the balance of food production and agriculture which demands country like India to adapt more robust approach in achieving climate resilience in agriculture. Location-specific IFS models have the potential to double the farmer's income besides providing year-round employment. Integration of different agriculturally related enterprises with crops provide ways to recycle the products and by products of one component as input to another and reduce the cost of production and increase the total income of the farm. In general, the concept of farming system involves best utilization of the growing space through the integrated farming approach. Ensures nutritional and economic security for better health of the farm family as they get different products and cash crops from their own land, boosting food security through local production, consumption and helps in reducing migration. Improves soil's physical and chemical properties, its nutrient status and biological components. Such interactive systems affect the microclimate and provide a strong base to good agricultural practices for sustained increased productivity. Hence, the farming system practices address the capacity to transform internally in response to endure stress and thus obtaining the required function. Some of the most notable researches in irrigated agriculture done for different ecosystems. The location specific IFS models are validated based on the biophysical indicators such as productivity, profitability, employment generation and resource use efficiency for soil fertility improvement. Due to ever increasing population and decline in per capita availability of land in the country, practically there is no scope for horizontal expansion of land for agriculture in the present situation.

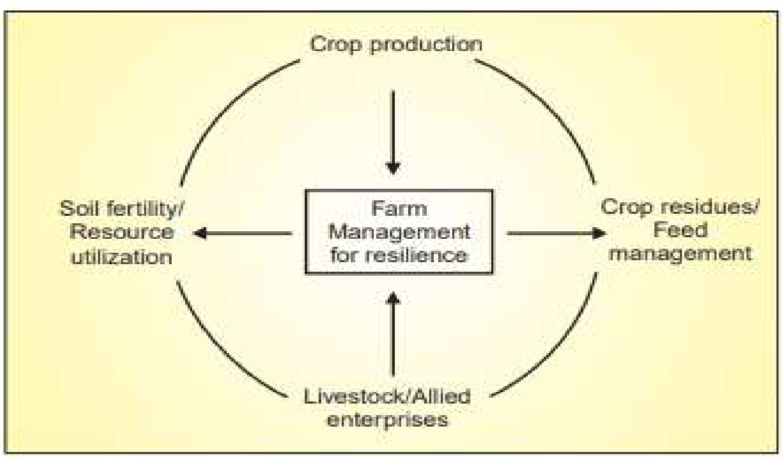

Fig: 1 IFS for resilient agriculture   C. Jayanthi *et al*., 2021

The only option is through vertical expansion of land is most feasible by adopting the IFS approach. The IFS assumes greater importance for sound management of farm resources to enhance the farm productivity and reduce the environmental degradation, improve the quality of life of resource poor farmers and maintain sustainability. Integrated farming systems are often less risky, if managed efficiently, they benefit from synergisms among enterprises, diversity in produce and environmental soundness.

The following are some of the examples of IFS for irrigated uplands :

1. Crop + dairy + biogas unit
2. Crop + poultry + biogas unit
3. Crop + sheep / goat rearing + biogas unit
4. Crop + sericulture
5. Crop + piggery
6. Crop + sericulture + biogas unit
7. Crop + dairy + biogas unit + homestead garden
8. Crop + dairy + biogas unit + vermicompost

Criteria for enterprise selection :

The basic points that are to be considered while choosing appropriate enterprise in IFS are:

- ✓ Soil and climatic features of an area/locality
- ✓ Social status of the family and social customs prevailing in the locality

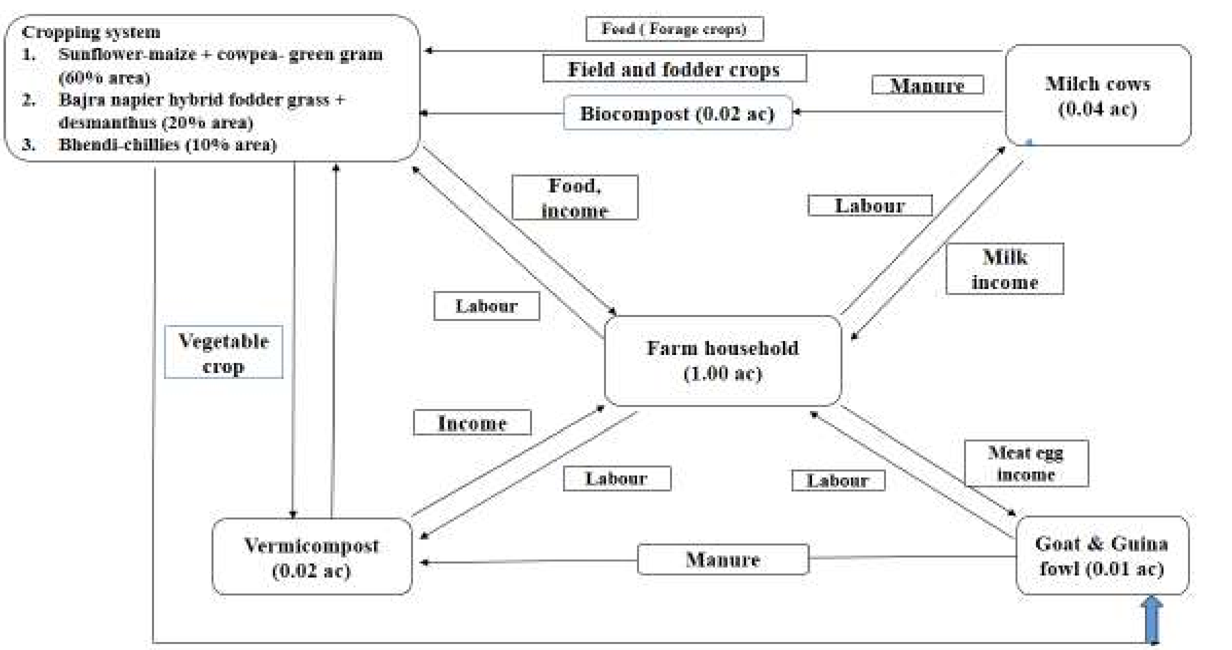

Fig: 2 Resource flow model of integrated farming system- Irrigated upland (1.00 ac)

C. Jayanthi

- ✓ Economical condition of the farmer (return/income from the existing farming system)
- ✓ Resource availability at farm and present level of utilisation of resources
- ✓ Economics of proposed IFS and credit facilities
- ✓ Farmer’s managerial skills
- ✓ Household demand
- ✓ Institutional infrastructure and technological know-how
- ✓ Market facilities

Conclusion

Integrated farming systems (IFSs) are well known for their sustainability and profitability all over the world. IFS should be considered for widespread adoption by small and marginal farmers. They need to be shown why it is challenging for them to meet their food and other basic requirements in single-product farms. Reduced size of land holdings and continuous non-integrated agriculture is slowly decreasing farm income. To maintain farm income, it is essential to integrate the various agriculture components i.e., crops, dairy, poultry, biogas unit, sericulture, piggery and vermicompost etc. in a single farm unit. IFS is a holistic approach and considers interactions among the different IFS components and the environment. IFS is also a unique system in waste recycling nothing is wasted, the by-product or waste of one system becomes the input for the other systems. In an IFS farm, labor intensive enterprises like dairy, poultry, fruits, vegetables, sericulture, piggery etc. can increase employment generation (man-days), especially for family labor and in irrigated upland conditions. Besides, expenditure on external inputs will be decreased.

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LAND SUITABILITY FOR MAJOR CROPS UNDER VERTISOLS (BLACK COTTON SOILS) OF SOUTHERN TAMIL NADU

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Introduction

Vertisols (Black cotton soil) occupy an area of 4,98,000 ha in Tuticorin, Tirunelveli, Ramanathapuram, and Virudhunagar districts of Tamil Nadu. The soils are mostly rainfed with cotton, chillies, millets, pulses and oil seed crops. Study was undertaken in four soil series namely *viz.*, Kumarapuram Series (Kp), Kalugachalapuram Series (Kl), Chandragiri Series (Cg) and Chidambarapuram Series (Cp) to characterize, classify and to suggest the land use system for suitable crops n the rainfed Vertic soil.

Physiographically the study area is a vast stretch of pedeplain with a slope gradient of less than 1.0 percent. The climate is basically semi arid. The major rainy season is north - east monsoon with 55 per cent, followed by summer 22 per cent, south west 16 per cent and winter 7 per cent rainfall. The mean annual maximum temperature for 50 years was 35.0^0 C and mean annual minimum temperature was 22.5^0 C with mean annual temperature of 31.0^0 C. The mean annual rainfall is 750 mm.

The detailed soil survey was carried out using cadastral map in the scale of 1:10,000. Profiles were opened at random locations upto 200 cm or rock or hard indurated substratum and studied in detail for all their morphological and physical characteristics. Pedons were examined and horizon-wise soil samples were collected and analysed for various physical and chemical properties (Jackson 1973; Piper 1966). The soils were classified as per USDA soil taxonomy (Soil Survey Staff, 1996). The soils were evaluated according to various interpretive systems such as All India Soil and Land Use Survey Organization (1970), Requier *et. al.* (1970) and FAO (1976). Land suitability for major crops in the watershed was worked as per (Dhanapalan Mosi *et. al.* (1977).

Physiography and morphological properties

Based on the profile study, the soil consisting of deep (100-105 cm solum depth), imperfectly drained, calcareous, clayey soils occurring in nearly level lands. They develop deep, wide cracks in periods of moisture stress. Slickensides are noticed in the subsoil. These soils develop deep, wide cracks in periods of moisture deficiency. Slickensides are found in the sub-soil. Occurrence of clay in surface and sub-surface layers of the pedons was observed, indicating moderate to high degree of soil development. The colour of the surface soil of the four series ranged from very dark grayish brown (10 YR 3/2) to very dark gray (10 YR 3/1) due to the presence of free cations (SS & LUO Staff, 2003).

Physical properties

Generally gravel and sand contents are lower in soils of the plain Vertisol whereas, the clay and silt contents are higher. The surface soils had high clay (> 50 per cent) content. In general the clay and calcium carbonate contents increase with depth because of illuviation (SS & LUO Staff, 2003).

Chemical properties

The soil reaction ranged from moderately alkaline (pH 7.9) to very strongly alkaline (pH 9.0). The organic carbon content of the four soil series ranged from 0.21 to 0.37 per cent and it decreased with the increase in solum depth. The electrical conductivity of surface soil was less than 1.0 dSm^{-1}. Generally, electrical conductivity increased with depth. The wide variation of these pH, EC and CEC was due to the nature of parent material, leaching, presence of calcium carbonate and exchangeable cations (SS & LUO, 1991). The free calcium carbonate content varied from 3.2 to 6.1per cent in the form of concretions and nodules. The precipitation of calcium carbonate from the solution rich in carbonate resulted in the high pH values. The organic carbon content was low (< 0.5 per cent) in all the soils.

The exchangeable cations and extractable bases were considerably high among the four series of soils. The cation exchange capacity of the soil ranged from 30.6 to 54.3 c mol $^{(+)}$ kg $^{-1}$.

Among the exchangeable cations, Ca was predominant followed by Mg, Na and K.

Soil fertility status

The surface and sub surface soils were analysed for fertility status. The soils are rated as low (<280 kg ha^{-1}) medium, (280 to 450kg ha^{-1}) and high (> 450 kg ha^{-1}) in case of available nitrogen; low (< 11 kg ha^{-1}) medium, (11 to 22 kg ha^{-1}) and high (> 22 kg ha^{-1}) in case of available phosphorus; and low (<118 kg ha^{-1}) medium, (118 -280 kg ha^{-1}) and high (> 280 kg ha^{-1}) in case of available potassium (Arora 2002). Available nitrogen content was low and it ranges between 181 and 258 kg ha^{-1}. Available phosphorus was also low and it varies from 9.5 to 12.5 kg ha^{-}1. The available potassium was high in all soils with the ranges between 388 and 432 kg ha^{-1}.

The available zinc and copper content (DTPA – extractable) in these soils ranges from 0.28 to 0.58 and 0.82 to 1.58 mg kg^{-1}, respectively and soils were deficient in available zinc and sufficient in copper. The critical limit for the DTPA extractable micronutrients Zn, CU, Fe and Mn is 0.6, 0.2, 2.5 and 2.0 mg kg^{-1}, respectively (Katyal and Rattan 2003). Available iron and manganese in these soils ranges between 9.5 to 18.85 and 3.88 to 10.52 mg kg^{-1}, respectively and they were sufficient in all the soils.

Classification

Based on the morphological, physical and chemical properties, the soils were classified into the order of Vertisol. The solum depth in all four series ranged from 100 to 150 cm. Thickness of 'A' horizon ranged from 15 to 25 cm. It's colour was very dark grayish brown in the hues of 10 YR and 2.5 Y or dark brown in the hue of 10 YR. All the four series consisted imperfectly drained, calcareous, clayey soils occurring in nearly level lands. They developed deep, wide cracks in periods of moisture stress. The frail cambic 'B' horizon was about 40 to 60 cm. It's colour was very dark grayish brown or very dark gray of 10 YR hue. Slickensides were noticed in the subsoil. The soils were taxonomically classified as fine, smectitic, calcareous, deep, isohyperthermic *Typic Haplusterts.*

Land suitability assessment for major crops adopted to the area

Considering the problems of soil management in the soil series of the study area, the range of the crops which are naturally suited is limited (Table 1). These soil series are not well suited to tree crops due to difficulties in the development of root system. Due to high clay content, high shrink swell potential, smectitic clay, very sticky plastic consistency when wet, poor internal drainage, little voids for root growth etc., roots grow on the soil surface with least tap root development. These trees become susceptible to moisture stress in the dry seasons.

Table 1. Land suitability for major crops

S. No.	Crop	Suitability sub class for soil mapping units			
		KpcA1	KlcA1	CgcA1	CpcA1
1.	Bajra	S2 tw	S2 tw	S2 tw	S2 tw
2.	Jowar	S2 b	S2 b	S2 b	S2 b
3.	Ragi	S2 tw	S2 tw	S2 tw	S3 tbw
4.	Minor millets	S2 t	S2 t	S2 t	S3 tb
5.	Cotton	S2 bw	S2 bw	S2 bw	S2 bw
6.	Coconut	S3 tbw	S3 tbw	S3 tbw	S3 tbw
7.	Groundnut	S3 tbw	S3 tbw	S3 tbw	S3 tbw
8.	Sesamum	S2 tb	S2 tb	S2 tb	S2 tb
9.	Sunflower	S2 tw	S2 tw	S2 tw	S2 tw
10.	Chillies	S2 b	S3 bk	S3 bk	S2 b
11.	Coriander	S2 b	S2 b	S2 b	S2 b
12.	Sapota	S3 tbw	S3 tbw	S3 tbw	S3 tbw
13.	Citrus	S3 tbw	S3 tbw	S3 tbw	S3 tbw
14.	Senna	S2 b	S3 bk	S3 bk	S2 b
15.	Alo vera	S3 tbw	S3 tbw	S3 tbw	S3 tbw

The major limitation(s) alone have been affixed with the suitability order.

Legend for soil suitability			Limitations		
S2	-	Moderately suitable	t	-	Soil textural limitation
S3	-	Marginally suitable	b	-	Soil alkalinity hazard
			w	-	Soil drainage problem
			k	-	Powdery $CaCO_3$

Using the suitability classification, land resources of the study area were assessed for their suitability for the following crops.

Millets : Bajra, jowar and ragi

Minor millets : Indian millet (*Setaria italica*), kodo millet (*Paspalum sorobiculatum*), little millet (*Panicum miliare*), common millet (*Panicum miliaceum*) and barnyard millet (*Echinochloa colona*)

Oil seeds : Coconut, sesamum and sunflower

Fibre crop : Cotton

Spices : Chillies and coriander

Fruit crops : Sapota and citrus

Medicinal plants : Senna and alovera

The above interpretative systems indicated that the soils are with severe limitations that reduce the choice of the crops and require special conservation and management practices. They can be brought to use by overcoming the manageable soil limitations. They are moderately suited to bajra, jowar, ragi, minor millet, cotton, sesamum, sunflower, chillies, coriander and medicinal plants like senna and alovera. However, they are marginally or least suited to most of the economic and tree crops including coconut, sapota and citrus. Further, careful soil management technique with conservation practices coupled with selection of suitable crop can help in better sustained output from the soils.

References

All India Soil and land Use Survey Organization (1970) Soil Survey Manual, Indian Agricultural Research Institute, New Delhi.

Dhanapalan Mosi A., K. Subramanian, M. Jeyaraman and S.N. Vivekanandan (1977). Soil survey interpretation for suitability for crop cultivation. Seminar on response of crop to application of P and K and soil fertility evaluation as AC & RI, Coimbatore, Vol. III, 112-115.

FAO (1976). A frame work for Land Evaluation, FAO, Soil Bull, FAO, Rome.

Jackson, M.L. (1973). Soil Chemical Analysis. (Prentice Hall of India pvt. Ltd: New Delhi)

Piper, C.S. (1966). Soil and Plant analysis. (Interscience publication, New York).

Requier, J, Bramao. D.L and Cornet J. B (1970). A new system of soil appraisal in terms of actual and potential productivity. FAO. AGRL, TESA/ 70 / 6, Rome

Soil Survey and Land Use Organisation staff (2003) Report No. 2: Land Resources of Ettayapuram taluk, Thoothukudi district, Tamil Nadu.

Soil Survey and Land Use Organization staff (1991). District report No. 3. Soils of V.O.Chidambaranar district, Tamil Nadu.

Soil Survey staff. (1996). 'Keys to Soil Taxonomy', Seventh Edition, USDA, Wasington, D.C.

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ADVANCES IN RICE PRODUCTION TECHNOLOGY

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Introduction

Rice is a high-energy staple that feeds more than half of the world's population. In India, it is the greatest food crop, covering 41.9 million hectares and producing around 83.13 million tons per year. This area represents approximately 37% of the total area under food grains, exceeding wheat, another key crop in India. Rice ranks second in terms of harvested area only to wheat on a worldwide scale. Surprisingly, almost 65% of Indians include rice in their daily diet. Compared to Europeans, who consume only 5 kg of rice each year, the average Asian consumes approximately 150 kilograms.

Notably, every portion of the rice plant serves many purposes in society. Rice is the staple diet for almost two-thirds of the global population. It has a nutritional value and calorie content similar to wheat and other cereal grains. Rice grains are mostly made of carbohydrates, particularly starch (up to 75%), with minimal protein content (about 7.5%). Additionally, the grains include around 2.2% fat, 0.8% cellulose, and 5.9% ash. Rice helps to keep your heart healthy because it is low in fat, sodium, and cholesterol.

Advances in Rice Production

1. System of Rice Intensification (SRI) Cultivation
2. Direct Sown Rice/Direct seeded rice (DSR) Technology
3. Alternate wetting and drying (AWD)
4. Aerobic

5. Drip irrigation system in rice field
6. Rice Fish System
7. Capsule seed cultivation

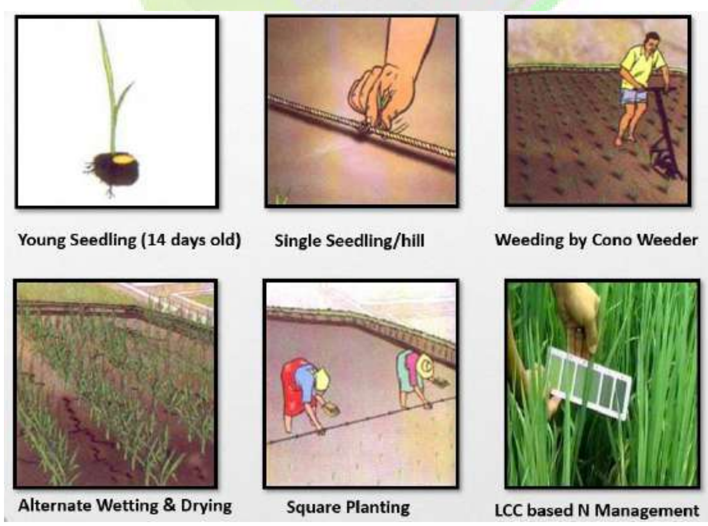
1.System of Rice Intensification (SRI) Cultivation

Developed by Fr. Henri De Laulanié in Madagascar during the early 1980s, the System of Rice Intensification (SRI) improved rice yields by transplanting single seedlings into moist soil, planting them in a square pattern, and using a rotary hoe in two directions. After 20 years, SRI gained international recognition and has since been adopted in countries like the Philippines, Myanmar, Sri Lanka, China, and Cuba. This approach has led to significant yield increases of 50% to 300%, potentially doubling the average rice yield.

Principles of SRI

- Nursery area and Seed rate
- Seedling age
- Square planting
- Water management
- Mechanical (Cono) weeder usage

To plant 1 hectare, use 7-8 kg of seeds and a 100 m² nursery. For raised beds (1 x 5 meters), use 20 beds per hectare. Cover beds with polythene, add 4 cm of soil, spread 375g of seeds per 5 m², water, and cover with coir pith or straw. Transplant seedlings at 14 days old (three-leaf stage)..



Use organic manure in the nursery and manage water with alternating wetting and drying. Start by moistening soil for 10 days; then, irrigate to 2.5 cm depth until panicle initiation, and increase to 5 cm depth afterward. Square planting with the System of Rice Intensification (SRI) allows effective weed management using a cono/rotary weeder every 10 days. Trampled weeds enrich the soil and manual removal can cut weeding costs by 52.5%.

Advantages of SRI

- Saving in Seed requirement
- Reduction in the nursery area
- Increased tillering
- Improver grain filling
- Water savings
- Less lodging
- **Increase grain yield**

Constraints in the adoption of SRI

- Strict water management practices are necessary.
- In the beginning, the SRI method demands a larger workforce.
- Transplanting requires a higher level of expertise.
- Due to its labor-intensive nature, SRI is not suitable for large-scale production.
- Farmers' traditional mindset poses a challenge.

2. Direct Sown Rice/Direct seeded rice (DSR) Technology

Direct seeded rice (DSR) involves sowing seeds directly into the field rather than transplanting seedlings from a nursery. There are three main DSR techniques: dry seeding, wet seeding, and water seeding.

Dry seeding: is used in rainfed areas with limited water. Seeds are sown into prepared soil through broadcasting, drilling, or dibbling, resulting in a 22% yield increase and 35-57% water savings compared to flooded systems. It is commonly used for upland rice.

Wet seeding: suits irrigated areas with sufficient rainfall. Pregerminated seeds are sown in well-puddled fields by broadcasting or using a drum seeder, which sows in eight lines per pass but may suffer from uneven seed distribution due to equipment clogging.

Water seeding: is for high-rainfall areas where seeds are sown in standing water. Fields are prepared with ridges and furrows to prevent seed drift and maintain proper crop spacing.

DSR saves resources, facilitates timely sowing of subsequent crops, and, despite generally lower yields compared to transplanting, often offers higher net returns and better benefit-cost ratios.

However, DSR faces challenges with weed control and crop establishment, and the risk of yield loss can be significantly higher compared to conventional transplanting.

The major constraint in DSR

- Weeds are the major constraint in DSR fields contributing to higher yield losses and sometimes complete crop failure.
- So integrated weed management options are to be discussed and conclusions should be drawn for successful DSR cultivation

3. Alternate Wetting and Drying

Alternate Wetting and Drying (AWD) is a water-saving method that reduces irrigation water use in rice fields while maintaining yields. In AWD, fields are alternately flooded and non-flooded, with irrigation applied a few days after water recedes. The duration of non-flooded periods between irrigations varies based on soil type, weather, and crop growth stage

Suitable Field Conditions for Implementing AWD

- Choose a field free from weed pressure at key growth stages.
- Avoid light, sandy loam soils and areas with low rainfall, as they drain too quickly. opt for heavy clay soils with high water retention.
- Select fields with minimal pest and disease issues.
- Ensure the land is properly levelled to prevent uneven water, fertilizer distribution, and excessive weed growth.
- Avoid salt-affected soils.

Advantages of AWD

- Continuous flooding results in the increase of pests, and diseases of rice which cause yield reduction. AWD controls the incidence of pest and disease infestation when compared to continuous flooding.

Disadvantages

- Delays in AWD management practices during grain filling, flowering, and tillering result in a greater reduction in yields.
- The weed population is higher in AWD fields than in flooded fields.
- AWD may increase salinity in the fields.

4. Aerobic rice

Aerobic rice is a production system in which especially developed “aerobic rice” varieties are grown in well-drained, non-puddled, and nonsaturated soils. With good management, the system aims for yields of at least 4-6 tons per hectare.

Target Area

Aerobic rice can be found, or can be a suitable technology, in the following areas:

Favorable uplands: Flat areas with sufficient rainfall or supplemental irrigation to keep soil near field capacity, where farmers can use fertilizers.

Fields on upper slopes or terraces: Coarse-textured, well-drained soils in undulating rainfed lowlands, where water ponding is minimal or brief.

Water-short irrigated lowlands: Areas where there is insufficient water to maintain flooded rice fields for long periods.

Advantages Of Aerobic Rice

- Saves water, labor, and energy.
- Allows for seed savings due to wider spacing.
- Utilizes rainwater more efficiently, improving water use efficiency (WUE).
- Reduces CH4 emissions, lowering environmental pollution.
- Preserves soil structure and supports inter or mixed cropping.
- Cost-effective with less need for chemicals and fewer disease and pest issues.

5. Drip Irrigation in Rice

Drip irrigation for rice, though initially met with skepticism, is both feasible and beneficial. Unlike traditional methods that rely on continuous flooding, drip irrigation delivers water directly to the root zone, significantly reducing water usage and increasing efficiency. This method is especially advantageous in areas with low rainfall and water scarcity. Drip irrigation combined with fertigation can cut water consumption by 70% and boost yields by up to 30% compared to conventional methods. For instance, using 50 to 60 lakh litters of water per hectare with drip irrigation can produce 5 to 6.5 tonnes of rice, which is more efficient than traditional irrigation. In India, where rice cultivation uses a significant portion of the country's water resources, adopting drip irrigation can help meet future demands and conserve groundwater. Additionally, drip irrigation minimizes nitrogen loss, reduces methane emissions, and prevents the accumulation of harmful heavy metals, making it a more sustainable option for rice production.

Advantages of adoption of drip irrigation for rice

- 70 to 80 % water saving.
- Reduces methane emission.
- Reduce weed growth.
- Decreases the cost of cultivation.
- Increases Water use efficiency.
- Reduces fertilizer losses.
- Fertigation is the technique of application of fertilizers along with a drip irrigation system which helps not only increase fertilizer use efficiency but also helps in saving fertilizers.

6. Rice – fish system

A rice-fish system integrates fish farming with rice cultivation in the same field or pond complex. Fish can be intentionally stocked, enter naturally during flooding, or both. Yields of fish vary widely from 1.5 to 174 kg per hectare per season, depending on the system, species, and management. These systems enable fish and other aquatic animals to be produced alongside rice without reducing rice yields, providing valuable animal protein for household nutrition and increasing farm income.

Suitable species of fish for rice-fish system

The most common Indigenous fishes found in Asian rice fields are the following:

- **Whitefish:** Small, plant or plankton-eating species like Danios, Barbs, Snakeskin Gourami, and Half beaks.
- **Blackfish:** Carnivorous air-breathers that handle low oxygen levels, such as Snakehead, Catfish, Climbing Perch, Spiny eels, and Sheatfish.
- **Exotic fish:** Introduced species like Common Carp, Tilapia, and Silver Carp.
- Other aquatic species: Crabs, shrimp, snails, and insects can also be harvested.

7. Capsule seed cultivation

A new rice cultivation method developed to tackle drought and boost productivity by 25% while using less seed combines aspects of Rice Intensification, Single Seeding, and Direct Sowing. This innovative approach, known as capsule seed cultivation, was invented by S. Venkateswaran, a businessman turned farmer from Sirugamani village in Tamil Nadu. His goal was to address the challenges posed by drought.

Seed capsule

The technique uses a capsule made of gelatine and sterilized fat, typically used in medicine. Each capsule contains two paddy seeds along with neem seed powder, humic acid, and micronutrients. The contents can be adjusted to include bio-fertilizers, fungicides, bactericides, or pesticides as needed. These capsules are sown directly into the field before water is applied. When water is released, the capsule dissolves, allowing the seeds to germinate. Machinery like nursery transplanters can be used to sow the capsules. Neem seed powder inside the capsule helps protect the seeds from pests and diseases. This method can also be used for other crops such as tomatoes, brinjals, and sesame.

Benefits

- The seed rate is reduced from 30 kg to 2.4 kg, requiring 60,000 capsules per acre.
- The productivity of paddy increases by 25% compared to traditional methods.
- The cropping period is shorter as it eliminates the nursery phase.
- Neem seed powder in the capsule helps protect seeds from pests and diseases.

Constraints

- Each capsule costs 65 paise, making the method relatively expensive.
- Capsules must be handled and stored in a dry environment.
- Manually sowing 60,000 capsules is labor-intensive.

Conclusion

The document highlights advancements in rice production, including the System of Rice Intensification (SRI), Direct Sown Rice (DSR), Alternate Wetting and Drying (AWD), aerobic rice, drip irrigation, rice-fish systems, and capsule seed cultivation. These methods aim to boost yields, save water, reduce labour, and enhance sustainability. SRI and AWD focus on water management, DSR on direct seeding, and aerobic rice on efficient water use. Drip irrigation reduces water usage and environmental impact, while rice-fish systems add protein and income. Capsule seed cultivation, a newer method, improves productivity and drought resilience. Despite challenges like weed control, labour demands, and costs, these innovations offer promising solutions for sustainable rice farming.

Reference

Bista B. 2018. Direct Seeded Rice: A New Technology for Enhanced Resource Use Efficiency. International Journal of Applied Sciences and Biotechnology6(3):181-198

Das Anup, Patel D.P, Ramakurshna G.I., Munda G.C., Nagachan S.V., Choudhury B.U., Mohapatra K.P., Rajkhowa D.J., Rajesh kumar and Panwar A.S.2012. Improved Rice Production Technology for resources concervation and climate resilience . farmers guide extension bulletin No. 78.

Jat,R.D ,Kakraliya S.K, Choudhary K.k, Kapoor P, Sardar Singh Kakraliya and Hardev Ram.2020.Advances in Rice production.

Lal B, Nayak AK, Gautam P, Tripathi R, Shahid M, Panda BB, Bhattacharyya P and Rao KS (2016). System of Rice Intensification: A Critical Analysis. Research Bulletin No. 9. ICAR-National Rice Research Institute,Cuttack, Odisha, 753006, India. pp 52

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THE EVOLUTION OF SMART FARMING: AN OVERVIEW

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Abstract

Smart farming, or precision agriculture, revolutionizes global agricultural practices by integrating advanced technologies like IoT, AI, and satellite imagery. This essay explores its widespread adoption and benefits across different regions. North America leads with extensive use of GPS-guided machinery and IoT sensors, optimizing resource management and boosting productivity. In Europe, countries such as Germany and the Netherlands emphasize sustainability through high-tech solutions in greenhouse farming. Asia-Pacific nations like China and Japan invest heavily in smart farming to tackle food security and environmental challenges. Latin American countries like Brazil and Argentina adopt precision agriculture to enhance crop yields and manage resources efficiently. Benefits include increased productivity, resource efficiency, and cost savings, driven by data-driven decisions and technological innovations. However, disparities persist between developed and developing regions, highlighting the need for global collaboration, policy support, and technological advancements to ensure equitable access and maximize the potential of smart farming for sustainable agriculture worldwide.

Key words: Smart Farming, Precision agriculture, Technological advancements, IoT

Introduction

Smart farming, also known as precision agriculture, is revolutionizing the agricultural sector by integrating advanced technologies into farming practices. The aim is to optimize the use of resources, improve crop yield, and ensure sustainability. Smart farming combines' data from various sources, including satellite imagery, weather forecasts, soil sensors, and farm machinery, to make informed decisions. This essay explores the various aspects of smart farming, its benefits, technologies involved, challenges, and its future potential.

Smart farming, often referred to as precision agriculture, has evolved significantly over the past few decades. Its development has been driven by the need to enhance agricultural productivity, improve resource management, and ensure sustainability. This essay explores the historical findings and early developments in smart farming, highlighting key milestones, technological advancements, and the challenges faced in its adoption.

Smart farming, also known as precision agriculture, is transforming agricultural practices worldwide. By integrating advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), robotics, and satellite imagery, smart farming aims to enhance productivity, improve resource management, and ensure sustainability. This essay examines the global scenario of smart farming, highlighting its adoption, benefits, technological advancements, regional disparities, and future prospects.

Early Developments in Smart Farming

1. **Introduction of Precision Agriculture (1980s-1990s)**:
   - **Yield Monitors**: One of the earliest applications of precision agriculture was the use of yield monitors on combine harvesters. These devices measured crop yield and moisture levels in real-time, allowing farmers to identify variations within their fields.
   - **GPS Technology**: The introduction of Global Positioning System (GPS) technology in the 1990s revolutionized farming. It enabled the precise mapping of fields and the application of inputs like fertilizers and pesticides. GPS-guided machinery reduced overlap and ensured even distribution, enhancing efficiency and reducing costs.
2. **Soil Sampling and Variable Rate Technology (VRT)**:
   - **Soil Sampling**: Traditional soil sampling methods evolved with the advent of GPS technology. Farmers could now conduct grid or zone sampling, leading to more accurate assessments of soil nutrient levels.
   - **Variable Rate Technology (VRT)**: VRT allowed farmers to apply inputs at variable rates across different parts of a field, based on soil sampling data. This targeted approach optimized resource use and improved crop yields.

     a significant barrier for many small and medium-sized farms.

Key Technological Advancements

1. **Satellite Imagery and Remote Sensing**:
   - **Satellite Imagery**: In the late 20th century, satellite imagery became an essential tool for monitoring crop health and growth. Multispectral and hyperspectral images provided valuable insights into plant conditions, allowing for early detection of stress and diseases.
   - **Remote Sensing**: Remote sensing technologies, including drones, further enhanced data collection. Drones offered high-resolution images and could cover large areas quickly, providing detailed information on crop conditions and helping in precision management.
2. **Development of IoT Devices**:
   - **Soil Sensors**: The integration of Internet of Things (IoT) devices into farming practices began with soil sensors. These sensors measured soil moisture, temperature, and nutrient levels in real-time, providing farmers with actionable data.
   - **Weather Stations**: IoT-enabled weather stations were deployed to monitor local climatic conditions. Data from these stations helped farmers make informed decisions about irrigation, planting, and harvesting times.

Global Adoption of Smart Farming

North America

North America, particularly the United States and Canada, is at the forefront of smart farming adoption. The region's advanced technological infrastructure, significant investment in research and development, and large-scale farming operations have facilitated the widespread implementation of precision agriculture techniques.

- **United States**: The U.S. has a high adoption rate of smart farming technologies. The use of GPS-guided machinery, IoT sensors, and drones is prevalent. Government initiatives and support from agricultural organizations have further promoted the adoption of these technologies.
- **Canada**: In Canada, smart farming practices are increasingly being adopted to address challenges such as labor shortages and climate change. Precision agriculture is helping Canadian farmers optimize input usage and improve crop yields.

Europe

Europe is another significant player in the smart farming landscape, with countries like Germany, France, and the Netherlands leading the way. The European Union (EU) has been proactive in promoting precision agriculture through various policies and funding programs.

- **Germany**: Germany is known for its advanced agricultural machinery and technology. The country has a robust framework for research and development in smart farming, focusing on sustainability and efficiency.
- **Netherlands**: The Netherlands is a global leader in agricultural innovation. With a focus on greenhouse farming, the country utilizes IoT, AI, and robotics to maximize productivity and minimize resource use.

Asia-Pacific

The Asia-Pacific region is witnessing rapid growth in smart farming adoption, driven by the need to feed a large population and address agricultural challenges such as water scarcity and labor shortages.

- **China**: China is heavily investing in smart farming technologies to modernize its agricultural sector. The use of drones, AI, and IoT is increasing, supported by government policies and investments.
- **Japan**: Japan's smart farming practices are focused on high-tech solutions, including robotics and AI. The country is known for its innovative approaches to greenhouse farming and vertical farming.

Latin America

In Latin America, countries like Brazil and Argentina are adopting smart farming technologies to enhance productivity and sustainability in agriculture.

- **Brazil**: Brazil is leveraging precision agriculture to improve the efficiency of its large-scale farming operations. The use of satellite imagery, soil sensors, and GPS technology is helping Brazilian farmers optimize their practices.
- **Argentina**: Argentina is focusing on integrating smart farming technologies to boost crop yields and manage resources more efficiently. The country's agricultural sector is increasingly adopting precision agriculture techniques.

Key Technologies in Smart Farming

1. **Internet of Things (IoT)**: IoT devices, such as sensors placed in fields, collect data on soil moisture, temperature, and nutrient levels. This data is transmitted in real-time to farmers, enabling them to make timely decisions.
2. **Drones and Satellite Imaging**: Drones and satellites provide aerial views of farms, helping in monitoring crop health, detecting pests, and assessing damage. They can cover large areas quickly and provide high-resolution images.
3. **GPS Technology**: GPS-guided tractors and machinery ensure precise planting, harvesting, and application of inputs. This reduces overlap and misses, enhancing efficiency.
4. **Artificial Intelligence (AI) and Machine Learning**: AI algorithms analyze data from various sources to predict outcomes and recommend actions. Machine learning models help in identifying patterns and trends, aiding in better decision-making.
5. **Robotics and Automation**: Robots are used for tasks such as planting, weeding, and harvesting. Automation reduces labor costs and increases precision, especially in large-scale farming operations.

Benefits of Smart Farming

1. **Enhanced Efficiency**: Smart farming allows for precise application of inputs such as water, fertilizers, and pesticides. This leads to significant reductions in waste and ensures that crops receive exactly what they need, when they need it.
2. **Increased Productivity**: By closely monitoring crop conditions and responding quickly to any issues, farmers can significantly increase crop yields. The use of predictive analytics helps in forecasting potential problems and addressing them proactively.
3. **Sustainability**: Efficient use of resources minimizes environmental impact. Precision agriculture practices reduce runoff of fertilizers and pesticides into water bodies, thereby protecting ecosystems. Additionally, optimized water usage helps in conserving this vital resource.
4. **Cost Savings**: With smart farming, operational costs are reduced. Less fuel, water, and chemicals are used, and labor costs decrease as automation and machinery take over repetitive tasks. This translates into higher profit margins for farmers.

5. **Data-Driven Decisions**: The data collected from various smart farming technologies provides valuable insights into crop performance, soil health, and climatic conditions. Farmers can make informed decisions, reducing risks and improving overall farm management.

Challenges in Smart Farming

1. **High Initial Costs**: The adoption of smart farming technologies involves significant upfront investment in equipment and infrastructure. This can be a barrier for small and medium-sized farms.
2. **Technical Expertise**: Farmers need to be trained to use new technologies effectively. There is a learning curve associated with the implementation and maintenance of smart farming systems.
3. **Data Management**: The vast amount of data generated needs to be managed and analyzed effectively. This requires robust data management systems and skilled personnel.
4. **Connectivity Issues**: Rural areas often face connectivity challenges, which can hinder the real-time transmission of data. Reliable internet access is crucial for the functioning of IoT devices and other technologies.
5. **Privacy and Security**: The use of digital technologies in farming raises concerns about data privacy and security. Farmers need to ensure that their data is protected from cyber threats.

Future Potential of Smart Farming

1. **Integration of Advanced Technologies**: The future of smart farming lies in the seamless integration of advanced technologies such as block chain for supply chain transparency, and edge computing for real-time data processing.
2. **Sustainable Practices**: Continued emphasis on sustainability will drive the adoption of smart farming practices. Innovations in renewable energy sources and biodegradable materials will further reduce the environmental footprint of agriculture.
3. **Customized Solutions**: As smart farming technologies evolve, more customized solutions will become available, catering to the specific needs of different crops, regions, and farming practices.

4. **Policy Support**: Government policies and incentives will play a crucial role in encouraging the adoption of smart farming. Financial support, subsidies, and training programs can help overcome the initial barriers.
5. **Global Impact**: Smart farming has the potential to address global food security challenges. By improving productivity and sustainability, it can contribute to feeding the growing global population and mitigating the effects of climate change on agriculture.

Regional Disparities

Despite the global advancements in smart farming, there are significant regional disparities in its adoption.

1. **Developed vs. Developing Countries**: Developed countries have higher adoption rates of smart farming technologies due to better infrastructure, greater financial resources, and access to advanced technologies. In contrast, developing countries face challenges such as high initial costs, lack of technical expertise, and inadequate infrastructure.
2. **Urban vs. Rural Areas**: Urban areas tend to have better connectivity and access to technology, facilitating the adoption of smart farming. Rural areas, especially in developing countries, often lack reliable internet access and technological infrastructure, hindering the implementation of precision agriculture.

Conclusion

The early findings in smart farming highlight the transformative potential of precision agriculture. Despite the challenges, the benefits in terms of improved resource management, enhanced crop yields, and economic gains have driven its adoption. Key technological advancements such as GPS, yield monitors, satellite imagery, and IoT devices laid the foundation for modern smart farming practices. As technology continues to evolve, addressing the initial barriers and improving accessibility will be crucial in realizing the full potential of smart farming, paving the way for a more sustainable and efficient agricultural future.

The global scenario of smart farming is marked by significant advancements and promising potential. While developed regions like North America and Europe lead in adoption, developing regions in Asia, Latin America, and Africa are catching up. The benefits of smart farming, including increased productivity, resource efficiency, sustainability, and cost savings, are driving its adoption worldwide. However, addressing regional disparities and ensuring equitable access to technology will be crucial for realizing the full potential of smart farming in transforming global agriculture. With continued innovation, policy support, and international collaboration, smart farming can pave the way for a more efficient, sustainable, and food-secure world.

References

Lowenberg-DeBoer, J. (Ed.). (2018). *Precision Agriculture Basics*. Purdue University Press.

Zhang, Q., & Zhang, X. (Eds.). (2020). *Internet of Things in Smart Agriculture: Smart Sensors and IoT for Improved Crop Production*. CRC Press.

Liu, J., & Zhang, X. (Eds.). (2019). *Artificial Intelligence and IoT for Smart Agriculture*. Springer.

FAO. (2021). *Smart Agriculture Sourcebook*. Food and Agriculture Organization of the United Nations.

Schmitz, M., & Rosen, S. (Eds.). (2019). *The Economics of Precision Agriculture*. Emerald Publishing Limited.

Zhai, Y., Zhu, Q., & Huang, D. (Eds.). (2021). *Precision Agriculture Technology for Crop Farming*. CRC Press.

European Commission. (2020). *Smart Farming: Digital Solutions for Agriculture*. Retrieved from https://ec.europa.eu/digital-single-market/en/smart-farming

USDA. (2020). *Precision Agriculture in the United States: A Comprehensive Review*. United States Department of Agriculture.

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HI - TECH CITRUS NURSERY PRODUCTION IN NORTH WESTERN INDIA

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Introduction

Citrus has a tremendous socio-economic and cultural impact on the whole society. The multifold nutritional and medicinal values make this fruit indispensable in several parts of the world, and India is one of the leading producers of citrus fruits globally. The country's diverse climatic conditions and soil types support the cultivation of various citrus species, including mandarins, sweet oranges, grapefruits, lemons and limes. However, the productivity and quality of citrus in India are often hindered by various biotic and abiotic stresses, such as diseases, pests, and adverse environmental conditions. To overcome these challenges and ensure the sustainable production of high-quality citrus fruits, the adoption of advanced propagation techniques and the use of suitable rootstocks have become increasingly important.

Citrus nurseries play a crucial role in the production of high-quality healthy and genetically uniform planting material for the establishment of new orchards. In India, the demand for high-quality citrus plants has been steadily increasing due to the expansion of citrus cultivation and the need to replace old, unproductive orchards. However, the traditional method of raising citrus plants from seed is not suitable for commercial production, as it results in genetically variable plants with inconsistent fruit quality and yield.

In this article we will navigate through all the stages which a seed has to go through to reach the farmer's field as a salable plant. A commercial citrus plant, mainly consist of two primary parts rootstock and the scion. A process in which a scion is joined to the rootstock is known as grafting or budding.

Citrus seed

The process begins with the selection of healthy and mature fruits from true-to-type mother plants of the desired rootstock cultivar. For rough lemon, a commonly used rootstock in North Western India, mature and healthy fruits should be picked after July-August to obtain a better percentage of seed germination.

The fruits are cut horizontally, and the juice and seeds are extracted. The seeds are then separated and washed thoroughly to remove any residual acidic materials, such as pulp particles and juice. It is essential to sort out shriveled, wrinkled, and underdeveloped seeds, as they may lead to spontaneous polyploidy.

The collected seeds should undergo a heat treatment to inactivate microbial and soil-borne fungi. This can be done by dipping the seeds in hot water at 52°C for 10 to 15 minutes, ensuring they are tied in a muslin cloth to avoid direct heating. Subsequently, the seeds are cooled to room temperature and dipped in a 10% sodium hypochlorite solution for 15 to 20 minutes, followed by washing to remove any remaining fungal infections. Alternatively, commercially available fungicides like Topsin-M can be used for seed treatment before sowing.

Picture 1: Green house structure for production of primary nursery

Rootstock raising

Furthermore, the next step is raising of rootstock saplings. There are various methods for raising rootstock seedlings, such as, open field sowing in which seeds can be sown directly in well-prepared nursery beds or in open fields. This method is suitable for areas with favorable environmental conditions during the sowing period. On the other hand, greenhouse or screenhouse are best for sowing rootstocks. Seeds are sown in protrays (multi-cell containers) or trays, containers, or raised beds within controlled environments, such as greenhouses or screenhouses. This method allows for better management of temperature, humidity, and light conditions, resulting in higher germination rates and healthier seedlings.

Picture 2: Rough lemon seedlings in individual protray cells.

Transplanting of saplings

Once the rootstock seedlings have reached a suitable height, typically 10-12 cm, they are transplanted into larger containers or polybags or plastic citri pots. Citri pots are light weight plastic pots, generally the citrus tree pot is 34 cm in height and 10 cm in width. These tree pots are perfect for propagating saplings. During transplantation, it is essential to select healthy, single-stemmed, and vigorous seedlings. The tap root should be trimmed to encourage the development of a fibrous root system. After transplanting, the soil around the seedling should be firmly pressed to eliminate air pockets and support root and plant growth.

Propagation Techniques

Propagation techniques play a crucial role in the production of citrus nursery plants. The selection of high-quality bud wood and the proper execution of budding or grafting methods are essential for obtaining true-to-type and healthy plants. One of the most widely used techniques in citrus propagation is T-budding, which involves the insertion of a bud from the desired scion cultivar onto a rootstock seedling. Additionally, bud forcing techniques are employed to induce early bud break and promote faster scion growth, thereby reducing the overall nursery production time.

T-budding and bud forcing

T-budding is the most commonly used technique for citrus propagation due to its higher success rate. Firstly, remove all the sprouts, leaves and thorns on the stem of the rootstock up to just below the point of operation site. Further step is making a vertical T-shaped cut on the bark of the rootstock seedling, approximately 1.5-2.0 cm in long made on pencil thickness rootstock 15- 20 cm from ground level. Next move is making another cut above the vertical cut. Then the flap of bark is lifted carefully without injuring the tissue below, by blunt end of the budding knife. Then a shield-shaped bud of suitable size about 2.5 cm with or without a slice of wood from the scion cultivar is inserted beneath the bark of the rootstock with the bud facing upwards. Then the bud is tightly wrapped with budding tape or suitable wrapping material like alkathene sheet above and below the bud, exposing the bud and petiole stub. Make sure the wrapping should be tight, but at the same time it should not press or girdle the bud. After 3-4 weeks, the bud union should be checked for successful grafting. If the bud appears green, it indicates a successful union, and the budding tape can be removed. Once the scion growth has reached approximately 6 cm above the union, the top portion of the rootstock seedling can be pruned.

Picture 3: T-budding method for citrus propagation

A.  B. 

Moreover, bud forcing is a method used in citrus nurseries to speed up scion growth and reduce production time. Two main techniques are cutting and bending. Cutting involves removing the rootstock shoot above the bud union, which stimulates bud growth but can limit nutrient supply. Bending disrupts apical dominance by tucking down the rootstock foliage from above the bud union to the base of the plant, allowing continued nutrient flow to roots and scion. Lopping is another option, where the rootstock is partially cut and bent after bud union forms. The choice of method affects plant growth and nursery efficiency. Proper timing and execution of these techniques help early production of quality citrus plants

C. 

Picture3: Bud forcing technique through A. Cutting, B. Lopping and C. Bending

Irrigation of Transplanted Rootstock and Grafted Trees in Citrus Pots

For the production of nursery trees in citri pots, drip irrigation using drippers with multiple outlets connected to microtubes is the most common method. This system is simple to operate and maintain, and it can have one emitter with one or multi-outlet small tubes to route water from the emitter to the trees. In addition, drip irrigation is becoming popular in water scarce areas. This method of irrigation improves fruit yield, uniformity and quality of fruits. Punjab Agricultural University, Ludhiana has developed irrigation schedule as per different growth stages. Thus, irrigation during critical stages results in the maximization of crop yield as well as water use efficiency. Excessive irrigation is detrimental to the citrus as it may lead to the citrus foot and root rot, a very serious fungal disease caused by *Phytophthora spp.*. Water logged conditions around the sapling should be avoided.

To encapsulate, by employing proper bud wood selection, budding techniques, bud forcing and irrigation methods nursery growers can produce high-quality citrus nursery plants in a timely and efficient manner, contributing to the overall success of the citrus industry.

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SIMPLE TEST FOR DETECTION OF ADULTERATION IN HONEY

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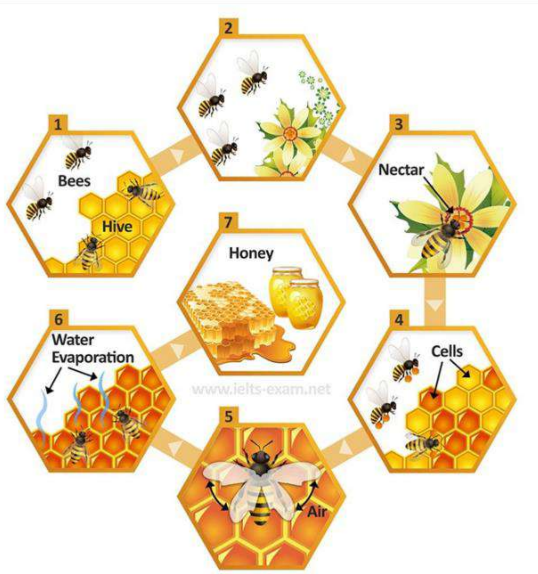
Introduction

Honey is the natural sweet substance produced by honeybees from the nectar of plants or from the secretions of living parts of the plants or excretions of plant sucking insects on the living parts of the plants, that bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature. This valuable commercial food product that is frequently targeted for adulteration. Adulteration can occur through two main methods: direct and indirect. Direct adulteration involves adding substances directly to the honey, while indirect adulteration happens when honeybees are fed adulterating substances. The substances used for adulteration are categorized as C3 or C4 plants based on their carbon metabolism. C3 plants include beet, wheat, and rice, while sugarcane and maize belong to C4 plants. Irresponsible beekeepers may engage in indirect adulteration processes, such as overusing veterinary drugs, harvesting honey before maturity, and overfeeding honeybees with sucrose or other sugars. These practices often result from the pressure of a competitive market. Direct honey adulteration can be classified into four main issues: addition of sugar, controlling water content, improper processing, and misrepresenting the honey's origin. (Jaafar et al., 2020). The analysis of honey purity is crucial due to the increasing prevalence of adulteration in the honey industry. Adulteration can be direct, where substances are added to honey, or indirect, where honeybees are fed adulterating substances. Adulterants like rice syrup and sugars from C3 plants (e.g., rice, wheat, and beet) are commonly used for honey adulteration.



The simple test purity tests for honey

Water Test:

- The Food Safety and Standards Authority of India (FSSAI) proposes a simple water test to assess the potential adulteration of honey.
- The procedure involves pouring warm water into a glass and adding a spoonful of honey to it.
- The observation entails two outcomes: if the honey settles entirely to the bottom of the glass, it is likely to be unadulterated; however, if the honey dissolves in water, it is considered impure. Honey's consistency and composition inherently prevent easy dissolution in water.
- Consequently, pure honey should exhibit limited solubility in water. Adulteration with sugar may lead to the formation of a solution when honey is mixed with water.

Flame Test:

- Dry matchsticks were chosen for consistent ignition properties and dipped into each honey sample. Subsequently, the honeyed matchsticks sre struck against the matchbox's striking surface.
- If the matchstick ignited, it indicated pure honey, while failure to ignite suggested moisture content and potential adulteration.

Thumb Test:

- The assessment of honey purity relies on its expected thick consistency.
- A small amount of honey was placed on the thumb, and its texture was observed.
- If the honey spilled, spread around, or exhibited a runny consistency, it indicates impurity. Unadulterated honey is expected to stick to the surface it is applied to without dripping, demonstrating its characteristic thick and cohesive nature.
- This simple and practical test serves as an indicator of honey purity and aids in identifying potential adulteration.

Heat Test: A small quantity of honey is heated in a controlled environment.

- Pure honey is expected to caramelize easily, forming a smooth and consistent texture.
- In contrast, impure honey, containing added moisture, water, and sugar, did not readily caramelize and instead bubbles when heated.

Blot Test:

- A small drop of honey is placed on a tissue paper or paper towel.
- The observation involved checking whether the honey drop was absorbed by the paper or left a watermark.
- Pure honey, being dense and viscous, does not get absorbed by the paper towel or leave a watermark. However, honey diluted with water or most sugar syrups would also exhibit a non-absorbent behavior.

pH Test:

- The pH test is performed to determine the acidity of honey, which influences its stability and texture.
- A sample consisting of 10g of honey was dissolved in 75ml of distilled water to create a honey-water solution.
- The pH of the solution is measured using a pH meter, which provided an accurate reading of the acidity level.
- The ideal pH value for honey is expected to fall within the range of 3.4 to 6.1, indicating its acidic nature due to the presence of organic acids that protect it from microbial spoilage.

Electrical Conductivity:

- A honey sample is prepared and dissolved in distilled water to create a honey-water solution. The electrical conductivity of the solution was measured using a suitable EC meter.

- The EC value of honey is influenced by its ash and acid content, with higher content leading to increased conductivity.

Ideally, the EC value for authentic honey should fall within the range of 0.13 to 0.56 mS/cm.

Optical density:

- The honey samples were first prepared by diluting them with distilled water to ensure that they fell within the linear range of the spectrophotometer.
- The spectrophotometer measured the absorbance of light at a specific wavelength as it passed through the honey sample.
- The optical density, represented by the absorbance value, provided insights into the concentration of certain components in the honey, such as antioxidants or other light-absorbing compounds.
- Optical density is used to assess mainly the color of honey as well as its freshness.
- The fermentation of honey after it is stored for too long may cause the optical density to increase, causing its color to get darker.

Water white - 0.08 Extra white - 0.11 White - 0.12, Extra light amber -0.33, Light amber - 0.55, Amber - 0.73

Fiehe Test:

- Commercial invert sugar is added to honey for adulteration and it can be checked with the help of **Fiehe test**. Add 5 ml of ether to equal amount of honey to be tested and shake the mixture well. Remove the ether and let the remaining mixture evaporate at room temperature. To this add 3 ml of resorcinol which completes the test.

- If the honey contains invert sugar then the acid layer would turn pink at first and cherry red in about 20 minutes.
- But this does not happen in case of pure honey.

Iodine Test:

- Another addition to pure honey comes in form of glucose, which can be tested with the help of **iodine test**.
- For the iodine test the sample honey must be diluted with equal amount of water.
- To this a solution made of 50 ml water, 3 gm potassium and 1 gm iodine must be added. Presence of additional glucose would turn the mixture red or violet but the pure honey 0would remain unchanged.

WATER TEST


Adulterated Honey Pure Honey

FLAME TEST


Pure Honey Adulterated Honey

THUMB TEST

Adulterated Honey Pure Honey

BLOT TEST

Pure Honey Adulterated Honey

Aniline Chloride Test:

- Aniline chloride test which detects the presence of commercial sugar in honey.
- The compound Aniline chloride is formed when hydrochloric acid and aniline are mixed in 3:1 ratio.
- When this solution is added to the sample honey, the crimson red color or the orange color tells that the honey is adulterated.

Starch or Flour Test:

- Starch or flour is added to honey for a simple reason, to increase the weight and whiteness of it. One can add cold water to sample honey and thus be sure whether it is free from flour and starch or not.
- If they are present in honey then honey falls down to the bottom of the vessel.
- When they are exposed to heat they obviously remain in the liquid form, but upon cooling down they turn hard.

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NEMATODE INTERACTION WITH MICROORGANISMS

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Introduction

Nematode is a member of the *Nematoda* phylum. There are nematodes in the sea as well as on land. Ten percent of the approximately 20,000 species of nematodes that are known are plant parasitic nematodes (PPN). Because they feed on plant components, nematodes known as Plant Parasitic Nematodes (PPN) are common in agricultural soils. In their life cycles, nematodes go through three stages: eggs, juveniles, and adults. Globally, yield losses due to nematodes are estimated to occur between 5 and 10% annually.

1. Bacteria - Nematode Interaction

Nematodes and bacteria associate the plants causing diseases with the nematodes. In PPN, the primary pathogen promotes the development of secondary pathogens. Such as bacteria, which otherwise cannot infect plants under normal conditions. Primary pathogens induce changes in host organisms that lead to a synergetic relationship in disease development. While secondary pathogens actively participate and change the causes of pathogenesis.

S. No.	Nematode	Bacteria	Host	Diseases
1.	*Aphelenchoides fragariae*	*Xanthomonas begoniae*	Rose	Hairy root
2.	*Meloidogyne sp.*	*Pseudomonas caryophylli*	Carnation	Vascular wilt

3.	*Aphelenchoides ritzemabosi*	*Rhodococcus faciens*	Strawberry	Cauliflower disease
4.	*Criconemella xenoplax*	*Pseudomonas syringae*	Peach	Crown gall
5.	*Meloidogyne javanica*	*Pseudomonas marginata*	Gladiolus	Scab

Bacterial biocontrol of nematode:

Bacterial species such as *Pasteuria penetrans* destroy nematodes due to their parasitic behaviour. While non-parasitic rhizobacteria reduce the nematode population by colonising the rhizosphere of the host plant.

Bacillus subtilis is able to control *Meloidogyne incognita* and reduce *Fusarium oxysporum* on the okra plant. In addition to having a beneficial effect on yield. *Bacillus subtilis* produces biofilm around plant roots to protect against bacteria and nematodes. This defence is also due to the secretion of antimicrobial compounds and the systematic resistance of plant responses.

2. Fungal - Nematode interaction:

As an alternative, fungi can exchange chemical signals with one another. Indeed, fungi release volatile organic compounds, which are chemical signals released by organisms.

It has been demonstrated that plants can reveal nematode and fungal interactions.

S. No.	Nematode	Fungus	Host	Diseases
1.	*Meloidogyne incognita*	*Rhizoctonia solani*	Tomato	Vascular wilt
2.	*Radopholus similis*	*Fusarium oxysporum f.sp. cubense*	Banana	Vascular wilt
3.	*Meloidogyne sp.*	*Fusarium oxysporum f.sp. dianthi*	Carnation	Vascular wilt

Antagonistic fungi:

Fungal antagonist of nematodes are

a. Nematode-trapping fungi,

b. Predaceous fungi,

c. Endoparasitic fungi.

a. Nematode-trapping fungi:

The fungi produce an extensive hyphal network, cap and contractile ring as traps to catch and hold the nematode.

Trapping fungi are *Arthrobotrys dactyloides* and *Arthrobotrys superba.*

b. Predaceous fungi:

The hyphae cover the exterior of the colonized nematode as a result of the mycelium's proliferation within its body, which leads to the creation of a penetration peg. The impact of *Arthrobotrys oligospora* on *Meloidogyne javanica* in tomato cultivars. The fungus uses a unique technique to penetrate the cuticle of nematodes via penetrating tubes.

c. Endoparasitic fungi:

Obligate parasites that exist as conidia in the environment and infect nematodes either by sticking to the surface of prey or directly consuming nematodes which grow or kill nematodes.

E.g.: *Harposporium, Drechmeria coniospora, Pochonia chlamydosporia.*

3. Virus - Nematode interaction:

These nematodes, *Longidorus* and *Trichodorus*, transmit the virus to genus NEPO virus and TOBRA virus. These nematodes are ectoparasites that feed on the outside of the root and use an extensible continent to price the root tip or cell behind it.

NEPO virus and TOBRA virus particles can be acquired from both young and adult vector nematodes, which can store the virus for a long time.

E.g.: The species of *Pachyderms* nematodes could transmit the virus TOBRA (Tabacco Rattle virus) after two years of cold storage in soil.

NEPO VIRUS

S. No.	Nematodes	Virus	Host
1.	*Xiphinema incognitum*	Ring Spot virus	Tomato
2.	*Longidorus elongates*	Raspberry ring spot	Raspberry
3.	*Xiphinema index*	Grape fan leaf virus	Grapes

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ROLE OF GAMMA AMINO BUTYRIC ACID (GABA) IN HUMAN HEALTH

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Abstract

GABA (γ-aminobutyric acid) is a nonprotein amino acid and naturally occurs in microorganisms, plants, and animals. In mammalian central nervous system, GABA is present in about 25%–50% of neurons as a chief inhibitory neurotransmitter. GABA improves plasma concentration, growth hormones, and protein synthesis in the brain. The lower GABA content is associated with several psychiatric and neurological disorders, including anxiety, pain, depression, insomnia, and epilepsy. Also GABA having hypotensive, tranquilizing, diuretic, and antidiabetic effects, it regulates lipid levels in serum, inhibits cancer cell proliferation, and improves memory and the learning abilities.Due to beneficial effects of GABA for human health, demand of GABA has increased, nowadays; it is classified as a bioactive component and used considerably in foods and pharmaceuticals. The synthetic GABA have significant side effects like drowsiness and dizziness to addiction, whereas natural GABA supplementation is nearly without side effects. In this article, general account of GABA, health benefits are discussed in detail.

Introduction

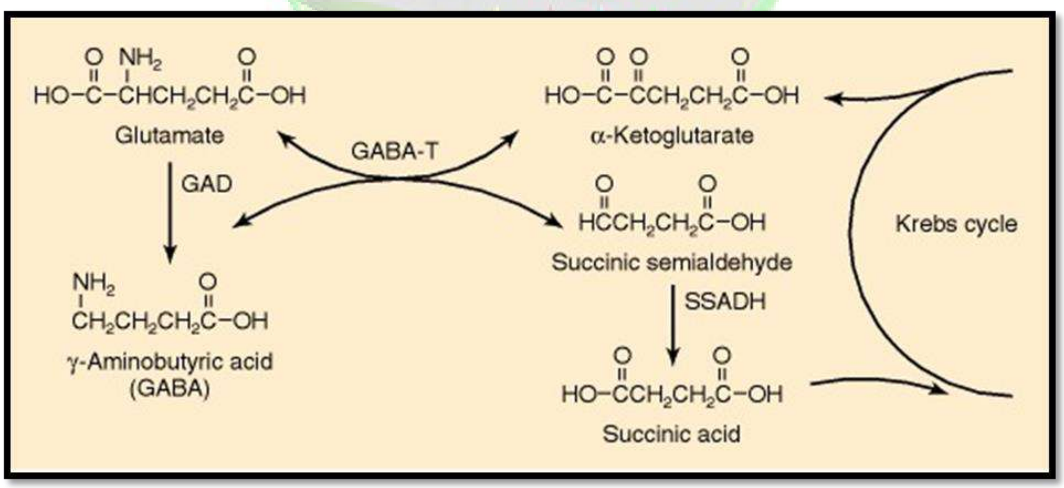
GABA (γ-aminobutyric acid), a nonprotein amino acid, is widely distributed among prokaryotes as well as eukaryotes. It is a four-carbon molecule present in every plant and part of the plant studied. GABA is synthesized prominently via GABA shunt. From Krebs cycle, glucose metabolized with α-ketoglutarate and transaminated by α-oxoglutarate transaminase (GABA-T) to form glutamate. Further, glutamate is decarboxylated by glutamate decarboxylase (GAD) to form GABA.

Initially, it was discovered in plants (potato tuber) and later the attention was shifted to animals where it was first identified in the brain Subsequently, GABA was found playing a major role as a neurotransmitter in the mammalian brains. Research gained further momentum in plants, when it was found that GABA concentration increases under abiotic stress. The omnipresence of GABA can be established by the fact that GABA has been found in higher plants lower plants ,vertebrates, several invertebrates, as well as in bacteria.

GABA is an important part of the free amino acid pool in prokaryotes as well as eukaryotes. The enzymes of GABA metabolism are highly conserved .In animal brain cells, GABA is present in high concentration, which is approximately 1000 times more than any other neurotransmitter in the same region. Interestingly in plants, rapid elevation of GABA has been observed under abiotic stress conditions. Various traditional foods produced through microbial fermentation having GABA content are safe and eco-friendly. The productions of GABA by living organisms (plants and microorganisms) can fulfill the demand with GABA-enriched health beneficial foods.

GABA Biosynthesis in Plants, Animals, and Microbes

In general, GABA is synthesized *in-vivo* by a metabolic pathway known as GABA shunt, which was first reported in plants. GABA shunt serves for synthesis as well as maintenance of optimum GABA levels.



(Source : George J Siegel *et al*., 1999).

Fig1. GABA shunt reactions are responsible for the synthesis, conservation and metabolism of GABA. GABA-T, GABA α-oxoglutarate transaminase; GAD, glutamic acid decarboxylase; SSADH, Succinic Semialdehyde Dehydrogenase

It consists of three key reactions catalyzed by cytosolic enzyme glutamate decarboxylaseand mitochondrial enzymes GABA-T and Succinic semialdehyde dehydrogenase (SSADH). Initially, GAD (Glutamate Decarboxylase) catalyzes α-decarboxylation of glutamate to GABA in an irreversible reaction.

Catabolism of GABA

In general, GABA is mainly catabolized into succinate by GABA-T and SSADH(Succinic semialdehyde)which then moves to TCA cycle for further metabolism. In plants, SSA can be catabolized to succinate simultaneously with the production of NADH in mitochondria. Alternately, γ-hydroxybutyrate (GHB) is produced by the action of SSA reductase activity SSADH activity is highly sensitive to the energy status in mitochondria. Therefore, stressful conditions inhibit SSADH activity as NAD^+.

Applications of GABA for Human Health

GABA has been associated with several physiological functions in human as well as in other vertebrates, such as strengthening of blood vessels, insulin secretion modulation, increased blood cholesterol prevention, mitigating emotional unrest, an improvement from stroke, liver and kidney functions' improvement, and guard against chronic alcohol-related diseases. An excitatory GABAergic system in the epithelium of airway was found to be activated in the presence of allergens.

GABA is involved in several disease states:

- Pyridoxine deficiency is a rare disease in which the vitamin is not available for the synthesis of GABA. It usually presents as frequent seizures during infancy that are resistant to treatment with anticonvulsants but responds very well to vitamin supplementation.
- The clinical features of hepatic encephalopathy are thought to be due to elevated ammonia levels binding to the GABA-A/GABA complex and increasing chloride ion permeability.
- The symptoms of Huntington disease are partially caused by a lack of GABA in the striatal projections to the globus pallidus.
- Dystonia and spasticity are believed to be related to a deficiency in GABA signaling

Dietary GABA and potential mechanism of action

While GABA is very active in the brain, there is still some debate as to whether dietary sources of GABA cross the blood brain barrier. Even so, there is mounting evidence that GABA interacts indirectly with the brain via the enteric nervous system (ENS). The ENS, often called the second brain, is the network of nerve cells that govern the GI tract, and there is significant communication between this and the brain via the vagal nerve. Dietary GABA binds receptors on nerve cells in the ENS which then pass signals along the vagus nerve to the brain. (Boonstra *et al.* 2015).

Dietary GABA may be available in some foods such as spinach, although the Concentrations are very small. GABA may also be synthetically manufactured or produced naturally by lactic acid bacteria fermentation (Cui *et al.* 2020). This latter source has been reported to be more effective than synthetic GABA in an unpublished human clinical trial conducted by the manufacturer of Pharma GABA. It is possible that this is due to a specific isomer of GABA that is produced by the Lactobacillus but cannot be made through the synthetic route. The improved Lactobacillus-derived GABA efficacy agrees with results of mouse studies wherein the feeding of Lactobacillus strains increased GABA content in the ENS, reduced anxiety, and modulated GABA receptor expression in neurons. Anxiety/Stress/Mental Health. In people afraid of heights, taking 100 mg of GABA reduced stress during a crossing of a 177 ft. tall suspension bridge. In brain wave tests, GABA increased brain alpha waves and decreased beta waves within 60 minutes. GABA’s effect was better than L-theanine, another well-studied anti anxiety supplement. Alpha waves occur when a person is alert and relaxed. Beta waves are seen in situations of high stress where concentration and focus is difficult. These two studies reveal that GABA was able to induce relaxation and reduce anxiety (Abdou *et al*. 2006).Within 30 minutes of drinking a GABA-fortified oolong tea (a 2.01 mg dose), young adults experienced improved heart rate variability and reduced stress scores when compared to those who drank an unfortified tea (Hinton *et al.* 2019).

In a placebo controlled clinical trial, 63 adults were given 100 mg GABA or aplacebo. Each person then participated in stress-inducing mental tasks while brain wave activity was simultaneously measured. A half-hour after intake of GABA of placebo, brain activity measurements revealed a reduction in stress in the GABA group when compared to the placebo group (Yoto *et al.* 2012).In autistic children, GABA fortified tea (279 mg/100g) improved manual dexterity, balance, sensory response, mental health symptoms and cortisol levels. These benefits were observed in a double-blind trial with a daily intake of 39.2 mg GABA for two weeks (Hannant *et al.* 2019).Consuming 30 mg GABA with a meal following an overnight fast, vs. placebo, increased autonomic nervous system and parasympathetic nervous system activity within 60 minutes in young healthy male adults within 60 minutes (Fujibayashi *et al*. 2008).In a double-blind test, defatted rice germ was infused with GABA or a placebo was fed to 20 menopausal or presenile women three times per day for 16 weeks. The daily combined GABA dose was 26.4 mg. GABA ingestion improved symptoms in 65% of the patients suffering from insomnia, other sleep disorders and depression. GABA also significantly improved headaches, joint/muscle aches, vasomotor neuropathy, nervousness, digestive symptoms and dizziness. GABA had no negative effects on liver function, kidney function, or blood chemistry (Okada *et al.* 2000)

Cognitive Function

Thirty young adults were given 800 mg GABA or a placebo in a double-blind clinical trial designed to evaluate effect on reaction times and responses to “go”, “stop” and “change” commands given by auditory and visual stimuli. GABA improved reaction time when two commands were given simultaneously (Steenbergen *et al.* 2015). Young adults that were given 800 mg GABA were better able to pay attention over time to the various visual stimuli that were being presented on a computer screen, when compared to those who were given a placebo (Leonte *et al.* 2018). A seaweed, Laminaria japonica,was fermented to increase its GABA content to 54.5 mg/g. The effects of this product on short-term memory and blood markers of inflammation and antioxidant activity, fitness and body composition were evaluated in a placebo controlled clinical trial involving 40 senior citizens. Eating 1.5 grams of the fermented seaweed (equivalent to 81.75 mg GABA) every day for 6 weeks improved score in five neuropsychological tests that are used to measure short-term memory. It also increased antioxidant enzyme activity and reduced the amount of oxidative damage that occurred to lipids and DNA. Improved fitness was also evident in those given the fermented seaweed. This GABA enriched seaweed may protect against cognitive degeneration associated with dementia via antioxidant mechanisms (Reid *et al.* 2018)

Pain reduction

A GABA oral rinse (5 mg/mL) reduced pain that was caused by placing capsaicin on the tongue. The effect was similar to a lidocaine solution (Zhang *et al.* 2018).

GABA and Stress

A study by Hinton *et al.* (2019) investigating the acute effects of GABA Oolong consumption on stress demonstrated that in both (low and high) stress groups, both GABA Oolong tea (2.01 mg GABA/200 ml tea) and standard Oolong tea (0.25 mg GABA/200 ml tea) increased average RR interval (the time between two consecutive R waves in the electrocardiogram). However, GABA Oolong had a greater influence on heart rate variability (HRV), eliciting a bigger change in RR interval in high compared to low stressed individuals. The effects of GABA on other HRV parameters and subjective stress were not significant. Another study by Yoshida *et al.* (2015) showed that 8 weeks consumption of GABA rice (16.8 mg GABA in 150 g GABA rice/day) improved subjective calmness and worry scores midway through the study at the 4th week of the treatment compared to white rice (4.1 mg GABA in 150 g GABA rice/day), however, these effects were not maintained. They also reported trends for reduced blood cortisol and increased adiponectin levels in GABA rice (vs. white rice) condition at the 8th week of the treatment. However, they did not observe any effects on adrenocorticotropic hormone (ACTH) at any stage of the intervention

Conclusions

Gamma-aminobutyric acid (GABA) plays a crucial role in the central nervous system as an inhibitory neurotransmitter. Imbalances of this neurotransmitter are associated with neurological diseases, such as Alzheimer’s and Parkinson’s disease, and psychological disorders, including anxiety, depression, and stress. However, emerging evidence has demonstrated that changes in both circulating and brain levels of GABA are associated with changes in gut microbiota composition and that changes in GABA levels and microbiota composition play a role in modulating mental health.

References

George J Siegel, MD, Editor-in-Chief, Bernard W Agranoff, MD, R Wayne Albers, Stephen K Fisher, and Michael D Uhler.1999. Basic Neurochemistry, 6th edition Molecular, Cellular and Medical Aspects . American Society for Neurochemistry ISBN-10: 0-397-51820-X.

Boonstra Evert, Roy de Kleijn , Lorenza S Colzato , Anneke Alkemade , Birte U Forstmann , Sander Nieuwenhuis . Front Psychol. 2015 Oct 6:6:1520. doi: 10.3389/fpsyg.2015.01520. eCollection 2015.

.Cui Yanhua, Kai Miao , Siripitakyotin Niyaphorn , Xiaojun Qu . 2020.Production of Gamma-Aminobutyric Acid from Lactic Acid Bacteria: A Systematic Review. Int J Mol Sci . 2020 Feb 3;21(3):995. doi: 10.3390/ijms21030995

Reid M.A., Salibi N., White D.M., Gawne T.J., Denney T.S., Lahti A.C. 2018.7T proton magnetic resonance spectroscopy of the anterior cingulate cortex in first-episode schizophrenia. *Schizophr. Bull.* 45(1):180–189.

Zhuang Kejin,Yujun Jiang , Xiaohan Feng, Li Li, Fangfang Dang, Wei Zhang, Chaoxin Man .2018. Transcriptomic response to GABA-producing *Lactobacillus plantarum* CGMCC 1.2437^{T} induced by L-MSG. https://doi.org/10.1371/journal.pone.0199021.

.Hinton Tina, Herbert F.Jelinek, Vincent Viengkhou Graham.A.Johnson Slade Matthews .2019. Effect of GABA –Fortified Oolong Tea on Reducing stress in a University Student Cohort.Front. Nutr.Sec. Neuronergetics and Brain Health.6. https://doi.org/10.3389/fnut.2019.00027

Yoshida S., Haramoto M., Fukuda T., Mizuno H., Tanaka A., Nishimura M., et al. (2015). Optimization of a γ-aminobutyric acid (GABA) enrichment process for hokkaido white rice and the effects of GABA-enriched white rice on stress relief in humans. *Nippon Shokuhin Kagaku Kogaku Kaishi* 62, 95–103. 10.3136/nskkk.62.95

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FLAVONOIDS AS DEFENCE COMPOUNDS AGAINST PLANT PARASITIC NEMATODES

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Introduction

Flavonoids constitute a large class of secondary carbon-based metabolites present in all terrestrial plants. More than 10,000 different types of flavonoids have been described from avariety of plant species. Flavonoids are a class of plant secondary metabolites. Chemically, it's have the general structure of a 15-carbon skeleton, which consists of two phenyl rings and a heterocyclic ring. This carbon structure can be abbreviated C6-C3-C6. There areseveral flavonoid subgroups based on their structural properties, including the chalcones, flavones, flavonols, flavandiols, anthocyanins, condensed tannins, aurones, isoflavonoids and pterocarpans.

Flavonoids within the subgroups are extensively modifiedthrough secondary modifications of the backbone, for example by hydroxylation, glycosylation, methylation, malonylation, prenylation, acylation, dehydration and polymerization. The functions of individual flavonoids are strongly affected by their structure and include roles in plant development via the control of auxin transport, flower pigmentation as antioxidants (ROS scavengers), as defence compounds,chemoattractants, signals for plant–microbe interactions (notably nodulation), male fertilityin some species and help in nutrient mining. Here, the article focuses on the rolesof flavonoids as defence compounds and as developmental regulators during feeding site formation by plant parasitic nematodes.

Flavonoids as Defense Compounds against Nematodes

Plant parasitic nematodes (PPN) will first encounter flavonoids in the soil when it is locating its host.This can occur whilst the PPN is in the egg or juvenile stage. For PPNs in the egg stages, flavonoids can inhibit egg hatching (Figure 1), as for juvenile PPNs, flavonoids can: (1) induce quiescence by slowing down their movement,resulting in periods of reversible inactivity; (2) modify their migration towards the roots by repelling them; (3) kill them.

For example, the flavonols kaempferol, quercetin, and myricetin repelled and slowed *M. incognita* juveniles at micro molar concentrations. Patuletin, patulitrin, quercetin, and rutin were shown to kill the juveniles of *H. Zeae* at various concentrations and durations of exposure. .

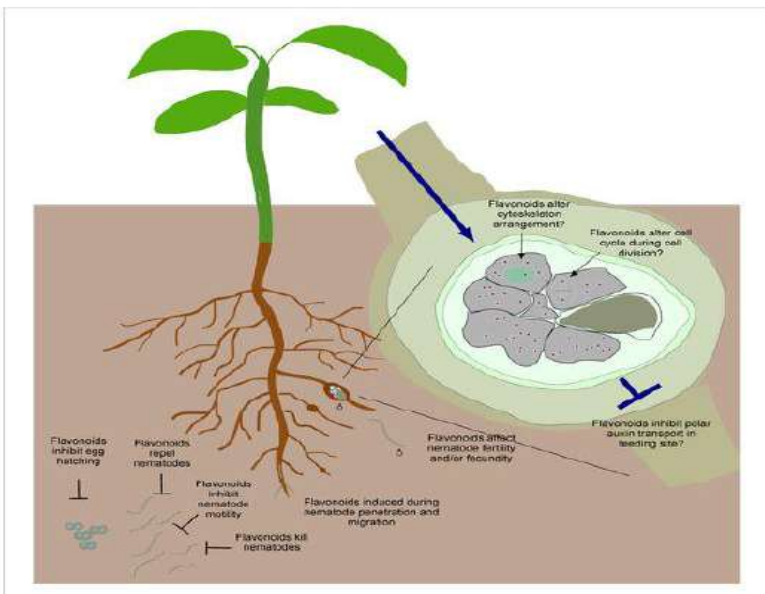

Fig 1 Role of Flavonoids during plant–nematode interactions

Courtesy: https://www.mdpi.com/2223-7747/7/4/85/htm

Flavonoid effects on PPNs are also species-specific. Using similar concentrations of flavonols, kaempferol, quercetin, and myricetin repelled *M. incognita* and *R. Similis* juveniles, but not *Pratylenchus penetrans*, whereas the flavonols inhibited the motility of *M. Incognita* juveniles but not *R. Similis* and *P. Pratylenchus* juveniles

The differences in flavonoid effects in different nematode species is likely due to the differences in chemosensory receptors, flavonoid receptor binding affinities, cell signalling cascade, and solute permeability across the cuticle in different species, although this has not been studied yet. Furthermore, not much is known about the existence or functions of putative flavonoid receptors in any PPN.

Once the PPN has reached the plant, it inflicts mechanical damage to the plant tissue to penetrate and/or to feed on the tissue. This is followed by the production and release of defence compounds (i.e., phytoalexins and phytoanticipins) to respond to PPN attack (Figure 1). Although some flavonoids such as (*E*)-chalcone, patuletin, and rutin killed pre parasitic stages of cyst nematodes (Faizi *et al*., 2011; Gonzalez and Estevez-Braun, 1998), their accumulation, concentrations, and activity in planta is unclarified. In addition, numerous studies have found increased flavonoid gene expression and flavonoid accumulation at infections sites of both endo and ectoparasitic PPNs, and induction of flavonoids has repeatedly been found to be higher in resistant compared with susceptible host cultivars. Flavonoids that have most commonly been implicated as defense compounds against PPNs mostly belong to the iso flavonoids and pterocarpan classes, (e.g., coumesterol, glyceollin (soybean specific), formononetin, and medicarpin) as well as the flavonols (e.g., kaempferol and quercetin).

Conclusion

Flavonoids in the rhizosphere can have effects on the pre-parasitic stages by inhibiting egg hatching, repelling hatched nematodes, inhibiting their movement and by killing them. Synthesis of flavonoids is induced when the nematodes penetrate and migrate inside the root; they can act as defence compounds or signals for defence via cross-talk with other defence/stress pathways. Flavonoids can affect adult stages of nematodes by altering their fertility and/or fecundity. The role(s) of flavonoids in feeding site development is less understood. They are postulated to be involved in the inhibition of auxin transport, cell cycle regulation, and cell cytoskeleton rearrangement.

Reference

https://www.mdpi.com/2223-7747/7/4/85/htm.

Faizi, S.; Fayyaz, S.; Bano, S.; YawarIqbal, E.; Lubna; Siddiqi, H.; Naz, A. 2011. Isolation of nematicidal compounds from *Tagetespatula*L. yellow flowers: Structure–activity relationship studies against cyst nematode *Heteroderazeae*infective stage larvae. *J. Agric. Food Chem.*, *59*: 9080–9093.

González, J.A.; Estévez-Braun, A. 1998.Effect of (*E*)-Chalcone on Potato-Cyst Nematodes (*Globoderapallida*and *G. rostochiensis*).*J. Agric. Food Chem.*, *46*: 1163–1165.

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GENE DEPLOYMENT - CONCEPTS, STEPS INVOLVED AND BENEFITS IN AGRICULTURE PERSPECTIVES

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Introduction

Gene deployment refers to the strategic placement and use of resistance genes across a landscape or over time to manage and minimize the impact of pests and diseases. It involves the spatial and temporal management of genetic resources. This approach aims to optimize the effectiveness and longevity of resistance genes, reducing the risk of pathogens or pests overcoming these defenses.

Gene deployment strategies have proven successful in various crops and regions by enhancing the durability and effectiveness of resistance genes. Strategic spatial and temporal deployment, combined with continuous monitoring, adaptive management and integrated pest management practices, has led to significant benefits in agricultural productivity, sustainability and food security. These successes underscore the importance of thoughtful planning, stakeholder collaboration and ongoing research to adapt and refine deployment strategies in response to evolving pest and pathogen challenges.

Key concepts of gene deployment

1. **Spatial deployment:**

   Geographic Distribution**:** Different resistance genes or gene combinations are used in different geographic areas or fields to avoid uniform selection pressure on pests and pathogens.

   Mosaic Planting: Planting varieties with different resistance genes in adjacent fields or within the same field in a mosaic pattern to disrupt the uniform selection pressure on pathogens or pests.

Benefits:

- Reduces the uniform selection pressure on pathogens, making it harder for them to overcome resistance.
- Limits the spread of any pathogen strain that overcomes one type of resistance gene.

2. **Temporal deployment:**
    - Rotational Deployment: Alternating the use of different resistance genes over time, either by rotating crops or by using different varieties with distinct resistance genes in different seasons.
    - Sequential Deployment: Introducing new resistance genes in a planned sequence to prolong the effectiveness of each gene.

Benefits:

- Delays the adaptation of pathogens and pests to resistance genes.
- Prolongs the effectiveness of each resistance gene.

3. **Dynamic deployment**

Continuously adapt and adjust deployment strategies based on monitoring and evolving pest and pathogen pressures.

Steps:

1. Monitoring: Regularly monitor pest and pathogen populations and resistance gene effectiveness.
2. Adaptation: Adjust spatial, temporal, and varietal deployment strategies based on monitoring data.
3. Research Integration: Integrate findings from ongoing research to refine deployment strategies.

Benefits:

- Ensures that deployment strategies remain effective in the face of changing pest and pathogen dynamics.
- Allows for rapid response to emerging threats.

4. **Gene mixtures and combinations:**
    - Varietal Mixtures: Planting mixtures of varieties with different resistance genes within the same field to reduce the risk of a pathogen overcoming all resistance genes simultaneously.

- Multiline Cultivars: Using cultivars that are a genetic composite of several lines, each with different resistance genes.

5. **Integrated pest management (IPM):**
   - Gene deployment is often part of broader IPM strategies, combining biological, cultural, mechanical, and chemical control methods to manage pests and diseases sustainably.

Steps in gene deployment

1. **Identification and Characterization**:
   - Identify and characterize resistance genes, understanding their mode of action and effectiveness against specific pathogens or pests.
2. **Strategic Planning**:
   - Develop a deployment strategy based on the local pest and disease pressures, cropping patterns, and environmental conditions.
3. **Implementation:**
   - Implement the deployment strategy through the distribution and use of resistant varieties according to the spatial and temporal plan.
4. **Monitoring and Evaluation**:
   - Continuously monitor the effectiveness of deployed genes and the emergence of new pathogen or pest strains.
   - Adjust deployment strategies based on monitoring data and evolving threats.

Applications of gene deployment

1. Disease Resistance:
   - Managing cereal rust diseases by deploying different resistance genes in wheat across various regions and seasons.
   - Using different bacterial blight resistance genes in rice in a spatial and temporal manner to manage disease pressure.
2. Pest Resistance:
   - Rotating Bt (*Bacillus thuringiensis*) crops with non-Bt crops and using different Bt genes to delay resistance development in insect populations.
3. Abiotic Stress Tolerance:

- Deploying drought-tolerant varieties in areas prone to water stress and alternating with varieties having other stress tolerances based on seasonal forecasts.

4. Epidemic Management:
   - Using resistant varieties strategically during outbreak years and rotating with susceptible varieties during years of low disease pressure to manage pathogen populations.

Benefits of gene deployment

- Extended Gene Lifespan: Delays the development of resistance in pathogens and pests, extending the useful life of resistance genes.
- Sustainable Agriculture: Reduces reliance on chemical controls, contributing to environmentally sustainable farming practices.
- Enhanced Crop Security: Provides a more stable and reliable defense against biotic stressors, improving crop yields and food security.

Challenges of gene deployment

- Complex Coordination: Requires coordination among farmers, researchers and policymakers to implement effectively.
- Monitoring and Adaptation: Continuous monitoring and adaptability are necessary to respond to changes in pest and pathogen populations.
- Resistance Evolution: Pathogens and pests may still evolve resistance over time, necessitating ongoing research and development of new resistance genes.

Case studies of successful gene deployment

The success of gene deployment strategies in agriculture can be measured by their ability to manage pest and disease resistance effectively, maintain crop yields and reduce reliance on chemical controls. Here are several case studies and examples that demonstrate the success of gene deployment:

1. **Wheat rust management in Australia:**
   - Strategy: Deployment of wheat varieties with different rust resistance genes across different regions and seasons.
   - Outcome: The strategic spatial and temporal deployment of rust-resistant varieties has significantly delayed the emergence of new rust strains. For instance, the use of

varieties like "Mace" with multiple resistance genes has provided long-term protection against various rust pathogens.

- Impact: Enhanced durability of rust resistance in wheat crops, reduced fungicide usage, and stabilized wheat production.

2. **Bt Cotton in India:**
    - Strategy: Spatial deployment of Bt cotton varieties carrying different Bt genes across cotton-growing regions, combined with non-Bt refuges.
    - Outcome: This approach has effectively controlled major pests like the cotton bollworm while delaying resistance development in pest populations.
    - Impact: Increased cotton yields, reduced pesticide applications and improved farmer incomes.
3. ***Phytophthora infestans* management in Potatoes (USA and Europe):**
    - Strategy: Use of potatoes with different combinations of resistance genes (R genes) against late blight in a spatial deployment strategy.
    - Outcome: Deployment of varieties like "Fortuna" and "Sarpo Mira," which carry multiple resistance genes, has led to sustainable management of late blight, reducing the incidence and severity of the disease .
    - Impact: Lowered reliance on fungicides, cost savings for farmers, and more stable potato yields.
4. **Rice blast management in Asia:**
    - Strategy: Temporal deployment of rice varieties with different blast resistance genes in different cropping seasons and regions.
    - Outcome: Rotational deployment of varieties with different resistance genes has reduced the adaptability of the rice blast fungus, leading to lower disease prevalence and improved yield stability.
    - Impact: Enhanced food security and reduced economic losses due to blast outbreaks.

Factors contributing to the success of gene deployment

1. Strategic planning: Effective gene deployment requires careful planning and coordination among researchers, extension services and farmers. Identifying the most effective spatial and temporal arrangements for deploying resistance genes is crucial.

2. Monitoring and adaptation: Continuous monitoring of pest and pathogen populations is essential to detect shifts in virulence and resistance. Adaptive management allows for timely adjustments to deployment strategies.
3. Integrated Pest Management (IPM): Combining gene deployment with other IPM practices, such as crop rotation, biological control, and the use of refuges, enhances the overall effectiveness and sustainability of pest and disease management.
4. Stakeholder collaboration: Successful gene deployment involves collaboration among various stakeholders, including researchers, farmers, extension agents, and policymakers. Ensuring that deployment strategies are communicated effectively and adopted widely enhances their success.

Benefits of successful gene deployment

1. Extended lifespan of resistance genes: By using different resistance genes strategically, gene deployment helps delay the breakdown of resistance, prolonging the effective lifespan of these genes.
2. Reduced reliance on chemical controls: Effective gene deployment reduces the need for chemical pesticides and fungicides, leading to cost savings and environmental benefits.
3. Stable yields and improved food security: By managing pests and diseases more sustainably, gene deployment contributes to stable crop yields and enhanced food security.
4. Environmental and health benefits: Lower pesticide usage results in reduced environmental contamination and improved health outcomes for farmers and consumers.

Differences and synergies of gene pyramiding and gene deployment

Gene pyramiding	Gene deployment
Differences	
Focuses on combining multiple genes within a single plant variety	Involves strategic use of resistance genes across time and space
Aims to create durable resistance in a single genotype	Aims to manage resistance at the population level of pests or pathogens
Requires advanced breeding techniques and detailed knowledge of resistance genes	Relies on spatial and temporal planning, often involving multiple stakeholders
Synergies	

Gene pyramiding can be complemented by gene deployment strategies to maximize the effectiveness of resistance genes	
Using pyramided varieties in a gene deployment framework can enhance the durability of resistance and reduce the likelihood of resistance breakdown	

Both gene pyramiding and gene deployment are crucial for sustainable crop production and effective pest and disease management. While gene pyramiding enhances the resistance of individual plants, gene deployment ensures that this resistance is managed effectively across agricultural landscapes to prolong its efficacy.

Conclusion

Gene deployment is a strategic approach to managing crop resistance by utilizing resistance genes in a spatial and temporal manner. This method helps prolong the effectiveness of resistance genes, reduces the risk of resistance development in pests and pathogens and supports sustainable agricultural practices. By integrating gene deployment with other pest and disease management strategies, farmers can achieve more resilient and productive cropping systems.

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GROWTH REVOLUTION: THE FUTURE OF FARMING ENTREPRENEURSHIP

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Abstract

Agricultural startups are revolutionizing the industry with innovative approaches. Precision agriculture utilizes technology like GPS and drones to optimize resource use and increase yields. Vertical farming and controlled environment agriculture address land scarcity and climate challenges by growing crops indoor. Agri-tech marketplaces connect farmers with suppliers and buyers online, enhancing efficiency and transparency. Farm-to-consumer direct sales meet consumer demand for locally sourced, organic food while promoting transparency. Robotics and automation are improving farm operations, reducing costs, and increasing productivity. These startups are reshaping farming by embracing technology, promoting sustainability and increasing resilience in the agricultural sector.

Keyword: Agricultural startups, Drones, GPS, Precision agriculture.

Introduction:

The Prime Minister Shri Narendra Modi's "Made in India" strategy intends to promote innovation, entrepreneurship, and investment, expand the nation's skill development. As Mahatma Gandhi correctly observed, "India lives in villages." The heart of Indian society is comprised of villages, which embody the true essence of India. Entrepreneurs in the rural sector of the economy who build industrial and business units are known as rural entrepreneurs.

The expansion and advancement of the rural economy is a crucial prerequisite for the national economy. The disparity between urban and rural areas Disparities ought to be reduced. The rural population's standard of living has to be raised because it is now inadequate. Considering the resources at hand, entrepreneurship in the rural sector could offer a solution to the aforementioned issues.

The Government of India's most recent definition states that "Any industry located in rural area, hamlet, or town with a population of 20,000 and less and An investment in plant and machinery of Rs. 3 crores is categorized as a village industry." In the field of entrepreneurship study, rural entrepreneurship is a relatively young sector. It is now one of the elements that promotes agribusiness and rural economic growth. The current study discusses the issues and obstacles to the growth of entrepreneurship in rural India against this backdrop.

Concept of Entrepreneurship

The Entrepreneurial Concept Being an entrepreneur involves initiating any kind of business venture in order to work for oneself. The activities of an entrepreneur is controlled by a different mix of socioeconomic, psychological, cultural, and other elements, such as caste or religion, family history, educational attainment, perception, professional background, character of migration, initiation into entrepreneurship, type of business, ability to invest, and ambition.

Entrepreneurship in Agriculture

Agriculture related Entrepreneurship Given the slow expansion of the agricultural sector and the rising unemployment rate in rural areas, it is essential to take advantage of the chances to foster agricultural entrepreneurship, which can then help solve the current issues with agricultural profitability and productivity. “A person or organization with the authority to use or exploit land or other associated resources needed to conduct mixed, agricultural or forestry operations is referred to as a "agricultural entrepreneur.” (Suarez, 1972)

Entrepreneurship research explores the reasons, timing, and methods behind individuals identification and exploitation of opportunities (**Shane & Venkataraman, 2000).** These exploited opportunities lead to the creation of new offerings that fuel market progression, including the growth of existing businesses, the initiation of new ventures or the instigation of entrepreneurial initiatives within established firms **(Davidsson, 2012).**

This article delves deep into the evolving landscape of agricultural startups, exploring emerging trends and the vast array of opportunities they present.

1**. *The Rise of Agricultural Startups*:** Traditionally characterized by age-old practices and slow adaptation to change, agriculture is now experiencing a surge of innovation and entrepreneurship. Agricultural startups, ranging from small-scale ventures to tech-driven enterprises are disrupting the status and reshaping the way to produce, distribute, and consume food. With a focus on sustainability, efficiency, and resilience, these startups are driving significant advancements across the agricultural value chain.

2***. Precision Agriculture:*** **Optimizing Resource Use:** Precision agriculture has emerged as a game-changer, enabling farmers to optimize resource use while maximizing productivity and minimizing environmental impact. Leveraging technologies such as GPS, Drones, Sensors, AI, startups in this space are providing farmers with real-time data and actionable insights on soil health, crop growth and weather patterns. By fine-tuning inputs such as water, fertilizers and pesticides, Precision agriculture startups empower farmers to make informed decisions, leading to higher yields and reduced costs.

3***. Vertical Farming and Controlled Environment Agriculture (CEA):*** Vertical farming, an innovative agricultural method, has become increasingly significant due to its ability to tackle critical issues in food production, resource management and sustainability. It is particularly highlighted for its role in enhancing food security, especially in densely populated urban regions, by minimizing food transportation distances and facilitating continuous crop cultivation throughout the year (**Sultan & El–Qassem, 2021).**

4. Revolutionizing Urban Agriculture: As urbanization accelerates and arable land becomes increasingly scarce, vertical farming and controlled environment agriculture (CEA) have emerged as innovative solutions to meet the growing demand for fresh produce. Startups in this space are leveraging indoor farming techniques, hydroponics and aeroponics to cultivate crops in vertically stacked layers or controlled environments. By optimizing growing conditions and minimizing resource usage, vertical farming startups are bringing agriculture closer to urban centers, reducing transportation emissions and enhancing food security

5. ***Agri-Tech Marketplaces:*** **Connecting Farmers with Solutions:** The digitization of agriculture has led to the proliferation of online platforms and marketplaces connecting farmers with suppliers and service providers. Agri-tech startups are leveraging technology to streamline agricultural transactions, offering e-commerce platforms, farm management software and market intelligence tools. By providing farmers with access to a wide range of products, services and information, these marketplaces enhance efficiency, transparency, and competitiveness in the agricultural value chain.

6. ***Farm-to-Consumer Direct Sales:*** Consumers are increasingly demanding locally sourced, organic, and sustainably produced food, driving the growth of farm-to-consumer startups. These startups enable farmers to bypass intermediaries and sell their products directly to consumers through online marketplaces, subscription services, or community-supported agriculture (CSA) models. By shortening the supply chain, F2C startups ensure fresher, healthier produce while providing farmers with better pricing and greater control over their sales channels, thereby promoting transparency, traceability, and consumer trust.

7. *Robotics and Automation: Enhancing Efficiency and Safety:* Advancements in robotics and automation are revolutionizing farm labor and operations, addressing labor shortages and increasing efficiency. Agricultural startups are developing autonomous drones, robots and robotic arms equipped with AI and machine learning algorithms to perform tasks such as planting, weeding, harvesting and sorting. By automating repetitive and labor-intensive processes, these technologies enable farmers to reduce costs, improve precision and enhance overall farm productivity, while also promoting safer working conditions and reducing reliance on chemical inputs.

8. ***Sustainable Agriculture and Agroecology:*** **Cultivating Resilience and Environmental Stewardship:** In response to growing environmental concerns and the need for regenerative farming practices, startups are focusing on sustainable agriculture and agroecology. These startups offer innovative solutions for soil health management, crop rotation, organic fertilization and biodiversity conservation. By promoting ecological balance, reducing chemical inputs and enhancing soil fertility, sustainable agriculture startups enable farmers to cultivate crops more resilient to climate change while preserving natural resources for future generations.

9*. Agri-Tech Marketplaces:* The digitization of agriculture has spawned the emergence of online platforms and marketplaces connecting farmers with suppliers, buyers, and service providers. Agri-tech startups are developing innovative solutions, including e-commerce platforms, farm management software, and market intelligence tools, to streamline agricultural transactions and foster collaboration within the agricultural ecosystem. By providing farmers with access to a wide range of products, services, and information, these marketplaces enhance efficiency, transparency, and competitiveness in the agricultural value chain.

10. *Farm-to-Consumer Direct Sales:* Consumer preferences for locally sourced, organic, and sustainably produced food have fueled the growth of farm-to-consumer (F_2C) startups. These startups enable farmers to bypass intermediaries and sell their products directly to consumers through online marketplaces, subscription services, or community-supported agriculture (CSA) models. By shortening the supply chain, F2C startups ensure fresher, healthier produce while providing farmers with better pricing and greater control over their sales channels, thereby promoting transparency, traceability, and consumer trust.

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Conclusion

In conclusion, the future of farming entrepreneurship heralds a growth revolution driven by innovative agricultural startups. By harnessing technology, promoting sustainability and enhancing resilience, these startups are reshaping the agricultural landscape. From precision agriculture to vertical farming and agri-tech marketplaces, each aspect contributes to a more efficient, transparent, and sustainable food system. As we embrace this future, it becomes evident that the entrepreneurial spirit combined with technological advancements will pave the way for a new era in farming. This growth revolution promises to not only meet the challenges of tomorrow but also unlock unprecedented opportunities for farmers and consumers alike.

References

Davidsson, P. (2012). The entrepreneurial process. In S. Carter & D. Jones-Evans (Eds.), Enterprise and small business, principles, practice and policy. Harlow: Pearson.

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. Academy of Management Review, 25(1), 217–226.

Sultan, S., & El–Qassem, A. (2021). Future prospects for sustainable agricultural development. *International Journal of Modern Agriculture and Environment*, *1*(2), 54-82.

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TOTIPOTENCY AND ITS IMPORTANCE IN AGRICULTURE PERSPECTIVE

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Introduction

Totipotency in the context of crop plants refers to the ability of plant cells to regenerate into whole plants under appropriate conditions. Totipotent cells are capable of giving rise to all cell types of an organism, including both embryonic and extraembryonic tissues (such as placental cells). These cells have the highest level of developmental plasticity and can generate a complete organism. This characteristic plays a significant role in various agricultural applications, including plant breeding, genetic engineering and propagation techniques. Here's how totipotency manifests in crop plants and its importance:

1. **Plant tissue culture:** Totipotency is exploited in plant tissue culture, a technique used to propagate plants from small tissue samples. By providing the right hormonal and environmental conditions, totipotent plant cells can be induced to form callus, an undifferentiated mass of cells, which can then regenerate into whole plants. This technique enables rapid propagation of elite plant varieties, preservation of germplasm and mass production of genetically identical plants.
2. **Genetic engineering:** Totipotency is essential in genetic engineering techniques aimed at introducing desired traits into crop plants. Using methods like *Agrobacterium* - mediated transformation or direct gene transfer, foreign genes can be introduced into totipotent plant cells. These cells can then regenerate into whole transgenic plants expressing the desired traits, such as pest resistance, herbicide tolerance, or improved nutritional content. Genetic

engineering has revolutionized crop improvement efforts by accelerating the development of novel varieties with enhanced agronomic traits.

3. **Somatic embryogenesis:** Totipotent cells can undergo somatic embryogenesis, a process where embryos develop from somatic (non-reproductive) cells. This technique is utilized for clonal propagation of crops, allowing the production of genetically identical plants with desirable characteristics. Somatic embryogenesis is particularly valuable for crops with recalcitrant seeds or low propagation rates through conventional means.
4. **Crop improvement:** Totipotency facilitates the development of new crop varieties through *in vitro* mutagenesis and selection techniques. Mutagenic agents can induce genetic variation in totipotent cells and plants regenerated from mutated cells can be screened for desirable traits, such as disease resistance, stress tolerance, or improved yield. This approach accelerates the breeding process by rapidly generating genetic diversity and identifying promising candidates for further evaluation.
5. **Germplasm preservation:** Totipotent cells are used in cryopreservation techniques to store plant germplasm under ultra-low temperatures. By cryopreserving totipotent tissues such as shoot tips, embryos, or callus cultures, the genetic diversity of crop species can be conserved for future use in breeding programs or research.
6. **Rapid Breeding:** Traditional breeding methods can take years to develop new crop varieties with desired traits. However, totipotent cells allow for accelerated breeding cycles through techniques like tissue culture and somatic embryogenesis. This enables breeders to rapidly introduce and combine desirable traits into crop plants, leading to the development of improved varieties with enhanced productivity, resilience and quality.

The mechanism behind totipotency involves a combination of cellular factors and processes that enable certain plant cells to retain the ability to regenerate into a whole organism. While the exact mechanisms are complex and not fully understood, several key factors contribute to totipotency are as follows:

1. **Cellular plasticity:** Totipotency is associated with the plasticity of plant cells, allowing them to undergo dedifferentiation and redifferentiation. Dedifferentiation involves the reversal of cellular specialization, where differentiated cells lose their specialized characteristics and revert to a less specialized state with greater developmental flexibility.

This process enables cells to regain pluripotency or totipotency, providing the basis for regeneration into various cell types and tissues.

2. **Cell cycle regulation:** Totipotent cells exhibit unique cell cycle dynamics that facilitate regeneration. They maintain high rates of cell division and possess the ability to enter the embryogenic pathway, leading to the formation of embryogenic callus or somatic embryos. Tight regulation of cell cycle checkpoints and coordination of cell division events are essential for the successful progression of regeneration processes.
3. **Epigenetic regulation:** Epigenetic mechanisms play a crucial role in maintaining totipotency and regulating gene expression patterns during regeneration. Epigenetic modifications, such as DNA methylation, histone modifications and chromatin remodeling, influence the accessibility of genomic DNA and regulate gene expression in a cell-type-specific manner. Dynamic changes in the epigenetic landscape occur during cellular reprogramming and differentiation, shaping the developmental fate of totipotent cells.
4. **Hormonal signaling:** Plant growth regulators, particularly auxins, cytokinins and gibberellins, play key roles in regulating totipotency and cellular differentiation. Hormonal signaling pathways orchestrate cellular responses to environmental cues and developmental signals, influencing processes such as cell division, differentiation and organogenesis. Optimal hormonal balance and gradients are critical for inducing and maintaining totipotency in cultured plant cells.
5. **Genetic regulation:** The expression and activity of specific genes and transcription factors are essential for maintaining totipotency and directing cellular fate during regeneration. Regulatory genes involved in cell fate determination, embryonic development and meristem formation are dynamically expressed in totipotent cells, guiding their differentiation into diverse cell types and tissues. Transcriptional networks and genetic regulatory cascades govern the transition between pluripotent and differentiated states, ensuring the fidelity of developmental programs.

In summary, totipotency is a valuable characteristic in agriculture that facilitates various biotechnological applications, including plant propagation, germplasm preservation, genetic engineering, varietal improvement and rapid breeding. Harnessing the regenerative capacity of totipotent cells contributes to increased productivity, sustainability and resilience in crop production systems, ultimately benefiting farmers, consumers and the environment.

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EMBRACING THE POWER OF MILLETS: A JOURNEY INTO THEIR POSITIVE IMPACT ON HEALTH, AGRICULTURE AND SUSTAINABILITY

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Introduction

In recent years, there has been a growing recognition of the nutritional, environmental, and economic benefits of millets. Once considered as "Poor man's food" millets are now making a comeback as a staple in diets worldwide. This reinvigoration is not just a culinary trend but a significant shift towards sustainable agriculture and healthier lifestyles. Millets are a group of small-seeded grains that are highly nutritious and versatile, often considered ancient cereals. They're known for their resilience and ability to grow in challenging conditions, making them an important crop in many parts of the world.

Important Millets with health benefits:

1. **Pearl Millet (Bajra)**: It is widely grown in Africa and India. Rich in iron, calcium, and fiber and commonly used in flatbreads, porridge and as a rice substitute.
2. **Finger Millet (Ragi)**: Known for its high calcium content, often used in Indian cuisines for making porridges, roti and baked goods.
3. **Foxtail Millet**: With a high content of protein and dietary fiber, it's often used in soups, salads and as a rice alternative.
4. **Little Millet**: It has very low glycemic index, making it a good option for those managing blood sugar levels.
5. **Kodo Millet**: Having high antioxidant content, it's used in a variety of dishes, from porridge to pilafs.

6. **Barnyard Millet**: It has a high fiber content and is often used in fasting recipes and as a substitute for rice.

The Nutritional Powerhouse

1. **Rich in Nutrients**: Millets are packed with essential nutrients such as proteins, dietary fiber, vitamins (especially B-complex), minerals (iron, calcium, magnesium, phosphorus), and antioxidants.
2. **High in Fiber**: The high fiber content in millets supports digestion, helps in maintaining a healthy weight, and reduces the risk of chronic diseases such as heart disease and diabetes.
3. **Gluten-free**: Unlike wheat and some other grains, millets are naturally gluten-free, making them suitable for people with celiac disease or gluten sensitivity.
4. **Low Glycemic Index**: Millets have a low glycemic index, which means they release glucose into the bloodstream more slowly, offering sustained energy levels and helping to manage blood sugar levels.

Agricultural and Environmental Benefits

Beyond their nutritional value, millets offer numerous advantages from an agricultural and environmental perspective:

1. **Climate Resilience**: Millets are well-adapted to harsh environments with low water availability and high temperatures. They require significantly less water compared to major cereal crops like rice and wheat making them ideal for regions prone to drought.
2. **Soil Health**: Millets have deep root systems that improve soil structure, enhance fertility, and reduce erosion. They contribute to sustainable agricultural practices by maintaining soil health over the long term.
3. **Biodiversity**: Cultivating a variety of millets promotes agricultural biodiversity, which is crucial for resilient food systems and ecosystem health. Millets also have a low susceptibility to pests and diseases, reducing the need for chemical inputs.

Social and Economic Impacts

The revival of millets is not only beneficial for health and agriculture but also has broader social and economic implications:

Food Security: Millets can be an affordable source of nutrition for millions of people, especially in rural areas of developing countries.

Their cultivation can enhance food security by providing a reliable food source even in challenging climatic conditions.

1. **Income Diversification**: Millets can generate additional income for small and marginal farmers. Their cultivation supports local economies and reduces dependency on monocropping.
2. **Cultural Preservation**: Millets are deeply ingrained in the cultural and culinary traditions of many societies. Promoting their consumption helps preserve traditional knowledge and practices related to food and agriculture.

Culinary Versatility and Modern Applications

In addition to their nutritional and environmental benefits, millets offer versatility in culinary applications:

1. **Cooking Methods**: Millets can be cooked in various ways—boiled, steamed, toasted, or ground into flour. They are used in a wide range of dishes such as porridge, bread, pancakes, and even fermented beverages.
2. **Gourmet Appeal**: Chefs and food enthusiasts are increasingly recognizing millets for their unique flavors and textures, incorporating them into gourmet recipes and modern cuisine.
3. **Commercial Products**: The popularity of millets has led to the development of a range of commercial products including breakfast cereals, snacks, baked goods, and gluten-free alternatives, catering to diverse consumer preferences.

Challenges and the Way Forward

Despite their numerous benefits, the widespread adoption of millets faces several challenges:

1. **Awareness and Perception**: In many regions, there is a lack of awareness about the nutritional benefits of millets and even there is a perception that it is a "Poor man's food" leading to low consumer demand and limited market opportunities.
2. **Processing and Infrastructure**: There is unavailability of processing units in many areas. The infrastructure for processing and marketing millets needs to be improved to meet quality standards and expand market reach.
3. **Policy Support**: Governments and policymakers need to incentivize millet cultivation through subsidies, research funding, and supportive policies that promote sustainable agriculture and dietary diversity.

Conclusion

Millets can be a promising solution to the global challenges faced due to climate change. Their resurgence is not just a trend but a transformative shift towards healthier diets, resilient agriculture and sustainable food systems. By embracing millets, we can foster a more inclusive and sustainable future. As awareness grows and supportive policies are implemented, millets have the potential to play a pivotal role in achieving food security, promoting economic development, and preserving cultural heritage worldwide.

The journey of millets from traditional grains to modern super food is a testament to their resilience, nutritional richness, and positive impact on health and sustainability. We should embrace millets as a cornerstone of a healthier, more sustainable food system for future generations.

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CALENDAR OF PLANT PROTECTION OPERATIONS TO COMBAT THRIPS INFESTATION IN MANGO ORCHARDS

Article ID: AG-V04-I08-18

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Introduction

Krishnagiri District is known for its mango cultivation and cultivated in an area of about 40,000 ha. In the recent years, mango cultivation is being threatened by various insect species. Of late, thrips species causes substantial crop losses by feeding on the petals, anthers, pollen and floral nectaries and ovipositing in the panicles which leads to discoloration and reduced vigour of the panicles (Kirk, 1997). They also feed and oviposit on the pericarp of the fruits, which causes bronzing of the fruit surface and severe infestations often result in the cracking of the fruit skin. These cosmetic injuries reduce the economic value of mango fruits and their marketability Recently, thrips insect has created havoc in most of the mango growing areas of northern plains. Approximately, 50 per cent of damaged fruits were recorded in severely affected orchards. There are twenty thrips species reported to be inflicting mangoes. Among them, *Scirtothrips dorsalis*, *Rhipiphorothrips cruentatus* and *Thrips hawaiiensis* are found to be predominant in mango ecosystem. The abundance of thrips was high during the flowering period of the dry season and decreased during the flowering period of the rainy season. The later period coincided with decreased temperature and increased relative humidity. Percent of adult emergence from the soil was lower in the rainy season than recorded in the dry season. Fifteen thrips species were recorded associated with mango trees in South Africa. Thirteen species were identified from the flowers, five from the leaves and three from the fruits (Grove *et al*., 2001). Four species of thrips were collected from mango inflorescence, *Thrips palmi* was observed to be dominant followed by *T. hawaiensis* (Krishnamoorthy and Ganga visalakshi, 2012). The nymphs and adults lacerate epidermis of tender leaves, flower buds, flowers, inflorescence ratches and fruits.

STATUS OF THRIPS INFESTATION IN MANGO

Survey on thrips infestation in major blocks *viz*., Krishnagiri, Kaveripattinam, Mathur and Uthangarai blocks of Krishnagiri district was made during August 2023 and April 2024 which coincides with the flowering and initial fruiting phase (Table 1).

Table 1. Survey of thrips gardens in Mango gardens of Krishnagiri district.

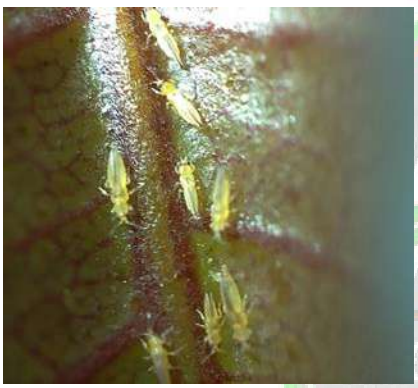
Period	Population (Nos/panicle)			
	Krishnagiri	Kaveripattinam	Mathur	Uthangarai
August 2023	7.17	6.33	4.33	5.23
September 2023	7.87	5.43	4.36	4.88
October 2023	7.60	6.21	6.33	5.23
November 2023	8.43	8.33	8.40	8.35
December 2023	9.47	9.21	9.62	9.33
January 2024	10.27	11.45	11.42	10.32
February 2024	10.60	10.25	10.35	10.40
March 2024	11.33	11.60	12.35	12.50
April 2024	6.53	7.33	5.38	7.35

The observations were recorded at monthly interval from August 2023 – April 2024 (first week). In Krishnagiri block, the thrips population ranged from 6.53 – 11.33 Nos per panicle (Table 1) and hoppers ranged from 3.97 -8.93 Nos per panicle (Table 2) and there existed a difference in the peak occurrence of each insect. In Kaverpattinam, thrips population (5.43-11.60 No.s), hoppers (4.23-7.95 Nos), Mathur block, thrips (4.33 -11.42 Nos) and hoppers (3.25 -7.85) and in uthangarai blocks, thrips (4.88-12.50) and hoppers (3.52-6.52). In all the blocks the maximum or the highest population of thrips was reported during November – March months, whereas the population of hoppers reported from October – January with slight decline and rise in population occurred till the April month.

Based on the survey of the affected fields, the farmers were sensitized on the biology of thrips, which is a pre-requisite for management of thrips at an early stage of infestation.

Thrips damage in nursery

Thrips damage in leaves



Thrips movement on undersurface of leaves

Joint inspection

BIOLOGY

The life cycle consists of five stages: egg, larval, prepupal, pupal and adult. Gravid females insert the eggs inside plant tissues including leaves, buds, inflorescence and fruits. The eggs are hatched between two to seven days. The larval stage consists of 2 instars that feed and develop on the leaves, flowers and fruits. The two larval stages completed in eight to ten days and the pupal stage lasts for **2-3 days**. The prepupal and pupal stages often complete their development on the ground, but sometimes pupation can also take place on the plant and plant debris. The adults are weak fliers, usually taking short flights from leaf to leaf or plant to plant. Thrips get spread over large distance by wind. The total lifecycle of thrips on mango varies from **15 to 20** days depending on the environmental conditions. Thrips population are low in winter whereas they reach their peak in summer. On mango, thrips infestation starts with the new flushes and panicle emergence during the 13 to 22nd standard meteorological weeks (last week of March to last week of May). The larval and adults stages are the damaging stages. They damage the mango young leaves, growing buds, inflorescence, flowers, immature and developing fruits by lacerating and sucking the sap from the tissues. This causes silvery or brown patches on the affected parts where the plant cells are destroyed. As a result of its damage, curling up of leaves and wilting of inflorescence were also recorded. In severe cases affected fruits become rusty in appearance. This pest can damage the entire new growth, if it is not treated properly.

SYMPTOMS OF DAMAGE

The nymphs and adults lacerate epidermis of tender leaves, flower buds, flowers, inflorescence ratches and fruits They damage the mango young leaves, growing buds, inflorescence, flowers, immature and developing fruits by lacerating and sucking the sap from the tissues. This causes silvery or brown patches on the affected parts where the plant cells are destroyed. As a result of its damage, curling up of leaves and wilting of inflorescence were also recorded. In severe cases affected fruits become rusty in appearance. This pest can damage the entire new growth, if it is not treated properly.

Management

- Field sanitation through removal of weeds which serves as alternate host
- Regular pruning for removal of old and criss-cross branches (August & september months)
- Monitoring of thrips through blue sticky traps (12 Nos/ha)
- Encourage the activity of predatory thrips, predatory mites, anthocorid bugs, ground beetles, lace wing bugs, lady bird beetles and spiders in orchard
- Neem based insecticides control young nymphs effectively, inhibit the growth of old nymphs and also reduce the egg laying ability of adults
- Use of Neem seed kernel extract (5%) and Neem oil (2%) reduce the thrips population when applied at low level of thrips population
- Application of *Metarrhizium anisopliae or Beauveria bassiana @ 10^8 cfu /ml on tree trunk once during off season and twice at 7 days interval during flowering season.*
- When the infestation is severe, spray any one of the insecticides thiamethoxam 25 % WG (0.3 g / L) or imidacloprid 17.8 % SL (0.3 ml/L) or spinosad 45 % SC (0.4 g/L) or Tolfenpyrad 15 % EC (1.5 ml/L) or Fipronil 5% SC (1.5 ml/L)

Note:

- Do not mix plant growth regulators or micronutrients with insecticide application
  Need based recommended dose only should be followed with rotation of chemicals

References

Krishnamoorthy, A and P.N. Ganga Visalakshi.2012. Record of thrips on mango. J. Hortl. Sci. Vol. 7(1):110-111

Kirk WDJ. 1997. Feeding, pp. 119-174. In Lewis, T. (ed.), Thrips as Crop Pests. CAB International, Wallingford

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BIOLOGICAL CONTROL IS A TOOL FOR ECO-FRIENDLY MANAGEMENT OF PLANT PATHOGENS

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Introduction

Biological agent that reduces the number or disease producing activities of the pathogen is called as antagonist or biocontrol agent. The important biocontrol agents used in plant disease management includes fungi, bacteria, actinomycetes, mycorrhizal fungi, viruses, amoebae, protozoa, Bdellovibrios, etc. Among them, fungal and bacterial antagonists especially species of *Trichoderma*, *Gliocladium*, *Pseudomonas* and *Bacillus* are most widely used against plant diseases. They act on the pathogen through one or more of the following mechanisms *viz.*, competition (for nutrients and space), parasitism, antibiosis and lysis.

Understanding the mechanisms by which biocontrol agents suppress the plant pathogens is essential for improvement and wider use of biological methods. Researchers working in biological control were able to establish the involvement of certain metabolites particularly antibiotics, siderophores, ammonia, hydrogen cyanide, enzymes and stress-induced plant proteins in the mechanisms of biological control.

Biological control is principally achieved through antagonism which involves

1. Competition
2. Siderophores
3. Mycoparasitism
4. Antibiosis
5. lysis

6. Induced Systemic Resistance (ISR)

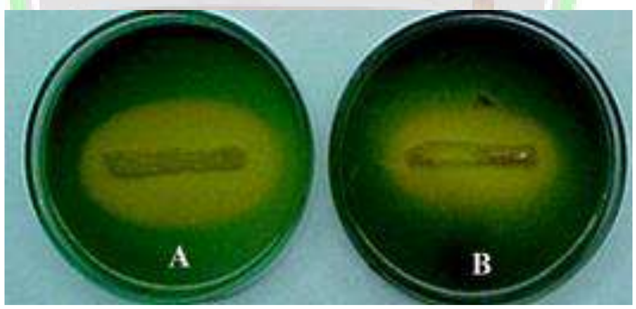
Microorganism, which fulfils all the above criteria, will have a better chance to be a successful biocontrol agent. Antagonists of plant pathogens may be resident or introduced. Resident antagonists are part of the natural microbiota in soil or on roots, leaves or other plant parts, which provide biological control of a plant pathogen through any of the aforesaid mechanisms.

1. Competition

Microorganisms compete for space and minerals and organic nutrients to proliferate and survive in their natural habitats. This has been reported in both rhizosphere as well as phyllosphere. In all these cases, there is opportunity to exploit competition by biocontrol agents so that pathogens are deprived of essential elements for the completion of the infection process or life cycle. Elements for which microorganisms generally compete are carbon, nitrogen and iron, essential for germination and penetration of host tissue by pathogens. Competition has been suggested to play a role in the biocontrol of species of *Fusarium* and *Pythium* (causing wilt and rot of several plants) by some strains of fluorescent pseudomonads. Competition for substrates is the most important factor for heterotrophic soil fungi. Success in competition for substrate by any particular fungal species is determined by competitive saprophytic ability (CSA) and inoculum potential of that species. Those fungi with highest number of propagules or the greatest mass of mycelial growth (biomass) have the greatest competitive advantage. Competitive saprophytic ability is the summation of physiological characteristics that make for success in competitive colonization of dead organic substrates.

2. Siderophores

Siderophores are the extra cellular, low molecular weight transport agents, which selectively make complex with iron with very high affinity. Most aerobic and facultative anaerobic microorganisms respond to low iron stress by producing siderophores. It is a particular form of nutrient competition involving iron and this has been proposed as one of the mechanisms of biological control. The siderophore system of iron assimilation is very widely distributed in the microbial world and is known to operate in Gram (-) and Gram (+) bacterial species, animal and plant pathogens, diverse types of aerobic bacteria and fungi, symbiotic and free-living N_2-fixing bacteria and others. The function of siderophore is to supply iron to the cell. The concentration of soluble ferric ion at pH 7 is very low (10^{-17} M) to sustain microbial growth. Soil borne microorganisms capable of producing siderophores are very active in low iron condition. In the field, these iron chelating compounds of Plant Growth Promoting Rhizobacteria (PGPR) such as fluorescent pseudomonads, are thought to suppress the Deleterious Rhizosphere Microorganism (DRMO) since it creates artificial scarcity of iron for phytopathogen. The siderophore produced by PGPR has higher affinity for iron than those produced by phytopathogens or DRMOs. The siderophore producing cell in PGPR possess a specific receptor in the outer cell membrane, which helps in picking up the iron-siderophore complex from the soil environment. Further PGPR also have the ability to utilize the ferri-siderophore complex produced by the DRMOs. On the contrary, DRMOs or the plant pathogens lack the receptor protein for ferri-siderophore complex of PGPR.



Siderophore production

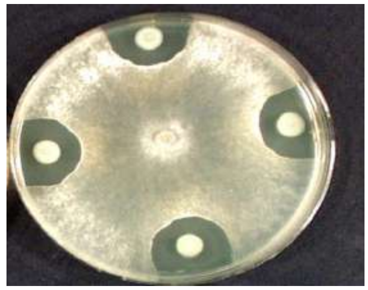
3. **Mycoparasitism**

Mycoparasitism occurs when the antagonist invades the pathogen by secreting enzymes such as chitinases, cellulases, glucanases and other lytic enzymes. Mycoparasitism is the phenomenon of one fungus being parasitic on another fungus. The parasitizing fungus is called hyperparasite and the parasitized fungus as hypoparasite. Mycoparasitism commonly occurs in nature. In mycoparasitism, two mechanisms operate among involved species of fungi. This may be hyphal interaction or destruction of propagules. As a result of inter-fungus interaction *i.e.*, fungus-fungus interaction, several events take place, which lead to predation *viz.*, coiling, penetration, branching, and sporulation, resting body production, barrier formation and lysis. If the antagonist has capability to secrete cell wall degrading enzymes, it can penetrate the cell wall of host hyphae and enter in lumen of the cells. The event of entering in lumen of host cell is known as penetration. Several cell wall degrading enzymes, such as cellulase, β-1, 3 - glucanase, chitinase, proteases, etc. have been reported.

Penetration and haustoria formation within the hypha of R. solani by T. virens

4. **Antibiosis**

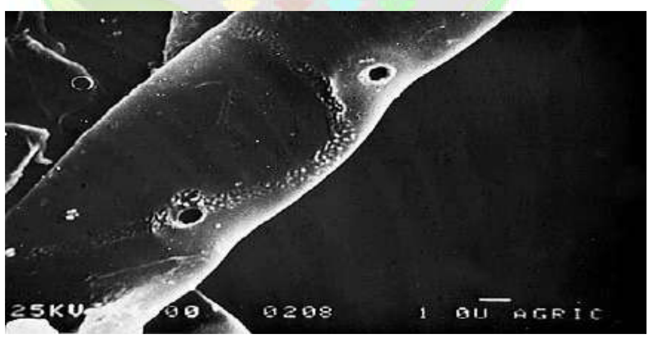
Antibiotics are generally considered to be organic compounds of low molecular weight produced by microbes and at low concentrations they are deleterious to the growth or other metabolic activities of other microorganisms. Antibiotic production as mechanism of biological control has largely been demonstrated for biocontrol agents used against soil-borne plant pathogens. Therefore, the challenging strategy in biological control involves manipulation of such antagonists so that they not only produce antibiotics for their own survival, but also interfere with pathogenic activity in the infection court by reducing inoculum potential or by interfering with saprophytic increase. Antibiotics may diffuse in water, air or substrate to other microbes and thus direct contact between the two is not necessary. Antibiotic production by some strains of fluorescent pseudomonads is now recognized as an important mechanism in disease control. A range of compounds are known to be produced by them. These include phenazines, pyoluteorin, tropolone, pyocyanin, 2, 4-diacetylphloro-glucinol (DAPG) and pyrrolnitrin. Some of these, like tropolone have broad spectrum activity against many bacteria and fungi. Some are specific in their activity towards a particular pathogen. Species of *Trichoderma* produce the following fungitoxic metabolites viz., gliotoxin, gliovirin, viridin, viridiol, trichodermin, trichozianin A and B harzianolide, pyrones, volatile compounds of lactones, alcohols, terpenes and few more antibiotics that are yet to be identified. They are not only good sources of various toxic metabolites and antibiotics but also of various enzymes such as exo-and endo-glucanases, cellobiase, chitinase, laminarinase, etc.



Antibiotics production

5. Lysis

Lysis is the complete or partial destruction of a cell by enzymes. It has been much studied in relation to the destruction of invading organisms by defense mechanisms in the blood of animals, but for our purposes we may distinguish two types, endolysis, and exolysis. Endolysis is the breakdown of the cytoplasm of a cell by the cell's own enzymes following death, which may be caused by nutrient starvation or by antibiotics or other toxins. Endolysis does not usually involve the destruction of the cell wall. Secondly, there is exolysis, which is the destruction of cell by the enzymes of another organism. Typically exolysis is the destruction of the walls of an organism by chitinases, cellulases, *etc.* and this frequently results in the death of the attacked cell. .



Hyphal holes in *R. solani* due to penetration by hyphae of *Trichoderma*

In exolysis the death is caused by the lysis, but in endolysis the death is the cause of the cell's own lysis. There can be some overlap between the terms. For example, when a bacterium colonizing a hypha, produces an antibiotic that causes endolysis and at the same time produces a chitinase that destroys the fungal wall so that both forms of lysis occur at the same time, and it may be difficult to determine exactly what is happening. Endolysis may be caused by normal death from old age or the use of all nutrients in that part of a resource. It may also be caused by an untimely death brought about by toxins from another organism

These toxins are often antibiotics (which operate at low concentrations: less than 10 ppm) and should be distinguished from such things as production of hydrogen ions to change pH or the production of ethanol, which is required in comparatively high concentrations to be toxic or to inhibit growth

6. Induced Systemic Resistance (ISR)

The phenomenon of induced systemic resistance is at present widely accepted and even exploited for the biocontrol of plant diseases. It is the ability of an agent (a bacterium, virus, fungus, chemical, etc.) to induce plant defense mechanisms that lead to systemic resistance to a number of pathogens. Inoculation of plants with weak pathogens or non-pathogens leads to induced systemic plant resistance against subsequent challenge by pathogens. The mechanisms remain largely unknown but typically the induced resistance operates against a wide range of pathogens and can persist for 3-6 weeks. Then a booster treatment is required. Rhizobacteria mediated induced systemic resistance (ISR) has been demonstrated against fungi, bacteria and viruses in *Arabidiopsis*, bean, carnation, cucumber, radish, tobacco and tomato under conditions in which the inducing bacteria and the challenging pathogen remain spatially separated.

Induced Systemic Resistance (ISR)

Induced resistance is thought to be the principal means by which non-pathogenic strains of *Fusarium oxysporum* protect sweet potato cuttings from attack by pathogenic strain. In summary, induction of systemic resistance by PGPR especially against soil-borne pathogens is associated with ultrastructural cell wall modification in such a way to prevent the invasion of mycelium of the pathogen in the vascular stele followed by the biochemical changes *viz*., accumulation of PR-proteins and phytoalexins.

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SYNTHETIC BIOLOGY IN AGRICULTURE

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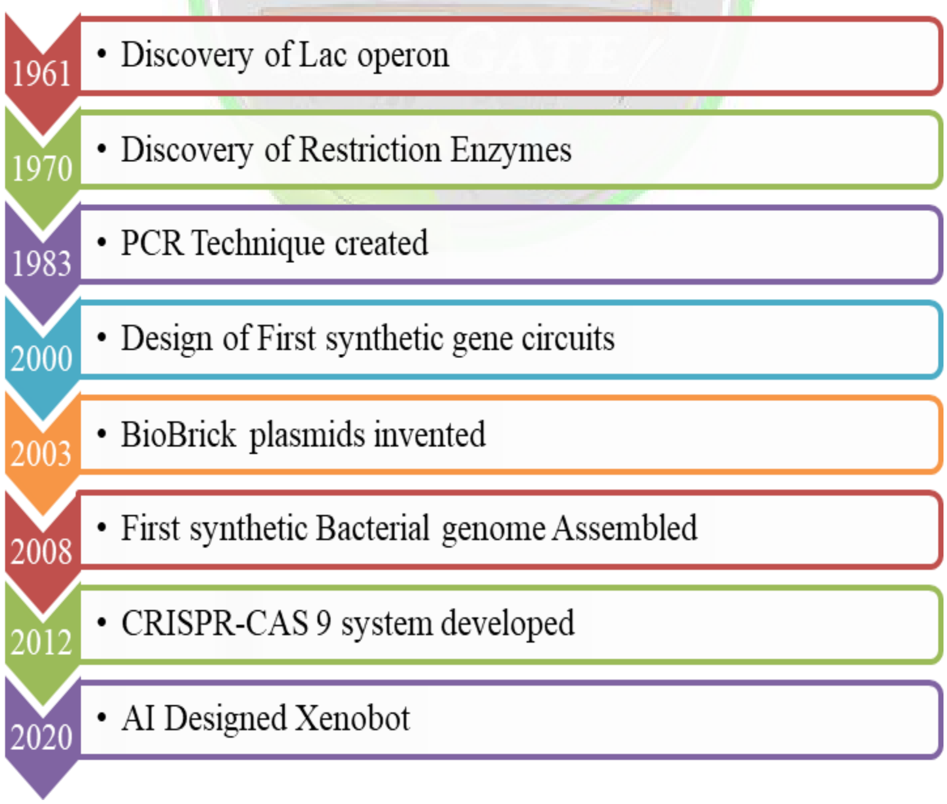
Introduction

Synthetic biology is a rapidly growing field that involves molecular biology, chemistry, physics, mathematics, engineering and informatics etc., The main objective is to design and construct new biological systems and devices as well as dismantle and reassemble of already existing biological system to address current and future challenges.

History of Synthetic biology (SynBio)



Applications of SynBio in Agriculture

SynBio mainly focuses on the following aspects in agriculture

- Enhancing crop growth and yield
- Improve soil health
- Enhancement of food and nutritional value in crop plants
- Resistance to biotic and abiotic stress
- Plant made vaccines and pharmaceuticals

Enhancing crop growth and yield

Photosynthesis is the main source for increase yield and biomass production. It is based on the efficiency of light energy utilized by plants. Several researches found out different strategies to improve the photosynthetic efficiency in crops.

a) Optimize the photoreaction of photosynthesis through higher production of cytochrome *b6f* content in electron transport chain and increase photosynthetic efficiency in C_4 plant (*Setaria viridis*). Increase plant biomass upto 15% by reducing the energy loss during non-photochemical quenching mechanism (NPQ) in tobacco.
b) Co_2 Concentrating mechanisms (CCMs) from cyanobacteria (*ictB* and *FBP-SbPase* enhances photosynthesis and yield in rice.
c) Design new photorespiratory bypass: Artificially construct new carbon fiber CETCH increase the Co_2 fixation more than to times than that of the traditional calvin cycle.

Improve soil health

Synthetic fertilizer usage can be reduced by optimizing plant nitrogen and phosphorus utilization. Nitrogen is the preeminent compound which is required for photosynthesis. On the other hand, phosphorus contributes to nucleic acid structure of plants. The main strategy is to transfer or improve of legume rhizobia nitrogen fixation pathway to the nonlegume grain crops. The nitrogen fixation gene *nif* (*vnf/anf*) or nodulation fixation pathway directly promote nitrogen to the plant and reduce the nitrogen fertilizer requirement of the crops.

Phosphorus fertilizer is easily fixed in the soil and difficult to be absorbed for plants. The solution for this problems is to increase or secrete the organic acid and acid phosphatase which is present in the rhizospere and also overexpression of phytase gene and purple acid phosphate promote dissolution of organic phosphorus by the plants and improve the intake of phosphorus elements.

Enhancement of food and nutritional value in crop plants

The various enzymes increase the nutritional value of the crop leads to counteract the problems faced by the human community are listed below.

Crops	Genes/ Enzymes	Phytonutrients
Rice	**OsCHs, OsPAL, AtFH, AtFLs**	**Flavanoids**
Tomato	**AtMYB12, SIMYB 75**	**Anthocyanin**
Tomato	**GDP-1 *galactose phosphorylase***	**Ascorbate**

Resistance to biotic and abiotic stress

By using synthetic biology, knock out and gene editing technology will fasten to produce resistant plants for both biotic and abiotic stresses.

Example

- Knockout of *CYP71* gene in rice, increase salicyclic acid content results in resistant to pests.
- Gene editing to delete *Xa1*3 gene – Bacterial blight resistant
- Drought resistant – CAM plants have evolved carbon assimilation pathway, this resource help to create abiotic stress resilient crops by synthetic techniques.

Plant made vaccines and pharmaceuticals

Molecular farming is a new emerging industry that involves genetic modification of crops for the production of proteins and chemicals for medicinal and commercial purposes.

Plant derived proteins

- Glucocerebrosidosis (glucose and lipid metabolism) – Treat Gaucher disease
- amiR471 and amiR519 (Artificial miRNAs) in transgenic lettuce – Treat Hepatitis B virus.

Challenges and limitations

1. **Safety concerns:** Using of gene editing / modification tools leads to unpredictable effects on the environment and health of the humans.
2. **Scalability and cost:** Production is more expensive and large scale production requires significant infrastructure.

3. **Regulatory frameworks:** Strict regulations are still formulated by government related to synthetic biology systems.

References

Bo Bi, Wei Li,Yushu Jiang, HaoDu (2022). Present and future prospects of crop synthetic biology, *Crop Design*. Vol 1.Issue 2, 100017.

Lateng Wang, Xin Zang, Jiahai Zhou (2022). Synthetic biology: A powerful booster for future agriculture.*Advanced Agrochem*. Vol 1, pp 7-11.

https:// hudsonrobotics.com (History of synthetic biology)

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THE BIOLOGY AND BEHAVIOUR OF *AULOCOPHORA* SPP.: IMPLICATIONS FOR PEST CONTROL

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Introduction

The family Chrysomelidae, which includes a wide range of insects referred to as "leaf beetles" or "chrysomelids," includes the genus *Aulocophor*a of leaf beetles. The unique physical characteristics, preferred habitats, and ecological roles of this genus define it. The majority of *Aulocophora* species are located in Asia, specifically in nations like Thailand, Indonesia, China, India, and Thailand. Implications for Pest Control gives a complete analysis of the ecological and behavioural foundations that underpin the management of these leaf beetles, as well as insights and recommendations for long-term pest control strategies in agricultural environments.

Aulocophora nigripennis

Description

With a strong, black exoskeleton and light yellowish spots along the sides, the beetle is comparatively small. *A. nigripennis* has a big, orange, segmented thorax, and the head is a deep, vivid orange.

Feeding

A. nigripennis is a pest that uses its mandibles to make a circular "trench" in which it feeds on the 28 species of plants in the *Dianthus* and *Tricosantes* genera. The trench fills with sticky phloem sap after slicing through the leaf in a circular pattern. The sap adheres to the leaf through cohesiveness, forming a semicircle around the beetle. The beetle then uses its jaws to suck the sap.

Life cycle

The yellow eggs are placed in groups of five or more in the soil around the base of cucurbit plants. After eight to fifteen days, they hatch, and the larvae feed on the roots or burrow into them. They go through four instar stages and feed for eighteen to thirty-five days. When the eggs hatch in underground chambers, their initial colour is creamy white, but by then they have turned yellowish-orange. After anywhere from four to fourteen days, the adult beetles emerge. They spread to other plants by powerful flying. There may be multiple overlapping generations of beetles because the adult beetles can survive for up to ten months and each female can lay roughly five hundred eggs.

Management

Using "trap plants" to reduce *A. nigripennis* populations. The population of *A. nigripennis* was reduced from 1.5 beetles per 100 carnation plants to just 0.1 beetles, a 93.3% decrease, thanks to the usage of *D. pungens* trap plants. This is because *A. nigripennis* is specifically drawn to *Dianthus pungens* in the *Dianthus* genera.

Aulacophora igripennis

The genus *Aulacophora*, also referred to as pumpkin beetles, belongs to the family Chrysomelidae; certain species of these insects are agricultural crop pests. The French entomologist and beetle expert Pierre François Marie Auguste Dejean gave the genus its name. The Ancient Greek term "furrow-bearer" (aulax, "furrow") is the source of the name.

Description

This genus of insects, known as beetles, are oval and can grow up to 8 mm (0.3 in) in length. They can be identified by their presence on the host plant.

Distribution

- ✓ Pumpkin beetles are found in Africa, Asia and Australia.
- ✓ Some of the more important pest species are
  - *A. foveicollis* from Africa, Europe and Asia
  - *A. similis* from southern and southeastern Asia
  - *A. coffeae* from Malaysia
  - *A. flavomarginata* from Malaysia and Indonesia
  - *A. femoralis* from Myanmar and Vietnam
  - *A. lewisii* from Malaysia and Vietnam, and
  - *A. frontalis* from Singapore, Thailand, Vietnam and Laos

Hosts

This genus of beetles feeds on Cucurbitaceae plants, such as cucumbers, pumpkins, melons, watermelons, gourds, and squash.

Life cycle

The cucurbit plant's base contains the eggs, which are yellow and deposited in batches of up to five. After eight to fifteen days, they hatch, and the larvae feed on the roots or burrow into them. They go through four instar stages and feed for eighteen to thirty-five days. When the eggs hatch in underground chambers, their initial colour is creamy white, but by then they have turned yellowish-orange. After anywhere from four to fourteen days, the adult beetles emerge. They spread to other plants by powerful flying. There may be multiple overlapping generations of beetles because the adult beetles can survive for up to ten months and each female can lay roughly five hundred eggs.

Damage

Adult pumpkin beetles consume the foliage and flowers of their host plants, potentially destroying seedlings and severely harming young plants. The beetles feed in between the veins, frequently slicing and detaching circular discs that they subsequently consume. Several of them may congregate on a single leaf, sparing surrounding leaves. The plant may perish as a result of the larvae's tunnelling into the roots, which enlarge, change colour, and become deformed.

Aulacophora foveicollis

Morphology

Adults' bright-red, 7 mm-long bodies are distinguished from one another by the black venters on the thorax and abdomen. Larva yellow-white, up to 15 mm in length, with a dark brown head.

Geographical distribution

Africa, Mediterranean region, India and Pakistan.

Host

Aulacophora foveicollis is a polyphagous species that preys on over 80 plant species, with a preference for members of the Cucurbitaceae family.

Life cycle

The average female lays 500 eggs near the host plant, from which the hatching larvae, which prefer the flowers, burrow into the soil and eat the roots, leaves, and fruits later on. They complete two to three yearly generations by pupating in the earth. Its optimal temperature is around 27–28°C

Management

Monitoring

Both mass-trapping and monitoring are accomplished with yellow sticky traps.

Horticultural techniques

Desiccation of the eggs might occur from light watering that does not hydrate the roots.

Plant resistance

It seems that resistance is linked to cucurbit species and cultivars with low levels of the feeding stimulant cucurbitacin. Cucurbits that have longer trichomes and more triterpenes are less likely to be attacked. Muskmelon cultivars resistant to beetles have been produced.

Chemical control

Parthenium hysterophorus L. plant extracts, neem, and carbamates all worked well as chemical controls.

Biological Control

Around the world, the beetle is attacked by a number of natural enemies. Among them are the reduviid *Rhinocoris fuscipes* Fabricius and the tachinid *Medinodexia morgana* (Hardy).

Conclusion

Aulocophora spp. is a remarkable group of leaf beetles with important ecological and agricultural consequences. *Aulocophora* species are known to harm crops, yet they are also vital parts of natural food webs and contribute to ecological processes. *Aulocophora* spp. must be managed effectively using a multimodal strategy that incorporates chemical, mechanical, biological, and cultural control techniques under the umbrella of integrated pest management (IPM). Through the application of biological and behavioural insights and the development of sustainable pest management techniques, agricultural productivity can be reduced without compromising human health.

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THE EFFECTS OF CLIMATE CHANGE ON ECOSYSTEMS OF WETLANDS

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Abstract

Climate change exerts significant pressure on wetland ecosystems, disrupting their critical functions and services. Altered precipitation patterns, increased temperatures, and rising sea levels profoundly affect wetland hydrology, leading to shifts in water availability and quality. These changes impact wetland biodiversity by altering species distributions, facilitating the spread of invasive species, and degrading specialized habitats. The ecosystem services provided by wetlands, including water filtration, flood regulation, carbon sequestration, and support for biodiversity, are also compromised. Adaptive management and conservation strategies, such as restoration projects and integrated land-use planning, are essential to mitigate these impacts and enhance wetland resilience. Addressing the challenges posed by climate change requires a comprehensive approach that balances ecosystem protection with proactive adaptation measures to preserve the ecological and socio-economic benefits of wetlands.

Keyword: Climate Change, Ecosystems, Wetlands, Hydrology, Carbon Sequestration

Introduction

Wetlands, often described as the Earth's "kidneys," play a crucial role in maintaining ecological balance. They act as buffers by filtering pollutants, controlling floods, and providing essential habitats for a myriad of species. However, the escalating impacts of climate change threaten these vital ecosystems in profound ways. Climate change, driven primarily by increased greenhouse gas emissions, is altering temperature regimes, precipitation patterns, and sea levels, all of which have cascading effects on wetland ecosystems. This essay explores the multifaceted impacts of climate change on wetland ecosystems, focusing on changes in hydrology, biodiversity, and ecosystem services.

HYDROLOGICAL CHANGES

Hydrology is the cornerstone of wetland functionality. Wetlands depend on a delicate balance of water input and output, and climate change disrupts this equilibrium in several ways.

Altered Precipitation Patterns:

Climate change leads to shifts in precipitation patterns, causing increased variability in rainfall. Some regions experience more intense rainfall, leading to flooding, while others face prolonged droughts. Both extremes impact wetlands. Increased flooding can lead to erosion and habitat destruction, while droughts reduce water levels, affecting plant and animal life dependent on consistent water availability.

Changes in Snowmelt and Runoff:

In regions where snowmelt contributes significantly to wetland hydrology, changes in snowmelt timing and volume affect water availability. Warmer temperatures lead to earlier snowmelt, which can alter the timing of peak water flow and disrupt the seasonal patterns that wetlands rely on. This misalignment can affect the growth cycles of wetland plants and the breeding patterns of aquatic species.

Sea Level Rise:

Coastal wetlands are particularly vulnerable to sea level rise, a direct consequence of global warming. Rising sea levels lead to saltwater intrusion into freshwater wetlands, altering salinity regimes and impacting species that are not adapted to saline conditions. Coastal wetlands may also face increased erosion and loss of habitat due to rising seas.

IMPACTS ON BIODIVERSITY

Wetlands are among the most biologically diverse ecosystems on Earth, hosting a variety of plant and animal species adapted to specific conditions. Climate change poses several threats to this biodiversity.

Species Distribution and Migration:

As temperatures rise, many species may be forced to migrate to cooler areas or adapt to new conditions. Wetland species, however, are often limited by the availability of suitable habitat. Shifts in temperature and precipitation can lead to habitat loss or alteration, making it difficult for species to find suitable environments. Additionally, migratory species may face disruptions in their migratory patterns due to changes in the timing of seasonal events, such as breeding or food availability.

Invasive Species:

Climate change can facilitate the spread of invasive species by altering habitat conditions in ways that favour non-native species. For example, warmer temperatures and changes in water chemistry can create conditions that are more hospitable to invasive plants or animals. These invaders can outcompete native species for resources and disrupt the ecological balance of wetland systems.

Loss of Specialized Habitats:

Many wetland species are adapted to specific habitat conditions, such as particular water depths or salinity levels. Climate change-induced alterations in these conditions can lead to habitat loss or degradation, threatening species that cannot adapt or relocate. For instance, changes in water levels can impact the availability of breeding sites for amphibians or the growth of critical aquatic vegetation.

IMPACTS ON ECOSYSTEM SERVICES

Wetlands provide numerous ecosystem services that are vital for both the environment and human well-being. Climate change threatens these services in various ways.

Water Filtration and Quality:

Wetlands are natural water filters, trapping sediments and pollutants before they enter larger water bodies. Changes in hydrology can affect the ability of wetlands to perform this function. Increased flooding may overwhelm the filtration capacity, while reduced water levels can decrease the wetland's ability to filter pollutants effectively. This can lead to degraded water quality and increased risks of waterborne diseases.

Flood Regulation:

Wetlands play a crucial role in regulating floods by absorbing excess water during heavy rainfall and releasing it slowly. Changes in precipitation patterns and increased runoff can disrupt this function. Flooded wetlands may lose their capacity to buffer against extreme weather events, leading to more frequent and severe flooding in surrounding areas.

Carbon Sequestration:

Wetlands are significant carbon sinks, storing large amounts of carbon in their soils and vegetation. The degradation of wetlands due to climate change can release stored carbon into the atmosphere, exacerbating global warming. Additionally, changes in wetland vegetation and soil conditions can affect the ability of wetlands to sequester carbon, reducing their effectiveness in mitigating climate change.

Biodiversity Support and Recreation:

Wetlands provide habitat for a wide range of species and offer recreational opportunities for people, such as birdwatching and fishing. The loss of biodiversity and habitat due to climate change impacts can reduce the recreational value of wetlands and affect local economies dependent on eco-tourism.

ADAPTATION AND MITIGATION STRATEGIES

Addressing the impacts of climate change on wetland ecosystems requires a combination of adaptation and mitigation strategies. These strategies aim to enhance the resilience of wetlands and reduce the negative effects of climate change.

Restoration and Conservation:

Restoring degraded wetlands and conserving existing ones can help maintain their ecological functions and services. Restoration projects may involve reintroducing native vegetation, improving hydrological conditions, and controlling invasive species. Conservation efforts should focus on protecting wetlands from further development and pollution.

Adaptive Management:

Adaptive management involves monitoring wetland conditions and adjusting management practices based on observed changes. This approach allows for flexible responses to evolving conditions and helps ensure that wetland management strategies remain effective under changing circumstances.

Integrated Approaches:

Integrating wetland management with broader landscape and water management strategies can enhance resilience. For example, incorporating wetlands into land-use planning and water management frameworks can help address the cumulative impacts of climate change and other stressors.

Policy and Legislation:

Effective policies and legislation are essential for protecting wetlands and promoting climate adaptation. Governments and organizations should implement and enforce regulations that limit wetland degradation, promote conservation, and support climate adaptation efforts.

Conclusion

The effects of climate change on wetland ecosystems are profound and far-reaching, impacting hydrology, biodiversity, and ecosystem services. As climate change continues to accelerate, the challenges faced by wetlands will likely increase, necessitating urgent and comprehensive action. By implementing restoration and conservation strategies, adopting adaptive management practices, and advocating for strong policies, we can work to mitigate the impacts of climate change and ensure the continued health and functionality of these vital ecosystems. The preservation of wetlands is not only crucial for maintaining biodiversity but also for sustaining the essential services they provide to both natural and human systems.

References

Almuktar, S.A., Abed, S.N., Scholz, M., (2018). Wetlands for wastewater treatment and subsequent recycling of treated effluent: a review. Environ. Sci. Pollut. Control Ser. 25, 23595–23623. https://doi.org/10.1007/s11356-018-2629-3.

Bridgham, S. D., Megonigal, J. P., Keller, J. K., Bliss, N. B., & Trettin, C. (2006). The Carbon balance of North American wetlands. Wetlands, 26(4), 889-916.

Corman, J.R., Bertolet, B.L., Casson, N.J., Sebestyen, S.D., Kolka, R.K., Stanley, E.H., (2018). Nitrogen and phosphorus loads to temperate seepage lakes associated with allochthonous dissolved organic carbon loads. Geophys. Res. Lett. 45, 5481–5490. https://doi.org/10.1029/2018GL077219.

Craft, C., Clough, J., Ehman, J., Joye, S., Park, R., Pennings, S. & Machmuller, M. (2009). Forecasting the effects of accelerated sea-level rise on tidal marsh ecosystem services. Frontiers in Ecology and the Environment, 7(2), 73-78.

Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. Marine and Freshwater Research, 65(10), 934-941.

Middleton, B. A. (2019). Wetland ecology: Principles and conservation. Cambridge University Press.

Javadinejad, S., Dara, R., Jafary, F., 2020. Climate change scenarios and effects on snow-melt runoff. Civil Engineering Journal 6, 1715–1725. https://doi.org/10.28991/cej- 2020-03091577.

Maleki, S., Soffianian, A.R., Koupaei, S.S., Baghdadi, N., Mohamad, E.H., Sheikholeslam, F., Pourmanafi, S., 2019. Wetland restoration prioritization using artificial neural networks. Wetlands 1–14. https://doi.org/10.1007/s13157-019- 01165-8.

Mitsch, W. J., Bernal, B., Nahlik, A. M., Mander, Ü., Zhang, L., Anderson, C. J. & Brix, H. (2013). Wetlands, carbon, and climate change. Landscape Ecology, 28(4), 583-597.

Salimi,S. Almuktar Suhad A.A.A.N. and Scholz M. (2021). Impact of climate change on wetland ecosystems: A critical review of experimental wetlands; Journal of Environmental Management; 1-15.

Zedler, J. B., & Kercher, S. (2005). Wetland resources: status, trends, ecosystem services, and restorability. Annual Review of Environment and Resources, 30, 39-74.

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GENOME EDITING AND CRISPR-CAS9 - ITS APPLICATION IN PLANT BREEDING

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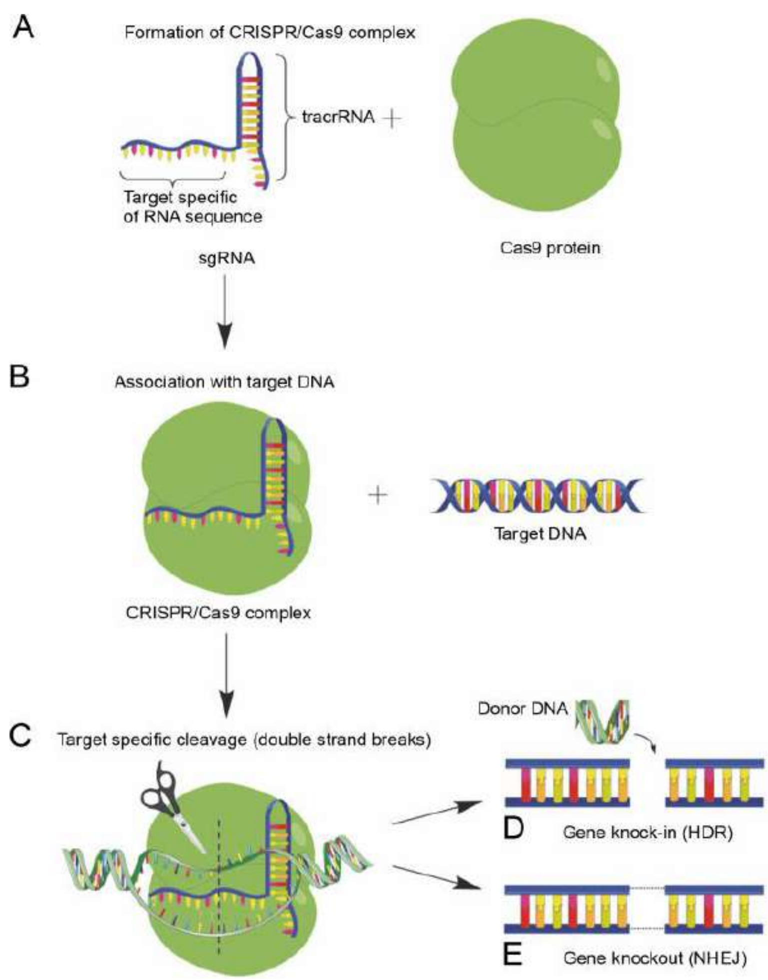
Introduction

Gene editing, also referred to as genome editing, encompasses a collection of methods that enable researchers to modify an organism's genetic code. These methods permit the addition, deletion, or modification of specific segments within the genome. Numerous techniques for gene editing have emerged. A prominent technique is known as CRISPR-Cas9, an acronym for clustered regularly interspaced short palindromic repeats and CRISPR-associated protein9. The CRISPR-Cas9 system has sparked considerable enthusiasm among scientists due to its speed, affordability, precision, and effectiveness compared to alternative gene editing techniques.

CRISPR-Cas9

CRISPR-Cas9 was modified from a naturally existing genetic modification system that bacteria employ as a defense mechanism against infections. Upon being infected by viruses, bacteria capture tiny fragments of the virus' genetic material and incorporate them into their own genetic makeup in a specific sequence to form CRISPR arrays. These CRISPR arrays enable the bacteria to "remember" the viruses (or closely related ones). If the viruses attempt to infect again, the bacteria generate RNA segments from the CRISPR arrays that identify and bind to certain parts of the virus' DNA. The bacteria then utilize Cas9 or a comparable enzyme to sever the DNA strands, rendering the virus inactive. Scientists modified this immune defense mechanism to alter DNA. They produce a brief RNA segment with a specific "guide" sequence that links to a particular DNA sequence within a cell, similar to the RNA segments that bacteria create from the

CRISPR array. This guide RNA also connects to the Cas9 protein. When this RNA is brought into cells, it identifies the desired DNA sequence, and the Cas9 protein cuts the DNA at that spot, replicating the action seen in bacteria. While Cas9 is the protein most frequently employed, other proteins (like Cpf1) can also be utilized. After the DNA is cut, researchers rely on the cell's natural DNA repair mechanisms to insert or remove genetic material, or to modify the DNA by substituting a part with a tailored DNA sequence.



The manipulation of the genome is highly sought after for the prevention and treatment of human illnesses. At present, genome editing is utilized in cells and animal models within research facilities to study diseases. Researchers are in the process of evaluating the safety and efficacy of this method for human application. It is being investigated in both research and clinical trials for a broad spectrum of conditions, including single-gene illnesses such as cystic fibrosis, hemophilia, and sickle cell disease. It also shows potential for the treatment and prevention of more intricate diseases, including cancer, cardiovascular disease, mental disorders, and human immunodeficiency virus (HIV) infection.

In recent years, the plant breeders also utilize this technique and modify plants faster and more accurately through genome editing than they can using traditional plant breeding techniques. With traditional plant breeding techniques, it can take decades for plant breeders to introduce a new characteristic into a crop; however, genome editing may be able to reduce that time to a few years.

CRISPR/Cas9 technology

Through genetic modification, certain phenotypes or qualities produced by plants, or in this case, crops, may be fine-tuned and altered. The anticipated result of this would be the production of an improved crop, which might have some advantages for the broader populace. The accuracy of CRISPR/Cas9 technology guarantees a very dependable genome editing technique that doesn't unintentionally cause unexpected changes in other parts of the genome. Since the technology's discovery, several attempts have been made to use CRISPR/Cas9 genome editing in plants.

Main application in plant breeding

1. Increased disease resistance to reduce the need for pesticides. increased ability to withstand abiotic stress in order to lessen the effects of climate change on our food production
2. Enhanced agronomic characteristics to increase yields, lower pre-harvest losses, and increase productivity
3. Strengthened and enhanced traits associated with health

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PRESERVATION TECHNIQUES OF MUSHROOM

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Abstract

Fresh mushroom production and consumption have significantly expanded in recent decades. As it contains more amount of nutritional value and by the presence of bioactive and medicinal properties that are associated with health benefits. Nevertheless, mushroom has a limited shelf life after harvest and quickly loose quality due to their high respiratory rate and high water content which restricts their commercialization in the fresh state. Several preservation techniques are used to increase their shelf life and retain their quality. In this article, we have discussed about some preservation methods that are commonly used to preserve fresh mushroom for extended periods of time.

Keywords: Preservation, Mushroom, Shelf Life, Bioactive.

Introduction

Mushrooms value for their unique flavour and nutritional benefits have long been used in various cuisines around the world. However their delicate nature and high water content make them highly perishable posing significant challenges for both small scale and large scale commercial producers and consumers as well preserving mushrooms effectively is crucial to extending their shelf life, maintaining their nutritional value and reducing waste. Traditional techniques such as drying and pickling have been used for centuries, leveraging simple process to keep mushrooms for extended periods. They can also be preserved by freezing and canning.

Understanding these diverse preservation technique is essential for anyone involved in mushroom cultivation .By adopting the appropriate methods producers can ensure a steady supply of high quality mushrooms, while consumers can enjoy their favourite fungi year round. The easiest way to overcome the perishability to consume their fresh. This doesn't mean they cannot be preserved. Harvested mushrooms can be kept fresh for about 24 hrs at room temperature. Mushroom can be packed in polythene bags with few holes and are refrigerated at 5^o to 8^oC or in ice container. These cold stored mushrooms commonly remain fresh for 4- 5 days.

Methods of Preservation

1. Short term preservation

1.1. Freezing

The shelf life of mushroom may vary from one day to two week depending upon the species. The shelf life of mushrooms can be extended by refrigerator at 1^o – 4^oC. This method is not applicable for all types of mushrooms particularly with subtropical and tropical mushrooms which commonly suffer the chilling injury. However the refrigerator is the most effective method of preservation based on the following reason

- It prevents the growth of harmful pathogenic microbes on mushroom.
- It checks the process of respiration in the tissue of mushroom after harvest.
- It checks the loss of moisture mushroom.

1.2. Steeping

This method can be applied for preservation of button mushroom, paddy straw mushroom, oyster mushroom, milky mushroom and wild edible variety. Fresh mushrooms are kept in earthern pots containing solution of 2.5 % salt, 0.1% ascorbic acid, 0.2% citric acid , 0.1% sodium bicarbonate and 0.1% potassium metabisulphate are preserved for 10 days without any contamination. (Prerna *et al*., 2015)

1.3. Preservation by gamma radiation

Mushrooms are subjected to gamma radiation of 250 Krad dose and stored at 15^oC button mushrooms can be preserved to 10 day by gamma radiation method (Akram and Kwon, 2010).

1.4. Preservation in fresh condition

The mushrooms are sent to distant markets in fresh conditions covered with PVC film during transportation mushrooms are kept at 15 – 21^o C to have a shelf life for 5 to 7 days under similar conditions, uncovered mushrooms can be preserved upto 2-4 days.

1.5. Preservation in controlled atmosphere

Mushrooms can be preserved in controlled atmosphere consisting of 9% O_2 and 25% CO_2. Partial evaluation followed by flushing with CO. Storage at low temperature can extend the storage life upto 20 days.

2. Long term preservation

2.1. Canning

Canning is the most common method for Button mushroom. This process is divided into 6 parts namely Cleaning, Blanching, Canning, Sterilization, Cooling, Labelling and packing (Fig. 1)

2.2. Drying

Drying is the most convenient and traditional method of long term storage preservation and transportation on drying mushrooms retain the specific aroma and escape from spoilage also. The dried form of shiitake mushroom is most popular. Typically fresh mushroom contains about 70 - 95% of moisture depending upon the type of mushroom. This has to be reduced to 10-13% to avoid any spoilage.

Mushroom can be dried by 2 methods

a. Sun drying
b. Thermal power drying in hot air oven

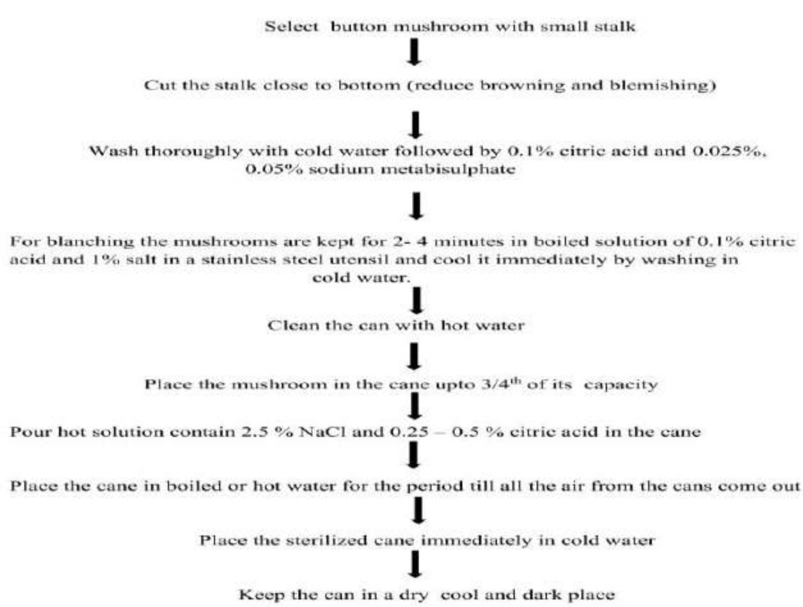

Fig.1 : Flowchart for canning

This picked mushroom are cut of at base part of the stalk and our arranged in single layer on shelves and are exposed to direct sunlight . Sun drying continuously for 4-7 days meets the purpose in alternative method thus shelves are placed in drying i.e. hot air oven being expected at 40 – 60^{o} C for 12 – 18 hrs, after drying if they are exposed to wet conditions or humid environment, they reabsorb moisture from the air and the moisture content reaches upto 20% the mushroom become vulnerable and very prone to pest and disease infestation . Therefore they must be stored at air tight contained (Yadav, 2017)

Pickling

The process of pickling is like that of vegetables in vinegar or oil, any one of it can be used for pickling . Blancing of mushroom should be preferably done prior to pickling.

Mushroom can be preserved by pickling them in salt which is considered the most convenient and profitable method of retaining the unique flavour. The cleaned and well drained mushrooms are cut into small pieces arranged into layers alternating the layers with salt. Thus layers can be arranged in wide mounted sterilized bottle and packed air tight .mushrooms can be preserved in this way for longer period.

One of the most popular method of preserving mushroom is pickling them with vinegar. Mushroom is cut into desired size and is placed in a pan half filled with water. The mixture is boiled on low flame for 20 minutes after adding salt, whole pepper corn and bay leaf. Then they are strained in clean muslin cloth mixed with required quantity of half boiled onion and or carrot and the entire moisture is packed and preserved in air tight sterilized glass jar. (Tanimola, 2022)

Vaccum cooling

In vaccum cooling, the water in the cell wall and inter hyphal space of mushroom is evaporated under low pressure and the evaporative cooling lowers the temperature from ambient to 2ºC in 15 to 20 minutes. Vaccum cooling is an uniform and faster process, where mushroom are subjected to very low pressure and water evaporates giving of the latent heat of vaporization, thus cooling itself. The storage of mushroom at 5ºC conserved quality and weight loss as compared with those stored at 18ºC. Vaccum cooled mushroom were significantly better with regards to colour than conventionally cooled. The rate of weight loss during storage at 5ºC was greater for vaccum cooled than conventionally cooled mushroom. (Burton,1987)

Modified Atmosphere Packaging

Modified atmosphere packaging is method of creating modified atmosphere in sealed package to delay senescence and maintain quality after harvest. The shelf life of mushroom is increased by wrapping them with PVC films. The punnets wrapped with PVC or poly acetate films create modified atmosphere about 10% O_2 and 2 % CO_2. Lopez -Briones *et al*., (1993) recommended 100 gauge polythene bag with 0.5% venting area for packaging mushroom in refrigerated storage. Button mushroom are stored in non perforated polythene bag for 4 days at 5 ^{o} C. For long distance transport polystyrene or pulp board should be used instead of using polythene bag. Four microporous films in oriented polypropylene and one film currently used to overwrap mushroom punnets were tested. Mushroom punnets placed in pouches were stored at 4^{o} C – 10^{o} C for 8 days.

Conclusion

By exploring and implementing various preservation techniques, from traditional methods like drying and pickling to modern techniques like vaccum cooling, Controlled atmospheric storage and so on, both producers and consumers can significantly extend the shelf life of mushroom. Each preservation techniques has its own set of advantages and the choice of techniques depend on factors such as the type of mushroom, available resources and intended use. As the demand for mushroom continues to grow adopting effective preservation strategies will become increasingly important. By reducing spoilage we not only ensure a more consistent supply of mushroom but also contribute to a more sustainable food system.

Reference

Burton, K. S., Frost, C. E., and Atkey, P. T. (1987). Effect of vacuum cooling on mushroom browning. *International Journal of Food Science & Technology*, 22(6): 599-606.

Prena, G., Anju, B., Harmeet, C., Anisa, M. and Naseer, A., (2015). Effect of steeping solution on the quality of button mushrooms (*A. bisporus*) preserved under ambient conditions. *Int J Life Sci*, *10*(1) :445-450.

Akram, K., and Kwon, J. H. (2010). Food irradiation for mushrooms: A review. *Journal of the Korean Society for Applied Biological Chemistry*, 53: 257-265.

Tanimola, A. R., Abai, O. P., Ibitoye, W. O., and Otegbayo, B. O. (2022). Effects of pickling treatments and species on the properties of processed mushrooms (*Pleurotus* species). *Food Research*, *6*(6), 13-20.

Yadav, A., Nagda, N., & Singh, U. (2017). Effect of pretreatments, drying methods on mushroom-A review. *Progressive Agriculture*, *17*(2), 261-265.

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EVOLUTION OF AGRICULTURE IN INDIA: FROM TRADITIONAL PRACTICES TO SUSTAINABLE FUTURES

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Abstract

This paper delves into the metamorphosis of agriculture in India, from the pre-1960s traditional practices (Agriculture 1.0) through the Green Revolution (Agriculture 2.0), the advent of precision and digital agriculture (Agriculture 3.0 and 4.0) and the emerging sustainable and regenerative practices (Agriculture 5.0). Each phase is marked by significant advancements and challenges, molding the contemporary Indian agricultural landscape.

Keywords: Green Revolution, Precision Agriculture, Digital Agriculture, Sustainability.

1. Introduction

Agriculture has been the backbone of India's economy and culture for millennia, evolving from traditional subsistence farming to incorporating modern practices. This transformation has been marked by significant innovations, each with its impact on productivity, sustainability and the socio-economic fabric of the nation. This paper reviews the historical progression of agriculture in India, highlighting key innovations and their implications for the future trajectory of sustainability in Indian agriculture.

2. Methods

The paper employs a historical and analytical approach, examining the evolution of agricultural practices in India across five distinct phases: Traditional Agriculture (1.0), the Green Revolution (2.0), Precision Agriculture (3.0), Digital Agriculture (4.0) and Sustainable and Regenerative Agriculture (5.0). Each phase is characterized by specific technological advancements, practices and challenges.

3. Agriculture 1.0: Traditional Agriculture

3.1 Overview

Traditional agriculture in India represents the era before the 1960s, characterized by manual labor and basic tools. Farming was largely subsistence-based, focusing on self-sufficiency rather than commercial output.

3.2 Practices and Techniques

Tools and Equipment: The primary tools were simple hand tools like plows and sickles, often powered by bullocks or manual labor.

Irrigation: Dependence on natural rainfall, with minimal irrigation infrastructure.

Crops: Diverse cropping systems including rice, wheat and pulses, with crop rotation and mixed farming practices.

3.3 Challenges

Low Productivity: Limited by manual labor and lack of technological advancements.

Pest and Disease Management: Reliance on traditional methods with limited effectiveness.

Climate Dependence: Vulnerability to weather conditions and lack of irrigation systems.

4. Agriculture 2.0: The Green Revolution

4.1 Overview

The Green Revolution, beginning in the 1960s, marked a significant shift with the introduction of high-yield variety (HYV) seeds and modern agricultural practices. This period aimed to increase food production and address food security issues.

4.2 Key Innovations

HYV Seeds: Introduction of high-yield varieties of crops such as wheat (Lerma Rojo 64A) and rice (IR 8) which significantly increased productivity.

Chemical Inputs: Adoption of chemical fertilizers and pesticides to enhance crop growth and protect against pests.

Mechanization: Introduction of machinery like tractors and combine harvesters to increase efficiency.

4.3 Impact

Increased Yields: Major improvements in crop yields and overall food production.

Economic Growth: Enhanced agricultural output contributed to economic stability and reduced famines.

Regional Disparities: While the Green Revolution benefited many regions, it also exacerbated disparities between different areas.

5. Agriculture 3.0: Precision Agriculture

5.1 Overview

The 1990s and early 2000s saw the emergence of precision agriculture, driven by advances in technology and data analytics. This phase focused on optimizing agricultural practices through the use of digital tools.

5.2 Technological Advancements

GPS and GIS: Mapping and monitoring fields for better management and efficiency.

Sensors: Soil and crop sensors for real-time data on moisture levels, nutrient content and crop health.

Data Analytics: Use of data for precise decision-making, including fertilizer application and irrigation scheduling.

5.3 Impact

Resource Efficiency: Improved management of resources such as water and fertilizers.

Yield Improvements: Enhanced ability to manage and predict crop performance.

Sustainability: Reduction in waste and better environmental stewardship.

6. Agriculture 4.0: Digital Agriculture

6.1 Overview

Digital Agriculture represents the integration of advanced digital technologies into farming practices. This stage emphasizes the use of AI, IoT and big data to further optimize and innovate agricultural practices.

6.2 Key Technologies

IoT and Smart Devices: IoT sensors for monitoring crop conditions, weather and soil health.

Drones: Use of drones for aerial surveys, crop monitoring and precision application of inputs.

Artificial Intelligence: AI for predictive analytics, automated machinery and decision support systems.

6.3 Impact

Enhanced Precision: Greater accuracy in farming practices leading to increased productivity.

Real-Time Monitoring: Continuous monitoring and adjustments based on real-time data.

Innovation: New tools and technologies that drive further advancements in agriculture.

7. Agriculture 5.0: Sustainable and Regenerative Agriculture

7.1 Overview

Agriculture 5.0 is focused on sustainability and regenerative practices, aiming to align agricultural production with ecological and environmental goals. This phase integrates advanced technologies with sustainable farming practices.

7.2 Sustainable Practices

Regenerative Agriculture: Techniques such as cover cropping, reduced tillage and organic farming to improve soil health and biodiversity.

Climate-Smart Agriculture: Practices that mitigate and adapt to climate change impacts, including carbon sequestration and water conservation.

Biotechnologies: Use of advanced biotechnologies for crop improvement and pest management.

7.3 Future Directions

Integration: Combining technology with sustainability for a holistic approach to farming.

Policy and Education: Need for supportive policies and education to promote sustainable practices.

Global Trends: Aligning with global movements towards sustainable and resilient agricultural systems.

8. Conclusion

The evolution from Agriculture 1.0 to 5.0 in India mirrors a journey of technological progress and a growing emphasis on sustainability. Each stage has revolutionized productivity, efficiency and environmental impact. The future challenge lies in harmonizing technological innovation with sustainable practices to ensure food security and environmental health.

References

Sharma, R., Aravind, T., & Sharma, R. (2019). Sustainable agriculture: Trends and opportunities for 21st Century. *Journal of Applied and Natural Science*, *11*(3), 666-672.

Singh, D. (1999). The green revolution and the evolution of agricultural education and research in India. *Genome*, *42*(4), 557-561.

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PLANT IMMUNE SYSTEM INDUCED IN THE CONTEXT OF AN ECOSYSTEM

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Introduction

An ecosystem is a region that is home to a wide range of living organisms, such as plants, animals, and other species. An ecosystem's biotic components include plants, animals, and other living creatures in addition to its abiotic factors, which include wind, temperature, and humidity. Each component of an ecosystem depends on the others, either directly or indirectly.

Plants have evolved defence systems against diseases over time in order to survive. Compared to plant immune systems, which have specialised immune cells or antibodies, animal immune systems are superior. Pattern recognition receptors (PRRs) detect microbe- or pathogen-associated molecular patterns (MAMPs or PAMPs), which initiates the first stage of plant immunity.

The initial layer of inducible defences in plants, known as pattern-triggered immunity (PTI), is triggered by extracellular identification of molecular patterns linked to microbes and host damage. The ability of pathogen/microbe-associated molecular patterns to be recognised by pattern recognition receptors (PRRs) is demonstrated by a variety of microorganisms, including fungi, bacteria, viruses, and oomycetes. Cell wall fragments that a plant may release in response to injury or pathogen invasion are known as danger-associated molecular patterns, or DAMPs. The wall associated kinases (WAK) family is a significant subset of PRRs that indirectly senses pathogens through DAMPs and triggers oligogalacturonide-dependent defence responses.

Plants have to defend themselves against a variety of creatures that consume them, such as insects, bacteria, protists, fungi, and vertebrates. Plant immunity is the ability, either natural or artificial, of plants to identify and neutralize invasive invaders before they have a chance to do any harm. Receptors on the surface of plant cells are either present or function to detect chemicals emitted by pathogens. This perception initiates complex signalling cascades that culminate in a defensive response to a pathogen attack.

Plant Immune System Categorisation

1) Baseline reactions, involving the control of gene transcription in response to pathogen-associated molecular patterns (PAMPs)
2) Hypersensitive reactions that result in infection site cell apoptosis
3) Acquired protection systemically, making the entire plant immune to infection
4) The reactions in the ethylene (ET)/jasmonic acid (JA) pathway, which shield the entire plant and nearby plants from herbivores,
5) Immunity against non-host cells

Plant signaling

Every cell in a plant needs to be able to initiate an immune response independently of other cells since plants are sessile organisms with immobile cells. Information exchanges not just among cells but also outside of them. Plant signaling is the process by which information is transmitted from receptor systems to effectors both inside and outside of plant cells. Even if the plants are from different species, chemical signals can still occur locally within one plant or even across multiple plants. Coordinating physiological and metabolic reactions, these signals will activate complex networks of interconnections.

Activated cell-surface receptors trigger PAMP-triggered immunity (PTI), as was previously described, but a host plant has other defence mechanisms against a pathogen. The immune response that occurs within cells and is facilitated by natural killer cells (NLRs) is regarded as a more potent form of defence. These NLRs detect the existence of host translocated effectors and/or their activity. Salicylic acid (SA), a stress hormone, reactive oxygen species (ROS), pathogenesis-related (PR) protein expression, the hypersensitive cell death response (HR), and the release of systemic signals leading to systemic acquired resistance (SAR) are among the defence responses that are triggered. Because this is a relatively extreme technique to limit the propagation of the function, the HR response is especially important.

Bioengineering and Plant Immunity

Enriching crops and changing plant immunity are now feasible thanks to modern molecular genetics. However, new advances in computer science and technology have also made it possible to gather a great deal of fresh data, which has expanded our knowledge of plant immunology and physiology and further exposed certain essential concepts. To generate new desirable traits, regulatory circuits comprising molecular motors, ligands, receptors, and other components of signal transduction can be created and incorporated into plants. It has been claimed that a bacterial two-component system that has been created has been used to design a fully synthetic signaling pathway for the detection of environmental pollutants. A two-component system usually consists of an internal response regulator and a membrane-bound receptor that functions as a sensor. Our understanding of the genotype-to-phenotype mapping theoretically limits the possible applications of these findings and techniques.

Biological Defenses Mediate Plant Immunity

In reaction to invasive infections, there may be antagonistic or synergistic interactions amongst hormone signal transduction pathways. The two main hormonal routes involved in plant defense are salicylic acid (SA) and JA. Plant defense systems are adaptable and adapted to the specific traits of their diseases. The SA route is predominantly triggered by biotrophic pathogens, while the JA/ET pathway plays a role in protecting the body from infections by necrotrophic or herbivorous pathogens.

Innate immune receptors, which are expressed in all cell recognition receptors (PRRs) and cause PTI on the cell surface, are essential for plant immunity. PRRs activate and detect invasion signals, which results in PTI or ETI. Plants employ receptor barriers for innate defense and start sophisticated defense signaling cascades to stop pathogen invasion. Modified host molecules or microorganisms are Innate immune receptors, which are expressed in every cell and are identified by PRRs in the plasma membrane to activate PTI, constitute the foundation of plant immunity.

Pattern-Triggered Immunity

PTI is the initial phase of the immune response. Conserved molecular patterns such as DNA, ergosterol, EF-Tu, chitin, flagellin, lipopolysaccharides, and peptidoglycans are used to identify PAMPs or MAMPs. Among the well-known MAMP assessments involved in the activation of signaling pathways and hydrolysis are the generation of reactive oxygen species

(ROS), the activation of MAP kinase, and the stimulation of transcription of pathogen-responsive genes.

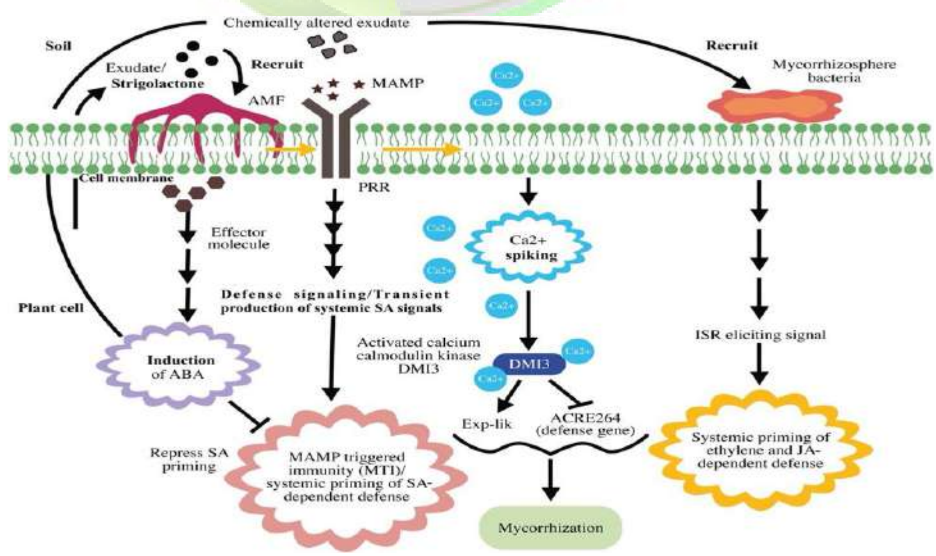
Effector-Triggered Immunity

R-proteins are among the many effectors that infections release that plants can identify and use to trigger defensive mechanisms. Nucleotide-binding oligomerization-like receptors (NOD), which are specific for effector molecules made by microorganisms, are used to detect ETI. One of the most important components of the plant immune system is the intricate network of cell walls and the essential proteins that comprise them. Recent developments in our understanding of how plant viruses impact cell wall remodeling in both susceptible and resistant plants have revealed that components of cell wall metabolism can alter the way viruses spread and activate defensive mechanisms based on apoplast and symplast.

Signal Transduction

Abscisic acid (ABA) is a phytohormone associated with plant defense that controls the immune system either favorably or unfavorably and is essential for responding to both biotic and abiotic stressors. In response to different abiotic stimuli, the ABA signaling system regulates stomatal closure, vegetative growth, seed dormancy and maturation, and plant growth and development. One important mechanism that regulates various abiotic stress responses to salt, osmotic, and drought problems is the ABA signaling pathways, which have been reported to extend from hormone receptors to numerous downstream components.

Fig.1 Signal Transduction in Plants



Gibberellic Acid (GA) Signaling Pathway

GA is a gibberellin family tetracyclic diterpenoid. It has a role in the metabolism, growth, and abiotic stress response of plants. Numerous studies have been conducted on the biosynthetic routes of GA. Enzymes necessary for GA production are ent-copalyl diphosphate synthase, ent-kaurene synthase, ent-kaurene oxidase, ent-kaurenoic acid oxidase, GA13-oxidase, GA20-oxidase (GA20ox), GA3-oxidase (GA3ox), and GA2-oxidase. Within the cytoplasmic matrix, GA20ox and GA3ox oxidize GA12 and GA53 to generate distinct GAs. The transcription factor GAF1 recruits GA-insensitive and topless-related members of the DELLA (aspartic acid–glutamic acid–leucine–leucine–alanine) protein family, which are negative regulators of GA signal transduction.

ET Signaling Pathway

The soluble GA receptor GID1 is used by plants to detect extracellular GA. PTI and ETI both induce the binding of ET biosynthesis, while SA amplifies this induction. The relationship between ET and GID1 depends on concentration. GA does respond to a variety of abiotic stressors in plants, even at low extracellular GA concentrations. As an example, the endogenous level of ET is altered by low-temperature stress. ET treatment reduced GID1 binding in Arabidopsis seedlings, and GID1's N-terminal extension domain binds to GA-response genes to inhibit transcription of those genes.

Plants adapt their metabolic circuits, gene expression, and protein structure to biotic and abiotic stresses. Many stress cues must be perceived and transmitted in order for these physiological reactions to occur, activating a variety of defense mechanisms in the process. Protein kinases and phosphatases play a crucial role in plant defense pathways because of the significance of protein phosphorylation and dephosphorylation in signal transduction. Large-scale changes in gene expression, which are linked to essential plant physiological processes including photosynthesis, respiration, and metabolic pathways, are typically brought about by abiotic stresses.

In plants, the transmission of stress signals also requires JA and SA. Through the stearic acid route, JA or SA stimulation of plants activates a variety of defense mechanisms, shielding them from abiotic stresses. Another hormone produced by plants, ET is triggered by both biotic and abiotic stresses. The purpose of ET-responsive genes remains mostly unknown, despite a great deal of study being done on ET signal transduction in plants.

Conclusion

In conclusion, the majority of effectors' roles in host colonization tactics employed by pathogens and plant defensive mechanisms are still unclear. Our study of plant–pathogen interactions has also been substantially aided by recent developments in live-cell imaging and histochemical characterization of effector-target complexes during pathogen invasions. Furthermore, the most recent transcriptional investigations in a number of pathosystems have demonstrated that effector expression is strictly controlled. Plants respond to pathogen infection by expressing genes relevant to certain cell types and organs. According to these publications, studying plant-pathogen interactions at temporal and geographical resolution can provide important insights into the intimate ties that develop during infection.

References

Ali Movahedi , Soheila Aghaei-Dargiri , Bahram Barati , Saeid Kadkhodaei , Hui Wei , Sirous Sangari, Liming Yang and Chen Xu, 2022. Plant Immunity Is Regulated by Biological, Genetic, and Epigenetic Factors. 12, 2790

Haney, Cara H., Urbach, Jonathan M. and Ausubel, Frederick M.I 2014. Innate immunity in plants and animals. The Biochemist, Vol. 36.

Hohmann, Lau, and Hothorn.2017. The Structural Basis of Ligand Perception and Signal Activation by Receptor Kinases. Annu. Rev. Plant Biol. Vol. 68.

Kazan, K. Diverse roles of jasmonates and ethylene in abiotic stress tolerance. Trends Plant Sci. 2015, 20, 219–229.

Zipfel C. 2014. Plant Pattern-recognition receptor. 2014.Trends in Immunology, Vol. 35; 7, 345-351

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TNAU - PROBE TRAP

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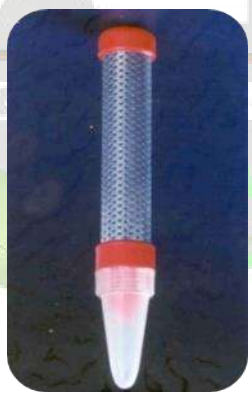
Introduction

The use of trap is relatively a new method of detecting, trapping insects in stored grains. The basic components of a TNAU probe trap consists of three important parts: A main tube, insect trapping tube and a detachable cone at the bottom. Equispaced perforations of 2 mm diameter are made in the main tube.



Concept: Insects love "AIR" and move towards air. This behaviour of the insect is exploited in this technology.

Method of working: The insect trap has to be kept in the grain like rice, wheat etc., vertically with the white plastic cone downside as shown the figure. The top red cap must be with the level of the grain. Insects will move towards air in the main tube and enter through the hole. Once the insect enters the hole it falls down into the detachable white cone at the bottom. Then there is no way to escape and the insects are trapped forever. The white detachable cone can be unscrewed once in a week and the insects can be destroyed.

Salient Features: No chemicals; No side effects and No maintenance cost.

Efficiency:

TNAU Insect traps are excellent insect detection devices in food grains and more effective in the detection of stored grain insects namely *Rhyzopertha dominica* (F.), *Sitophilus* *cryzae* (L.) and *Tribolium castaneum* (Herbst) in stored food grains both **in terms of detection** as well as **number of insects caught** than the standard normal sampling method (by spear sampling). The detection ratio (trap: normal sample) is higher in trap than of normal sampling method by factors ranging from 2 : 1 to 31 : 1. The insects catch is also higher in the probe trap than the normal sampling method by factors ranging from 20 : 1 to 121 : 1. They are also good mass trapping devices when used at 2 – 3 numbers / 25 kg bin (28 cm dia and 39 cm length). They should be placed at top 6 inches of the grain, where the insect activity is seen during early period of storage. They can remove > 80% of the insects within 10 – 20 days.

Currently used by:

- Around 4 lakh people in India in states like Tamil Nadu, Kerala, Telangana, Uttar Pradesh and Madhya Pradesh uses TNAU insect trap.

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DRONE USAGE AND ITS APPLICATIONS IN AGRICULTURE

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Introduction

Drones are unscrewed aerial vehicles (also known as UAVs), which are used for surveillance in various industries. Till now, they were primarily used by companies working in industrial sectors such as mining and construction, army, and hobbyists. But now, drone technology is increasingly available for use in various sectors of agriculture as well. Though the technology is still nascent in India, many companies are trying so that it is easily available to Indian farmers and ready to be used to reduce the cost of application and increase efficiency in agricultural production.

Use of Agri-Drones is on the Rise:

A lot of drone-based agricultural projects are undergoing in India. Consider the following real-life scenarios:

- The Government of India has also released a certification scheme for agricultural drones, which can now carry a payload that does not include chemicals or other liquids used in spraying drones. Such liquids may be sprayed by following applicable rules and regulations.
- To promote the use of drones for agricultural purposes and reduce the labour burden on the farmers, the government of India has recently offered, a 100% subsidy or 10 lakhs, whichever is less, to the Farm Machinery Training and Testing Institutes, ICAR Institutes, Krishi Vigyan Kendras & State Agriculture Universities.

Additionally, a contingency fund of Rs.6000 / hectare will also be set up for hiring drones from custom hiring centres. The subsidy and the contingency funds will help the farmers access and adopt this extensive technology at an inexpensive price.

- The Indian government granted the International Crops Research Institute (ICRISAT), to use of drones for agricultural research activities. With this move, the government hopes to encourage budding researchers and entrepreneurs to look at budget-friendly drone solutions for more than 6.6 lakh Indian villages.
- Though the usage will be conditional, yet it is a revolutionary step that drones are poised to play a big role in agriculture, especially in areas including precision agriculture, improvement in crop yield, and locust control.

Advantages of using Drones in Agriculture:

Soil and field analysis

For efficient field planning, agricultural drones can be used for soil and field analysis. They can be used to mount sensors to evaluate moisture content in the soil, terrain conditions, soil conditions, soil erosion, nutrients content and fertility of the soil.

Crop monitoring

Crop surveillance is the supervision of crop progress from the time seeds are sown to the time for harvest. This includes providing fertilizers at the right time, checking for pest attack and monitoring the effect of weather conditions. Crop surveillance is the only way that a farmer can ensure a timely harvest, especially when dealing with seasonal crops.

Any errors at this stage can result in crop failure. Crop surveillance helps in understanding and planning for the next farming season. Drones can help in effective crop surveillance by inspecting the field with infrared cameras and based on their real-time information, farmers can take active measures to improve the condition of plants in the field.

Crop spraying

Agri-drones can be used to spray chemicals as they have reservoirs, which can be filled with fertilizers and pesticides for spraying on crops in very little time, as compared to traditional methods. Thus, drone technology can usher in a new era for precision agriculture.

Check crop health

Farming is a large-scale activity that takes place over acres of land. Constant surveys are necessary to monitor the health of the soil and the crop that has been planted. Manually, this may take days, and even then, there is space for human error. Drones can do the same job in a matter of hours. With infrared mapping, drones can gather information about both the health of the soil and the crop.

Avoid overuse of chemicals

Drones can prove to be especially effective in reducing the overuse of pesticides, insecticides and other chemicals. These chemicals indeed help to protect the crop. But, their overuse can prove to be detrimental. Drones can detect minute signs of pest attacks and provide accurate data regarding the degree and range of the attack. This can help farmers calculate the required amount of chemicals to be used that would only protect the crops rather than harming them.

Prepare for weather glitches

Weather conditions can prove to be a farmer’s best friend and worst enemy. Since these cannot be accurately predicted, it becomes extremely difficult to prepare for any shift in patterns. Drones can be used to detect upcoming weather conditions. Storm drones are already being used to make better predictions. And this information can be used by farmers to be better prepared. Advance notice of storms or lack of rain can be used to plan the crop to be planted that would be best suited to the season, and how to take care of planted crops at a later stage.

Monitor growth

Even when everything is going according to plan, crops need to be surveyed and monitored to ensure that the right amount of yield will be available at the time of harvest. It is also important for future planning, whether it is about determining the right price for the open market or harvesting cyclical crops. Drones can provide accurate data about every stage of the crop growth and report any variations before they become a crisis. Multispectral images can also provide accurate information about subtle differences between healthy and unhealthy crops that may be missed by the naked eye. For example, stressed crops will reflect less near-infrared light as compared to healthy crops. This difference cannot be detected by the human eye always. But drones can provide this information in the early stages.

Geo-fencing

The thermal cameras installed over drones can easily detect animals or human beings. So, drones can guard the fields from external damage caused by animals, especially at night.

Benefits of agri-drones:

- **High efficiency -** Drones do not have any operational delays and can work double the speed of human labour.
- **Water-saving -** In comparison to traditional spraying methods, agricultural drones use ultra-low volume (ULV) spraying technology, thus saving more water.
- **Low cost and easy to maintain -** Agri drones are sturdy, low in cost and require minimum maintenance. Some of the key features include a detachable container, low-cost frame, precise spraying of pesticides.

Limitations of agri drones:

Connectivity issue

Often, online coverage is unavailable in rural areas. Under such circumstances, a farmer needs to invest in internet connectivity, which can turn into a recurring expense.

Weather dependent

Drones do not have any operational delays and can work double the speed of human labour. Drones are heavily dependent on good weather conditions. Under rainy or windy weather conditions, it is not advisable to fly drones.

Knowledge and Skill

Using new technology is a welcoming change but using it daily requires the right skillset and adequate knowledge. An average farmer may struggle to understand drone functions. Either he must acquire the knowledge or remain dependent on an experienced person.

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CONSTRAINTS FOR PRODUCTION OF SESAMUM IN RAINFED CROP

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Introduction

Sesame (*Sesamum indicum* L.) is the oldest indigenous oilseed crop, with longest history of cultivation in India. Sesame or gingelli is commonly known as til (Hindi, Punjabi, Assamese, Bengali, Marathi), tal (Gujarati), nuvvulu, manchinuvvulu (Telugu), ellu (Tamil, Malayalam, Kannada), tila/pitratarpana (Sanskrit) and rasi (Odia) in different parts of India. Sesame seeds are called as the seed of immortality. Sesame grows in well drained, sandy loam soils,. Usually the crop is grown under rainfed conditions. India ranks first in world with 16.73 Lakh ha area and 6.5 Lakh tonnes production. The average yield of sesame (391 kg/ha) in India is low as compared with other countries in the world. Sesame seed (contain 50% oil, 25% protein and 15% carbohydrate) is used in baking, candy making and other food industries. It is an integral part of rituals, religion and culture. The oil is used in cooking, salad oils and margarine (contains about 40% oleic and 40% linoleic acid).

Sesame oil and foods fried in sesame oil have a long shelf life because the oil contains an antioxidant called sesamol. The oil can be used in the manufacture of soaps, paints, perfumes, pharmaceuticals and insecticides. Sesame meal is an excellent high quality protein (40%) feed for poultry and livestock. Sesame seeds are store house of energy and very rich in vitamins E, A, B Complex and minerals viz., calcium, phosphorus, iron, copper, magnesium, zinc and potassium. It is a best substitute for mother's milk especially incase of milk allergies. Sesame seed contains extraordinary quantities of methionine, tryptophan, amino acids with innumerable benefits. The oil is used as the base for Ayurvedic preparations and known as the Queen of oils.

CONSTRAINTS TO SESAME PRODUCTION IN RAINFED

Lack of access to improved varieties, high cost of seeds, low quality of seeds, low yield, climate change, insect pests, diseases, weeds, lack of market information, and low market price as the most critical constraints affecting sesame production. The most important constraints for production of sesamum in rainfed is identified as low yield. There are many constraints in sesame production in rainfed areas. However its production is affected by various constraints that limit its yield and quality. Farmers expressed poor seed systems and lack of quality seed producers as a bottleneck in sesame production.Climate change and insect pests are among the most essential yield-limiting factors mentioned by the sesame growers in the rainfed areas. Insect pests primarily cause yield reduction. A mean yield loss of 25% has been reported due to insect pest attacks. Similarly, sesame growers reported that drought and insect pests were among the major sesame production constraints in Myanmar. Therefore, the development and introduction of drought-tolerant and insect pest-resistant varieties to the seed system is crucial to minimize the risk of crop failure due to abiotic and biotic stresses and increase the crop's productivity.

Constraints:

Moisture stress

Sesame is highly sensitive to drought, and rainfed areas often face moisture stress, leading to reduced yields.

Soil erosion:

Rainfed areas are prone to soil erosion, which leads to soil degradation and reduced fertility.

Limited access to inputs:

Farmers in rainfed areas often have limited access to quality seeds, fertilizers, and pesticides.

Inadequate extension services:

Lack of extension services and training hinders farmer's ability to adopt best practices.

Pests and diseases:

Sesame is susceptible to various pests and diseases, which can significantly reduce yields. Sesame is susceptible to pests like aphids, whiteflies, and diseases like powder mildew, leaf spot and root rot.

Climate change:

Climate change is altering rainfall patterns, leading to uncertainty for sesame farmers.

Unpredictable rainfall:

Rainfed sesame farming relies on rainfall, which can be unpredictable and irregular, leading to failures.

Soil nutrient depletion:

Continuous cultivation without proper soil management leads to soil nutrient depletion, affecting sesame yields.

Weed competition:

Weeds compete with sesame for water and nutrients, reducing yields and quality.

Inadequate water harvesting:

Inadequate water harvesting and storage techniques lead to water sacarcity during critical growth stages.

Limited mechanization:

Lack of mechanization increases labour costs and reduces efficiency in sesame production.

Market fluctuations:

Sesame prices can fluctuate , affecting farmers income and livelihoods.

Soil salinity:

Soil salinity can affect sesame growth , especially in areas with poor drainage.

Limited access to credit:

Farmers in rainfed areas often have limited access to credit , hindering their ability to invest in inputs and technologies.

Climate -smart agriculture:

Limited adoption of climate-smart agriculture practices makes sesame productin vulnerable to climate change impacts.

Conclusion

Addressing these constraints requires a comprehensive approach, multifaceted approach including:

- Developing drought-tolerant sesame varieties
- Implementing conservation agriculture practices.
- Improving access to inputs and extension services.

- Promoting integrated pest management.
- Supporting climate-smart agriculture practices.

There is a need to improve the sesame value chain through incorporating improved and high-yielding varieties into the formal seed system, more expansive use of the best agronomic practices, strengthening the extension services, and developing market infrastructure and on-time market information delivery. These attributes can motivate farmers to produce higher quantities of better-quality seed to the market.

References:

Machhar R.G., Patel S.K., Kacha H.L., Patel U.M., Patel G.D. and Radha Rani R. (2015) American Journal of Agriculture and Forestry, 3(6), 376-379.

Machhar R.G., Patel S.K., Kacha H.L., Patel U.M., Patel G.D. and Radha Rani R. (2015) American Journal of Agriculture and Forestry, 3(6), 376-379.

Venkattakumar R. and Padmaiah M. (2020) INDIAN Research Journal of Extension Education, 10(30), 75-80.

Kumar A, Rathod M.K, and Kalantri L.B. (2012) Indian Research Journal of Extension Education, 2, 223-227.

Al-Eqaili, S.N.M., Lahmod, N.R. and Eshkandi, O. H. (2017). Weed management in sesame field (Sesamum indicum L.) Using wheat straw and tillage or no tillage systems. Am. J. Agric. Biol. Sci., 12(2):100-103.

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TOP TEN PET BIRDS OF INDIA

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Introduction

In India, many people have started adopting pet birds into their family due to their growing popularity. Birds are intelligent creatures and have an interactive nature which makes them great companions. They are friendly, gentle and well suited as family pets. There are many friendly pet birds that bring happiness into human life and make excellent companions.

The Common pet birds reared in India are:-

1) Cockatiels
2) Budgerigars
3) Love Birds
4) Zebra Finches
5) Conures
6) Dove
7) Hyacinth Macaw
8) Hahn's Macaw
9) Cockatoo
10) African grey parrot

1. Cockatiels (*Nymphicus hollandicus*)

Cockatiels are small parrots with a variety of colour patterns, head crest and capability of mimicking speech. They were discovered in Australia in 1770 in the northern part of the continent. Cockatiels are gentle, affectionate and have friendly personalities which make them easy to breed in captivity. Originally cockatiels have grey body with a yellow face and crest and orange cheek patch but there have been several colour mutations over the years due to breeding in captivity.

Cockatiel color	Indicators of male	Indicators of female
Wild type	Yellow head; no wing or tail spots/barring	(Mostly) grey head; wing or tail spots/barring present

Some common variations are albino, lutino, pied, pearl, laced or opaline, cinnamon, fawn or Isabelle and silver. It is not recommended to feed these birds with avocados, chocolate, coffee, and salt. It is important to clip their wings and nails twice a year and visit a veterinarian or breeder for the same to prevent them from bleeding to death.

The bird can be bathed or sprayed with water once a week to get rid of the powdery dust on its feathers.

Scientific Name	*Nymphicus hollandicus*
Common Name	Cockatiel, weiro, quarrion , tiel
Size	12 – 13 inches [Medium]
Sound Level	Low
Life Span	15 to 20 years depending on care
Interaction	Yes
Apartment Friendly	Yes
Colour	Grey, Albino, Lutino, Pied, Pearl, Cinnamon and Mixed patterns.

2. **Budgerigars (*Melopsittacus undulates*)**

Budgies are the smallest parrot species and are also known as parakeets. They are native to Australia and are extremely friendly, easy to tame and have the ability to mimic human speech. Budgies are very gentle and docile birds and can be handled well if adopted at a young age.

There are two types of budgies that are common in pet trading – the American budgie that is commonly found in pet stores and the English budgie that has a different appearance. Due to selective breeding in the pet trade, many colours and patterns of budgies are available including violet, blue, yellow, pied, albino and the classic neon green.

Sexing:-

Once a budgie is a few weeks old, you will be able to tell the sex of the bird by looking at its cere (the nose and nostril area). In normal circumstances, a hen's is brown, and a cock's is blue. The hen's cere becomes enlarged and scaly during the breeding season, and the male's becomes a darker shade of blue.

3. **Love Birds**

Love birds, also called pocket parrots, have origins from the African continent and are available in different species. There are three most popular species that prove excellent companions for human families of bird lovers. They are charming, loving, active, curious and feisty and playful and form deep bonds with the owner. They can be very cuddly birds but if not properly tamed and worked on from an early age they can be aggressive. They are known for their short, blunt tails with stockier build and are available in colours like peach, teal, white and green. Their main body has different colours than the head and face and over the years, there have been many colour mutations in them. They produce a loud, high pitched screech when trying to seek attention with normal chips that are not loud but they like to chatter. To maintain a tamed lovebird regular handling and training is important along with good socialization.

Types of lovebirds

The nine species of lovebirds have been mentioned below:

1) Grey-headed Lovebird.
2) Black-winged Lovebird.
3) Red-headed Lovebird.
4) Peach-faced Lovebird.
5) Black-cheeked Lovebird.
6) Fischer's Lovebird.
7) Lilian's Lovebird.
8) Yellow-collared Lovebird.
9) Black-collared Lovebird

No Sexual Dimorphism. DNA sexing is the best method of sexing.

4. Zebra Finches (*Taeniopygia guttata*)

Zebra finches are active, highly social, fun to watch and must be kept in large cages for flight. Zebra finches have their native habitats in the arid areas of central Australia, Indonesia and East Timor where they live in large flocks but they originated in Costa Rica and Portugal. The wild flocks of this bird prefer grasslands and forests preferably close to water. These birds are easy to care for, an excellent choice for first-time bird owners and should be kept in pairs. These birds are to be kept in pairs and if there are many pairs it is recommended to keep them in a large cage for flight and movement. They can tolerate a wide range of temperature but the cage must not be placed in direct sunlight or near air conditioning ducts.

Sexing:-

Male Zebra Finches have black and white bars on their throat and breast, brown patches on their side and orange on cheeks. The females have grey in those areas.

The male beak is brighter in colour both male and female zebra finches have red-orange beaks. Many colour mutations have developed over the years due to selective captive breeding.

5. Conures

Conures are affectionate and want to spend time with their owners. It is not easy to care for a conure bird as they require daily exercise and socialisation. There have been several colour variations including pineapple conures, turquoise, yellow-sided, cinnamon due to selective breeding in captivity.

Types of Conures:-

There are 15 Types of Pet Conure Parrots are available. Some of the important conures are:- ·

- Sun conure (*Aratinga solstitialis*)
- Jenday conure (*Aratinga jandaya*)
- Nanday conure (*Aratinga nenday*)
- Dusky headed conure (*Aratinga weddellii*)
- Gold capped conure (*Aratinga auricapillus*)
- Dusky headed conure (*Aratinga weddellii*)
- Green cheeked conure (*Pyrrhura molinae*)

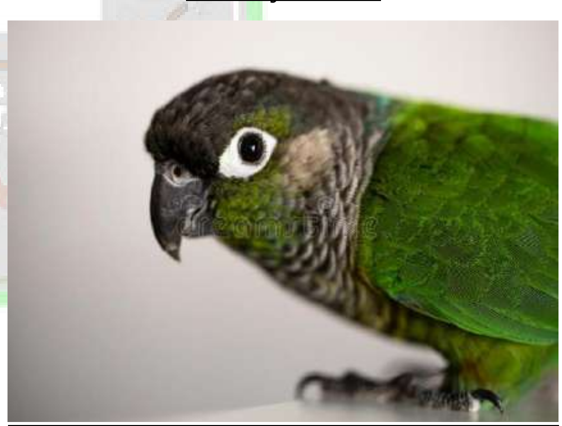
Continuous supply of fresh fruits and vegetables every day ensures good immunity against all Potential diseases. There have been several colour variations other than pineapple conures including turquoise, yellow-sided, cinnamon due to selective breeding in captivity.

Conures

Sun conure

Nanday conure

Jenday Conure



Green Cheeked Conure

6. Doves

Doves are peaceful in nature and are a great choice for older children who understand how to be calm and gentle with companion animals. There are more than 300 species of doves but the term commonly refers to the ring-necked dove originating from Africa, fruits doves in Australia and mourning doves in North America. They are friendly, non-demanding pets that can be kept indoors or outdoors. These birds are tame, domesticated, handfed and have sweet, gentle dispositions as they rarely bite or damage with their beaks.

Pet doves have a variety of selectively bred colours and colour combinations like pure white, tangerine, pied, orange and white-grey combination with specific markings.

Their eyes and bill are black coloured and they have dark purple feet. These birds have similar-looking males and females, although males are slightly larger in size. They need exposure to natural UV lights from the sunlight or supplemental lighting indoors to avoid vitamin D deficiency.

Their diet can be supplemented with millets, commercial pellets formulated for softbills, and a variety of bird-safe fruits and vegetables. They need plenty of free flight time and interaction with the owner.

7. **Hyacinth Macaw Bird (*Anodorhynchus hyacinthinus*)**

Hyacinth macaw is a beautiful, cobalt blue bird and is more common in zoos than in private homes. It is native to the central and eastern region of South America and has populations in Brazil, eastern Bolivia and northeastern Paraguay. It is a rare and threatened species and must be kept by an owner that can fulfil all its needs and take good care. Hyacinth macaw is a gentle bird as opposed to how frightening it appears due to its enormous size and powerful, sharp hooked beak.

These birds are easy to train by positive reinforcement and bond strongly with their human caregivers. They have multiple varieties of vocalizations from deep growls, loud screeching to high vibrating sounds and are also capable of purring. These birds have a beautiful deep solid blue shade with bright yellow patches around the eyes and beak.

These birds are very destructive and it is important to ensure there are many wooden toys and branches to chew on in their spacious cage. Investing in a strong, durable stainless steel cage is necessary to avoid the bird from breaking the cage into rubble with its beak. They must be taught at an early age not to use their beak on their human caregivers no matter how gently as they have very powerful beaks. They are often considered neurotic due to their screaming, destructive and self-mutilating behaviour. However, with good socialisation and ample attention from the owner, this bird proves to be among the friendliest of all macaw species. They are highly intelligent and learn to use words and phrases in correct context and repeat a few of them continually. A macaw's diet consists of nuts, fruits, and seeds that it cracks open with its powerful beak. They will also eat some insects as a snack. Macaws are not picky about what they eat and will eat whatever is available in the wild. They require more amounts of carbohydrates compared to other parrot species. They can also be given specially formulated species-specific pellets supplementing with the diet.

No Sexual Dimorphism. DNA sexing is advisable.

8. **Hahn's Macaw** *(Diopsittaca nobilis)*

Hahn's macaw is one of the two varieties of red-shouldered macaws and is the most popular among the miniature macaws. It is native to South America and is the smallest among the macaws. They are intelligent, charming and have a great personality in a small compact body. They perform spirited antics that are fun to watch and their size makes them suitable for families who live in smaller space and with children. They are very noisy and hence cannot stay in apartment living as they can be annoying for the neighbours. Though they nip a bit during young age, they are very gentle birds that grow out of that habit.

Cost of Macaws:-

The price of Macaw Parrot in India starts from Rs.60,000 and it can go up to Rs.44,00,000 depending upon the sub-species and color of the Macaw parrot that you want to buy. The most affordable species of Macaw parrots are Hahns Macaw as they cost anywhere between Rs.60,000 to Rs.90,000 and the most expensive species of Macaw parrots is Hyacinth Macaw. They are also very rare and come at a price tag of whooping **40 lakhs rupees.**

Life span:- Macaws live between 30 and 60 years in the wild, considering the fact that it varies and is dependent on the species. In captivity, it will live up to 70 years.

9. Cockatoos

A cockatoo is a parrot species belonging to the family Cacatuidae, the only family in the superfamily Cacatuoidea. Along with the Psittacoidea and the Strigopoidea, they make up the order Psittaciformes. The average cockatoo lifespan is 20 – 40 years in the wild. However, in captivity, cockatoos have been known to live much longer. There are about 44 different birds in the cockatoo family Cacatuidae. Some of the common cockatoos are:-

- Sulphur-crested cockatoo (*Cacatua galerita*)
- White cockatoo or umbrella cockatoo (*Cacatua alba)*
- Red-vented cockatoo or Philippine cockatoo (*Cacatua haematuropygia*)
- Galah Cockatoo (*Eolophus roseicapilla*)

- Palm cockatoo (*Probosciger aterrimus*)

 Sulphur crested Cockatoo	 Umbrella Cockatoo
 Red Vented Cockatoo	 Galah Cockatoo
 Palm Cockatoo	 Sulphur crested cockatoo- in balcony

The cockatoos are generally medium to large parrots of stocky build, which range from 30–60 cm in length and 300–1,200 g in weight. The movable headcrest, which is present in all cockatoos. Cockatoos share many features with other parrots, including the characteristic curved beak shape and a zygodactyl foot, with the two middle toes forward and the two outer toes backward. They differ in the presence of an erectile crest.

Like other parrots, cockatoos have short legs, strong claws, a waddling gait and often use their strong bill as a third limb when climbing through branches. They generally have long broad wings used in rapid flight, with speeds up to 70 km/h being recorded for galahs Cockatoo.

Cockatoos are diurnal and require daylight to find their food. They are not early risers, instead waiting until the sun has warmed their roosting sites before feeding. All species are generally highly social and roost, forage and travel in colourful and noisy flocks.

Price:- Rs. 60,000 to 1,50,000

10. African grey parrot (*Psittacus erithacus*)

The grey parrot, also known as the Congo grey parrot, Congo African grey parrot or African grey parrot, is an Old World parrot in the family Psittacidae. Grey parrots, commonly called African greys, are native to rainforests of central Africa. African grey parrots generally inhabit savannas, coastal mangroves, woodland and edges of forest clearings in their West and Central Africa range. Though the larger of the African grey subspecies is referred to as the Congo African grey, this bird actually has a much wider natural range in Africa, including the southeastern Ivory Coast, Kenya, and Tanzania. The largest parrot in Africa, this species has silver feathers, a white mask, and a bright, reddish tail. Males and females are very similar in appearance

. The African grey parrot is one of the most talented talking/ mimicking birds on the planet, giving it quite a reputation among bird enthusiasts. The African grey parrot is not just a top talker — this bird is also known for its extreme intelligence, which gives them the moniker "**The Einstein's of the Bird World**."

These monogamous parrots, which mate for life, begin searching for mates between three and five years of age. A pair will seek out pre-existing tree cavities in which to make a nest, lay a clutch of about three to four eggs, which are incubated by the female. Parents are attentive, building well-made nests and feeding their chicks together. African grey parrots have an estimated average lifespan of 22.7 years in their natural environment. They are very long-lived in captivity, potentially surviving for 40-60 years with good care.

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FINGER MILLET BASED CROPPING SYSTEM

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Introduction

The term "cropping system" refers to the combination of crops, crop sequences, and management techniques employed on a specific agricultural field over several years. It encompasses all spatial and temporal aspects of agricultural system management. In general, cropping systems are designed to optimize crop yield, increase farm net income, and promote environmental sustainability and soil health.

Millet-based cropping systems are particularly compelling due to the nutritional value and climate resilience of millets. Millets, known for their high nutritional content including proteins, iron, and calcium, are excellent sources of energy and antioxidants. The Indian Government acknowledged the importance of small millets by declaring 2018 as "The Year of Nutri-Cereals," while the FAO celebrated 2023 as the "International Year of Millets," highlighting their global significance.

In India, agriculture mainly depends on rainfed conditions with common cropping systems like paddy-paddy, paddy-groundnut, paddy-sesame, paddy-little millet, and vegetable-vegetables. However, diversification in agriculture has led many farmers away from strict adherence to proper cropping systems. Educated but unemployed or underemployed youth are exploring entrepreneurial opportunities in agriculture. Although they inherit traditional farming knowledge, they often find it less financially rewarding. Equipping them with knowledge and skills related to healthy and profitable cropping systems is crucial.

The adoption of millet-based cropping systems offers several benefits:

- Enhanced millet productivity
- Improved soil fertility
- Reduction in soil erosion
- Enhancement of soil structure
- Diversification and reduced production costs

Finger millet, in particular, is a significant nutri-cereal crop, constituting over 25% of India's food grain production. It is nutritionally comparable to or even superior to wheat and rice, containing essential amino acids, minerals, and fiber. Traditional malting processes enhance finger millet's nutritional value, producing products like "ragi malt" used in infant foods and milk thickeners.

Approaches for Sustainable Production of Finger Millet

To ensure the sustainable production of millets, several innovative technologies and practices are essential:

- Development of Millet-Based Intercropping Systems
- Integrated Nutrient Management
- Utilizing Natural Resources for Nutrients and Soil Water Conservation
- Development of Millet-Based Integrated Farming Systems
- Integrated Weed Management
- Adoption of Integrated Pest and Disease Management

Development of millet based cropping system

Incorporating millets into cropping systems alongside pulses, oilseeds, cereals, and sugar crops offers a multitude of benefits, including:

- Enhanced Soil Fertility Assessment
- Pest and Disease Monitoring
- Optimal Resource Utilization
- Time and Space Optimization
- Efficient Nutrient Utilization
- Diverse and Stable Fields
- Resource Sharing

- Weed Control and Reduced Susceptibility
- Reduced Chemical/Fertilizer Use

Some compatible finger millet-based cropping systems include:

i. Finger millet + Black gram / Green gram / Cowpea

ii. Finger millet + Red gram

iii. Finger millet + Mustard

iv. Finger millet + Amaranthus

v. Finger millet + Groundnut, and more.

Implementing these diverse cropping systems can contribute to sustainable agriculture while maximizing productivity.

Integrated nutrient management

Integrated Nutrient Management refers to the maintenance of soil fertility and plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic, and biological components in an integrated manner. The reason for nutrient depletion in the soil is as follows

- Continuous cultivation of the same type of crop leads to the depletion of nutrients
- Each and every crop have different nutrient interaction with the soil

Because of this, the cultivation of finger millet along with pulses as intercrop and rotational crop helps to enrich the soil fertility, which may help to reduce chemical fertilizer usage and can also get a quality product free from chemical residues.

Utilizing natural resources as nutrients as well as for soil water conservation

Generally, cropping systems have a different rooting pattern which enhances the full use of water and water usage in the root zone. When we use wide-growing crops as intercrop reduces the inter-row evaporation and reduces transpiration and it creates a microclimate to plant growth and development.

Development of millet based integrated farming system

Ray, *et al*., (2014) refered that the multi cropping is probably one of the best methods where optimum utilization of natural resources is made. Mixed farming and inter cropping are the different ways of multi cropping by which the net yield per area can be increased. Mixed cropping along with allied enterprises improves the farmers livlihood.

Optimum planting geometry

The arrangement of the plants in different rows and columns in an area to efficiently utilize natural resources is called crop geometry. This is very essential to utilize the resources like light, water, nutrient and space. The plant geometry helps to maintain the plant population which decides the following parameters

- Plant yield
- Plant population is higher - depletes the soil moisture before maturity, low single plant yield
- Less plant population - leave the soil moisture unutilized and high single plant yield
- Utilizing solar radiation efficiently and nutrients

To get maximum yield per unit area, optimum plant population is necessary. Praveen jakhar *et al*., 2015. Stated that the strip cropping of 6 rows of finger millet with 4 rows of groundnut steadily gave higher finger millet equivalent yield, maximum net returns, lowest values of soil loss, higher values for other nutrients conservation and highest benefit: cost ratio.

Intercropping

Intercropping is a farming technique defined as the concurrent cultivation of two or more crops on the same piece of land. This approach is particularly valuable in rainfed agriculture, where crop yields can be unstable due to variable rainfall patterns. In India, finger millet is a commonly grown rainfed crop during the Kharif season. When practicing intercropping with finger millet, it's essential to consider the following points:

- Rooting Patterns
- Diverse Plant Families
- Legumes and Non-legumes
- Allelopathic Properties

Irrigation requirement

Irrigation is the process of applying water to crops artificially to fulfill their water requirements. Some points to be considered in finger millet-based intercropping system

i. Total water requirement of finger millet – 350 mm
ii. Critical stages of finger millet – Tillering and flowering
iii. Problems in rainfed agriculture
    a. Prolonged dry spell during the cropping period

b. Rainfall water stagnation

iv. Soil erosion leads to the leaching of top-fertile soil

Generally, In India finger millet is grown in the rainfed condition which does not need any irrigation. If the rain stops for a long day or prolongs a dry spell during the growth period, then irrigation is necessary for obtaining good growth and yield. Before sowing formation of bunds and trench allows rainwater to cover the field and moisture to percolate and be retained in the soil. It will help to escape the crop from the dry spells without any loss. During rainfall water stagnation making drainage facilities to remove the excess water is also essential. Adopting the following practices increase moisture conservation in the soil which reduces yield loss and also increased yield from a finger millet-based cropping system.

i. Supplemental irrigation during critical stages

ii. Mulching with crop residues – retain the moisture and also suppresses the weeds

iii. Quick growing and wide spread crops as intercrop

iv. Application of organic manure to retain soil moisture

Weed management in millet based cropping system

Weed management is the major issue in the present day agriculture due to lack of labour availability. But we have to produce food for the growing population. Kept field free from weeds during the critical period helps to avoiding competition between the crops and weeds and which paves way to acheiving optimum yield in fingermillet based cropping system.

Wanted plants grown in an unwanted place called weeds. Weeds compete for light, moisture and nutrients to the crops and also affect the quality and quantity of produce. It acts as a harbor for pests and diseases.

Weeds smother the finger millet resulting in a significant reduction in the yield by 5 to 70%. The critical period for weed competition in finger millet is the first 4-6 weeks from planting/seeding (Rao, 2021)

Weed management practices

1. Summer plouging – weed seed and propagating materials exposure to sunlight
2. Conventional tillage – Reduced number of weeds compared to reduced and minimum tillage
3. Mulching – which suppresses weed growth and also helps to conserve soil water
4. Intercropping - suppress weed growth and pest and disease problem

5. Application of herbicides suitable for cropping system

Finger millet + legumes recorded a more sustainable yield and fewer weeds, insects, and disease infestation in the crop. When including legumes and oilseeds in finger millet-based cropping systems reduced fertilizer, herbicides, and insecticides application in crops than sole cropping. (Dharam Singh Meena *et al*.,2017)

There was a significant reduction in weed density and biomass for the intercropping system over both monocrops. Finger millet facilitated an increase in nodule number and dry weight in horse gram under intercropping over monocrops, moreover, the root length of horse gram was greater when intercropped (Pradhan *et al*., 2018).

Mishra *et al*., (2018) revealed that most herbicides are crop specific and therefore all herbicides cannot be used in intercropping systems. Use of pendimethalin (0.75 to 1.0 kg/a), metolachlor (1.0 kg/ha), butachlor (0.75 to I.0 kg/ha) was found safe and effective in finger millet intercropping systems.

Pest and disease management

In agricultural crop yield loss due to pests and diseases ranges from 20-40 %. Fingermillet is an hardiest crop. Even though, It was affected by various pests and diseases. The major pest of finger millet is stem borer and the disease is a blast. It causes severe yield loss in finger millet-based cropping systems.

Adarsh *et al*., 2019 referred that the cropping system including pulses consists of intercropping sequential cropping, mixed cropping, relay cropping and paira cropping. They improve soil properties and reduced pest and disease problems.

Dharam Singh Meena *et al*., 2017 revealed that in different finger mill-based cropping systems finger millet + legumes recorded more sustainable yield and fewer weeds, insects and disease infestation in the crop. Also, finger millet-based cropping systems reduced fertilizer, herbicides and insecticides.

Conclusion and forward

Finger millet is the most important Nutri cereals crop. It has several health benefits and is also stable food for most Indian people. In this present situation taking care of health is more challenging. Developing a finger millet-based cropping system is one of the ways to improve our health and improve the farmer's livelihood. In a finger millet-based cropping system inclusion of pulses, oilseeds, greens, etc, reduce the external input usage, increase the soil fertility, smothering effect control runoff soil loss and the weed population. Weed management also plays a major role in pest and disease management. When following various cropping systems sustain the finger millet production.

The following studies were needed in future

i. Bio-fortification of finger millets with minerals,
ii. A study needs on precision agriculture
iii. Crop models need to develope
iv. Need to develop an organic package of practices
v. Develop more compatible cropping systems to enhance productivity and reduces the weeds, pest and disease population.

References

Adarsh, S., Jacob John, Giffy Thomas. 2019. Role of pulses in cropping systems.A Review. Agricultural Reviews, Vol 40; Issue 3.

Adusumilli Narayana Rao.2021. Weed management in finger millet in India- an overview. Indian Journal of Weed Science 53(4): 324–335.

Binod Kumar and Dr. Pankaj Kumar Ray. 2017. Performance of intercropping of legumes with finger millet (Eleusine coracana) for enhancing productivity, sustainability and economics in Koshi region of Bihar. Journal of Pharmacognosy and Phytochemistry 2020; 9(3): 1568-1571.

Dharam Singh Meena , Chirag Gautam, Om Prakash Patidar , Ranvir Singh , Hari Mohan Meena , Vishwajith1 and G. Prakash. 2017. Management of Finger Millet based Cropping Systems for Sustainable Production. Int.J.Curr.Microbiol.App.Sci. 6(3): 676-686.

Mishra, J.S, Rakesh kumar, P.K. Upadhyay and Hansraj Hans. 2018. Weed management in millets. Indian farming 68 (11) : 77 -79.

Praveen Jakhari, P.P. Ashikary, B.S. Naik and M. Madhu. 2015. Finger millet (Eleusine coracana)–groundnut (Arachis hypogaea) strip cropping for enhanced productivity and resource conservation in uplands of Eastern Ghats of Odisha. Indian Journal of Agronomy 60 (3): 365-371.

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ROOT WILT (or) KERALA WILT: A DESTRUCTIVE DISEASE IN COCONUT PLANTATION

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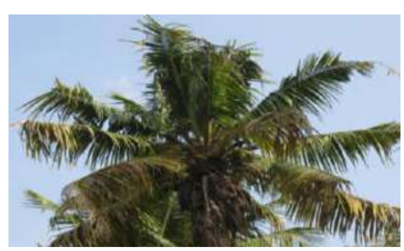
Introduction

In Tamil Nadu, a deadly disease, the root wilt of coconut is causing concern to the coconut growers. The disease has wide spread occurrence especially in the adjoining areas of Kerala state.

Causal Organism: *Phytoplasma*

SYMPTOM:

- Tapering of terminal portion of the trunk.
- Reduction of leaf size
- Abnormal bending or Ribbing of leaf lets termed as flaccidity.
- Flowering is delayed and also yield is considerably reduced.
- The characteristic symptom is the **flaccidity** of leaflets. This is the earliest visual symptom. In the beginning yellowing is restricted from the leaf tips to the middle of the leaves, necrosis of leaflets and deterioration and decay of root system are other salient features of the disease. The leaflets curve inwardly to produce ribbing so that the whole frond develops a cup like appearance. Abnormal shedding of buttons and immature nuts are also noticed.



Flaccidity

Yellowing

Marginal Necrosis

Leaf rot

Rotting of Spindle

Necrosis of Inflorescence

Rotting of roots

Vector

Stephanitis typica

Proutista moesta

MANAGEMENT:

Cultural Method:

- Cut and remove disease advanced, uneconomical palms yielding less than 10 nuts per palm per year
- Grow green manure crops - cowpea, sunhemp (*Crotalaria juncea*), *Mimosa invisa*, *Calapagonium mucanoides*, *Pueraria phaseoloides* etc. may be sown in coconut basins during April-May and incorporated during September-October.
- Grow suitable inter and mixed crops (banana, pepper, cocoa, elephant foot yam, turmeric etc.).
- Irrigate coconut palms with at least 250 litre water in a week.
- Adopt suitable inter/mixed cropping in coconut gardens.
- Provide adequate drainage facilities.
- Grow suitable inter and mixed crops (banana, pepper, cocoa, elephant foot yam, turmeric etc.).
- Root feeding with TNAU coconut tonic @ 200ml/palm at 6 months interval

Biological method:

- Apply farm yard manure @ 50 kg.
- Soil application of neem cake @ 5kg/palm.
- Soil application of *Bacillus subtilis* @ 100g/palm and *Trichoderma asperillum* @ 100g/palm at three months interval.
- Soil application of Phosphobacteria @ 100g+ Azospirillum @ 100g + VAM @ 50g/palm/year (two times per year at six months intervals).

- Soil application of Cococon (microbial consortia) @ 2 litres / palm at three months' interval can be done in the plantations having mild infection.

Chemical Method:

- Apply fertilizers for coconut palms in average management at the rate of 1.3 kg urea, 2.00 kg super phosphate and 3.5 kg potash (MOP) / palm / year in the form of urea, rock phosphate and muriate of potash, respectively.
- Magnesium may be supplied @ 500 g MgO per palm per year
- Soil application of copper sulphate @ 200g and magnesium sulphate @ 100g/ palm (copper sulphate 100g and magnesium sulphate 500g applied alternatively at three-month intervals twice in a year).
- Root feeding with TNAU coconut tonic @ 200ml/palm at 6 months interval.
- Fipronil 0.3G mixed with fine sand @ 1:1 ratio and apply around the base of the spindle leaf for managing the insect vectors.
- The associated leaf rot disease can be managed by r emoving and destroying the severely rotten leaves
- Pouring hexaconazole 5 EC (2 ml in 300 ml of water) around the spindle leaf and spray with mancozeb @ 0.3%

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MEDICINAL PROPERTIES OF *ACALYPHA INDICA*

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Abstract

Acalypha indica is an important medicinal herb belonging to the family Euphorbiaceae. It is largely used in traditional medicinal system and modern medicina has recently studying its potential medicinal activity in terms of antimicrobial, antioxidant, anti-diabetic and hepatoprotective properties. The phytochemical studies has revealed its potential medicinal components belonging to the classes of phenols and flavonoids which are the reason behind its medicinal properties.

Introduction

Acalypha indica is a herb with potential medicinal properties which is not being utilized to its possible magnitude. It is found to be distributed more in the tropical regions; But it can be found in wet and temperate regions. In India it is categorized as weed by modern crop science though its medicinal utility is known in Siddha and Ayurvedha systems of medicine. It is reported to treat ulcer, bronchitis, asthma, wounds and has marked anti-bacterial, anthelmintic and emetic properties being utilized by the local people. I is very good in curing skin problems and hence gets the tamil name ‘Kuppaimeni’, where the name ‘meni’ indicates skin. It is proven to have many medicinal principals such as Acaindinin, Flindersin *etc. In vitro* and *in vivo* studies have proven the antimicrobial, antioxidant, anti-diabetic and hepatoprotective properties.

Common names:

English	-	Indian Copper Leaf
Tamil	-	Kuppameni

Malayalam	-	Kuppamani
Kannada	-	Chalmari
Telugu	-	Kuppintaku
Hindi	-	Kuppi

Botany

Acalypha indica is an annual herb, belongs to the family Euphorbiaceae; growing upto 60 cm tall; stem striate, pubescent. The leaves are broadly ovate, base rounded to shortly attenuate, margin crenate-serrate, apex acute or obtuse, basally 5-nerved; petiolate. Inflorescence is a spikes; borne axillary; solitary or paired; monoecious, rachis ending in a triradiate hood at the tip. The lower portion of the spike bears female flowers to about 75 % and the male flowers in the upper portion. Bracts of female flowers are ovate, toothed. Female flowers are sessile without petals; 3 triangular to ovate ciliate sepals. Ovary superior, 3-celled, slightly 3-lobed, styles 3, fused at base and fringed Male flowers four lobed, minute, granular dotted with greenish calyx and stamens 8. Fruits are small and hairy with minute seeds; Seeds are ovoid, pale brown in capsules with granular dots.

Medicinal properties

Origin of Acalypha indica is India, Indo China and Ethiopia. The plant is a well known herb in traditional medicinal system in these regions. It gets the name Kuppaimeni in Tamil from its usage in skin health care. It is said to have antidiuretic, anthelmintic properties in addition to its activity against respiratory problems and rheumatoid arthritis. It is used as green leafy vegetable which reduces ulcer. Vomiting, earache, head ache are treated by leaf decoction. It is used to treat asthma, pneumonia, stomach discomforts, skin injuries and snake bites.

Phytoconstituents

S.No.	Constituent	Part
1.	1-Eicosanol	**Chaichoowong** *et al.*, 2017
2.	Acaindinin	Zahidin *et al.*, 2017
3.	Acalyphamide	Zahidin *et al.*, 2017
4.	Acetonylgeraniin	Zahidin *et al.*, 2017
5.	Antimycin A	Sahukari *et al.*, 2021
6.	Aurantiamide	Zahidin *et al.*, 2017
7.	Bumetanide	Sahukari *et al.*, 2021
8.	Choline	Sahukari *et al.*, 2021
9.	Corilagin	Zahidin *et al.*, 2017
10.	Dihydroactinidiolide	**Chaichoowong** *et al.*, 2017
11.	*Docosanol*	**Chaichoowong** *et al.*, 2017
12.	Fenofibrate	Sahukari *et al.*, 2021
13.	Flindersin	Zahidin *et al.*, 2017
14.	Geranin	Zahidin *et al.*, 2017
15.	Loliolide	**Chaichoowong** *et al.*, 2017
16.	Octacosanol	**Chaichoowong** *et al.*, 2017
17.	Oxprenolol	Sahukari *et al.*, 2021
18.	Quinone	Sahukari *et al.*, 2021
19.	Ramipril glucuronide	Sahukari *et al.*, 2021
20.	Stigmasterol	Zahidin *et al.*, 2017
21.	Succinimide	Zahidin *et al.*, 2017
22.	Swietenine	Sahukari *et al.*, 2021
23.	Tectoquinone	Zahidin *et al.*, 2017
24.	Triacetonamine Leaf	Zahidin *et al.*, 2017
25.	Tricosene	**Chaichoowong** *et al.*, 2017

Antimicrobial activity

The root, stem and leaf of *A. indica* possess antibacterial pathogens. activity Historically, against plants human have provided a good source of anti-infective agents and many of them remain highly effective in the fight against microbial infections. Besides, they are cost- effective and have fewer side effects (Vijayrekha *et al*., 2015). The ethanol extract of leaves was found to be exhibit activity against *Escherichia coli*, *Salmonella typhi*, *Pseudomonous aeruginosa* and *Staphylococcus aureus* (Chandramohan *et al*., 2012)

Antioxidant activity

Methanolic extract of *A. indica* stems improved the antioxidant status in diabetic rats (Priya *et al*., 2016). Root of A. indica showed the highest antioxidant activity than that of the leaves according to the results of Shanmugapriya *et al*., (2011). Polyphenolic fraction of the methanolic extract of *A.indica* induced the antioxidant enzymes in diabetic rats. The extract also potentially showed cytotoxic activity against brine shrimp. In vitro and in vivo experiments showed rich amount of polyphenols (antioxidants) and cytotoxic compounds for their respective activities. Polyphenolic fraction has the induction capacity to elevate cellular antioxidant enzymes in diabetic animals (Ravi *et al*., (2017).

Anti diabetic activity

Methanolic leaf extract of *A. indica* has good potential in the control of hyperglycemia, diabetes and the related state of oxidative stress (Kumar *et al*., 2023) . *A. indica* stems extract is effective in suppressing maltose and sucrose-induced postprandial hyperglycemic spikes in rats. The α-glucosidase inhibitor isolated from *A. indica* stems is a good supplement to control postprandial blood glucose level in the management of type 2 diabetes (Priya *et al*., 2016). Ai has a strong potency to be developed as antihyperglycaemia-antiobesity. *A. indica* has a strong potency to be developed as antihyperglycaemia-antiobesity.

Hepatoprotective activity

A. indica is reported to have hepatoprotective activity in comibination with *Centella asiatica*. In vitro study of methanolic leaf extract of *A. indica* against CCl4 induced hepatic damage in goat liver slice culture proven its efficacy against liver diseases. Treatment with *A. indica* protects the liver against paracetamol-induced hepatotoxicity probably due to its antioxidant effect. In diabetic rats recovery from liver damage caused by streptozotocin was reported (Priya *et al*., 2016).

Neuroprotective activity

Water extract of *A. indica* Linn. root has comparable protective and treatment effect on nervous system. Purwaningsih *et al*. (2010) stated the stigmasterol compound wasresponsible for the neuroprotective activity since it was found in the root.

References

Chaichoowonga S, Bolb J. B, Bolc P, Gamseb T, Sriariyanuna M. 2017. Chemical Profiling of *Acalypha indica* Obtained from Supercritical Carbon Dioxide Extraction and Soxhlet Extraction Methods. Orient J Chem. 33(1).

Kumar N. R, Srikrishna P, Rani S, Swathi, Rani A. R. 2023. Evaluation of Antioxidant and Antidiabetic Potential of *Acalypha indica* leaf extract: Identification of Bioactive Factors. Biosc.Biotech.Res.Comm. 16(3).

Mohan, Chandra & Dinakar, S & Thirupathi, Anand & Elayaraja, R and Sathiyapriya, B. 2012. Phytochemical, GC-MS analysis and Antibacterial activity of a Medicinal Plant *Acalypha indica*. International Journal of Pharm Tech Research. 4. 974-4304.

Priya CL, Bhaskara Rao KV. 2016. Postprandial Antihyperglycemic And Antioxidant Activities of *Acalypha indica* Linn Stem Extract: An *In-vivo* Study. Pharmacogn Mag. doi: 10.4103/0973-1296.191461. PMID: 27761078; PMCID: PMC5068127.

Purwaningsih, Ernie , Ibrahim, Nurhadi and Zain, Hamdani. 2010. The nerve protection and in vivo therapeutic effect of *Acalypha indica* extract in frogs. Medical Journal of Indonesia. 19. 96. 10.13181/mji.v19i2.389.

Ravi S, Shanmugam B, Subbaiah GV, Prasad SH, Reddy KS. 2017. Identification of food preservative, stress relief compounds by GC-MS and HR-LC/Q-TOF/MS; evaluation of antioxidant activity of *Acalypha indica* leaves methanolic extract (in vitro) and polyphenolic fraction (in vivo). J Food Sci Technol. 54(6):1585-1596.

Shanmugapriya, Ramanathan Palaniyandi, and Thirunavukkarasu. 2011. Evaluation of Antioxidant Potential and Antibacterial Activity of *Acalypha indica* Linn. using in vitro model.. Asian Journal of Biomedical and Pharmaceutical Sciences. 1. 18-22.

Vijayarekha P, Sangottaiyan N, Noorjahan A and Ambiga S. 2015. Antibacterial Activity of *Acalypha indica* Linn. Int.J.Curr.Microbiol.App.Sci. 4(6): 1133-1138.

Zahidin NS, Saidin S, Zulkifli RM, Muhamad II, Ya'akob H, Nur H. 2017. A review of *Acalypha indica* L. (Euphorbiaceae) as traditional medicinal plant and its therapeutic potential. J Ethnopharmacol. 31;207:146-173. doi: 10.1016/j.jep.2017.06.019. Epub 2017 Jun 21. PMID: 28647509.

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SEAGRASS MEADOWS: A CRITICAL HABITAT FOR MARINE FAUNA

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Abstract

The seagrass meadows are one of the most productive and ecologically significant ecosystems, which provide critical habitats for a diverse range of marine fauna. They are found in the coastal and estuarine regions across the globe except in the polar regions due to ice scouring. As compared to mangroves and coral reefs, the seagrass beds have wider distribution owing to their unique adaptability to a wide range of environmental conditions. They provide important ecological services, which are crucial for maintaining resilience and the overall health of the marine environment. The seagrass is home to various species of fish and invertebrates. The high primary and secondary productivity offer enormous food resources to associated fauna. Organisms such as polychaetes, bivalves, gastropods, crustaceans, cephalopods, fishes, turtles and dugongs live within the seagrass ecosystem. This article emphasizes the role of structured habitat in the overall biodiversity of an ecosystem.

Keywords: Seagrass, Ecosystem, Habitat, Fauna

Introduction

The seagrass meadows are one of the most productive ecosystems on the Earth, which plays an important role in harbouring a wide variety of marine fauna. They are named “seagrass” despite not being a true grass owing to their terrestrial grass-like appearance. These are monocotyledonous vascular plants that are found in coastal and estuarine regions of the world. The seagrasses provide a complex habitat for several benthic organisms. By offering food, shelter and breeding grounds, they support a high diversity of organisms. The seagrass ecosystem can be defined as a unit of biological organisation consisting of biotic and abiotic components interacting with each other. These seagrass meadows are more widespread than coral reefs and mangrove forests. They are present worldwide (except in polar areas due to ice scouring), which can be attributed to their ability to adapt various environments. They can be found in shallower to deeper regions of both tropical as well as temperate environments where sufficient light can penetrate sufficiently for photosynthesis. On the other hand, coral reefs are primarily found in tropical and subtropical regions where water is relatively warm. Similarly, mangrove forests are limited to these regions only. Globally, there are approximately 72 species of seagrasses (Short et al., 2011), ranging from temperate to tropical environments, with most of them co-occurring (Orth et al., 2006).

The longest recorded species is *Zostera caulescens* (7 meters) and the deepest growing species, *Halophila decipiens* (at 86 meters of depth), are found in Japan and Mauritius, respectively. These plants have unique morphological and physiological adaptations for completely submerged conditions, including internal gas transportation, submarine pollination, marine dispersal and epidermal chloroplasts. The seagrass ecosystem provides various ecological services to the marine environment, such as protection from coastal erosion through sediment stabilization and water quality improvement via filtration, sediment trapping and oxygen pumping (during the photosynthesis, they release oxygen into the water column and pump oxygen into the sediments through the root systems and therefore create an oxic environment which leads to higher nutrient uptake).

In addition, higher primary and secondary productivity supports a wide range of faunal communities including fish and invertebrates. The high richness of marine biodiversity can be attributed to their productivity as well as nutrient cycling (Hemminga and Duarte, 2006), emphasizing their importance in nutrient cycling. Despite occupying only 0.1% of the seafloor, they are responsible for 12% of the total organic carbon buried in the ocean. The seagrass can sequester a large amount of carbon dioxide from atmosphere, making them one of the major carbon sinks (about 15% of total carbon storage in the ocean), thus playing a crucial role in maintaining the global carbon cycle. The seagrass ecosystem is important for maintaining resilience and overall health of the marine ecosystem (Orth et al., 2006).

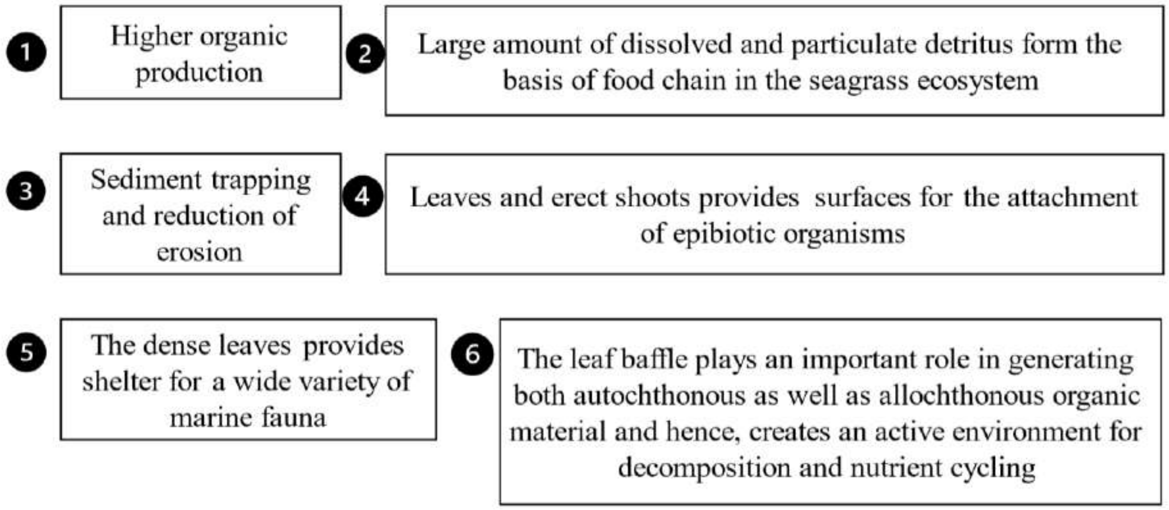

Figure 1: Functions of seagrass ecosystem (Wood et al., 1969)

Faunal communities within seagrasses:

The seagrass beds can serve as breeding grounds, food resources and shelter for a wide variety of fish and invertebrates for several stages of their life cycle. The seagrasses can provide diverse habitats for marine fauna, such as on the plant, among the plants, on the substrate surface and in the substrate (Stauffer, 1937). The seagrass beds are typically positioned between inshore mangrove forests and offshore coral reefs or open ocean. Therefore, it can be utilized as temporary habitat for migratory species. There are various species of finfish and shellfish that take shelter and feed within the seagrass ecosystem during their seasonal migration. The excessive illumination in the daytime facilitates the refuge effect for prey species, enhancing their survival rates (Kikuchi, 1980).

Based on the microhabitat structure and mode of life, the faunal communities within seagrasses can be classified into four main types (Kikucki and Peres, 1977):

1. Organisms residing on the leaves (mobile epifauna and swimming epifauna, which often rest on the leaves)
2. Organisms attached to the stems and rhizomes (nest building polychaetes and amphipods)
3. Highly mobile organisms swimming through/under the leaf canopy (decapods, cephalopods and fishes)
4. The organism living on/in the sediment (crustaceans, gastropods and polychaetes)

The complex structure of seagrasses offers an ideal habitat for a wide variety of faunal communities. The seagrass morphology is characterized by an underwater rhizome system and erect shoots having bundles of leaves that extend into the water column, thus creating a highly structured ecosystem. The plant, firmly attached to the seabed via rhizome, stabilizes the sediments and therefore, provides a stable substrate for benthic organisms such as crustaceans, bivalves and polychaete worms (Orth et al., 2006). The dense leaves and shoot system protect juvenile fish and invertebrates from predators as well as harsh environmental conditions, thus enhancing their survival rates (Heck et al., 2003). Several commercially important fish species, such as cod, haddock and snappers depend on the seagrasses for food and shelter during their early life stages (Boström et al., 2006).

The higher productivity of the surrounding water supports the higher growth of epiphytes on leaves, such as algae and microbes, which provide food to herbivores and detritivores (Duffy, 2006). Furthermore, larger organisms (mega-herbivores) such as dugongs and sea turtles are important consumers of seagrasses. Fresh seagrasses are directly consumed by sea urchins, fish, geese and ducks. These animals can influence the composition and abundance of faunal communities associated with seagrasses, directly or indirectly. The structured habitat created by seagrasses is a decisive factor in the high biodiversity (Phillips and Menez, 1988).

Conclusion

The structural complexity of seagrasses offers diverse microhabitats for a wide range of marine fauna, including fish and invertebrates. The underwater rhizome system, erect shoots and dense canopy support complex habitats that serve as shelter, feeding and breeding grounds for several faunal communities. The sediment stabilization by an extensive rhizome system creates a stable substrate for benthic organisms such as polychaetes, bivalves and crustaceans. The dense bundle of leaves extends into the water column and provides refuge to various life stages of several fish and invertebrates. The leaves also support epiphytic growth which provide the base of several food webs within the seagrass ecosystem, supporting herbivores and detritivores. Additionally, seagrasses provide important ecological services such as erosion retardation, water quality improvement, sediment stabilization and carbon sequestration, which are crucial for maintaining the overall structure and function of marine environments.

References

Boström C, Jackson E L and Simenstad C A (2006). Seagrass landscapes and their effects on associated fauna: A review. Estuarine, Coastal and Shelf Science. 68:383-403.

Duffy J E (2006). Biodiversity and the functioning of seagrass ecosystems. Marine Ecology Progress Series. 311:233-250.

Heck K L, Hays G and Orth R J (2003). Critical evaluation of the nursery role hypothesis for seagrass meadows. Marine Ecology Progress Series. 253:123-136.

Kikuchi T (1980). Faunal relationships in temperate sea-grass beds, Handbook of Seagrass Biology: An Ecosystem Perspective, New York: Marcel Dekker. 153-172p.

Kikuchi T and Peres J P (1977). Consumer ecology in sea-grass beds, Seagrass Ecosystems: A Scientific Perspective, New York: Marcel Dekker. 147-193p.

Orth R J, Carruthers T J B, Dennison W C, Duarte C M, Fourqurean J W, Heck K L, Hughes A R, Kendrick G A, Kenworthy W J, Olyarnik S, Short F T, Waycott M and Williams S L (2006).A global crisis for seagrass ecosystems. BioScience. 56(12): 987-996.

Phillips R C and Menez E G (1988). Seagrasses- Smithsonian Contributions to the Marine Sciences. 34:104p.

Short F T, Polidoro B, Livingstone S R, Carpenter K E, Bandeira S, Bujang J S, Calumpong H P, Carruthers T J B, Coles R G, Dennison W C, Erftemeijer P L A, Fortes M D, Freeman A S, Jagtap T G, Kamal A H M, Kendrick G A, Judson Kenworthy W, La Nafie Y A, Nasution I M,…, Zieman J C (2011). Extinction risk assessment of the world's seagrass species. Biological Conservation. 144(7):1961-1971.

Stauffer R C (1937). Changes in the invertebrate community of a lagoon after disappearance of the eelgrass. Ecology. 18:427-431.

Wood E J F, Odum W E and Zieman J C (1969) Influence of sea grasses on the productivity of coastal lagoons. Universidad Nacional Autónoma de México.495 – 502p.

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POTENTIAL GREEN MANURE AND GREEN LEAF MANURE CROPS

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Introduction

The soil organic matter and nitrogen levels is vital to sustained crop production are often limiting in the cultivable soils. Further, the sustainability of soil productivity has become greater concern, as lands are intensively tilled to produce higher yields from a single crop and higher total annual yields under intensive cropping system. so, occurrence of multi-nutrient deficiencies and overall decline in the productive capacity of soils under intensive fertilizers use has been widely reported. Hence, there is an urgent need to identify alternate nitrogen sources to supplement inorganic fertilizers. Green manuring is a low cost but effective technology in minimising the investment cost of fertilizers and in safeguarding the productive capacity of the soil.

Crops grown for the purpose of restoring or increasing the organic matter content in the soil are called green manure and green leaf manure crops. Green manure crops are grown *in situ* or brought from outside and incorporated. Green manuring has a positive influence on the physical and chemical properties of the soil, maintains the organic matter status of the arable soils and serve as a source of food and energy for the soil microbial population, which multiplies rapidly in the presence of easily decomposable organic matter.

GREEN MANURE CROPS

Green manure is a specific crop grown with the purpose of being dug into the soil while still green. Such crops are usually planted on unoccupied land between the main crops. When incorporated into the soil, the plant's residues decompose and turn into a mass of green manure that can be either dug into the soil or used as mulch, an organic material that covers the soil surface. The list of important green manure crops are as below.

Sesbania bispinosa- Daincha

Sesbania rostrata-Manila Agathi

Tephrosia purpurea -Tephrosia

Sesbania sesban - Chithagathi

Crotalaria juncea - Sunnhemp

Calopogonium mucunoides - Calopo

Phaseolus trilobatus - Pillipesara

Centrocema pubescens - Spurred butterfly pea

Macroptilium atropurpureum - Siratro

Stylosanthus hamata - Stylosanthus

Pueraria phaseoloides - Kudzu

Dolichos lab lab var. *lignosus* - Garden bean

Vigna mungo - Black gram

Vigna radiata - Green gram

Vigna ungiculata - Cowpea

Macrotyloma uniflorum - Horse gram

Cymopsis tetragonoloba - Cluster beans

Trianthema portulacastrum - Giant Pigweed

Trigonella foenum-graecum- Fenugreek

CHARACTERISTICS OF GREEN MANURE CROPS

1. They are annual legumes and are capable of establishing and growing quickly.
2. They are tolerant to adverse climatic conditions such as drought, water logging and high as well as low temperatures.
3. They are tolerant to pest and diseases, and not act as a host.

4. They possess adequate nodulation and have efficient nitrogen fixation capacity.
5. They are capable of growing very fast and ready for incorporation into the soil within four to six weeks.
6. They are easy to incorporate and quickly decompose to release their nutrients.
7. They are ecofriendly and do not pose any adverse impact on soil and environment.
8. Helps to maintain the fertility of the soil on a long-term basis.
9. They encourage the multiplication of microflora and soil health.
10. They produce sufficient viable seeds to cultivate in the next crop rotation.
11. Green manure crops are incorporated into the soil before seed set so that maximum nutrient addition is made.
12. They trap the nitrogen of sub-surface soil and return them as nitrate forms to the upper surface soil.
13. They are ecofriendly and are a great substitute for Chemical nitrogen fertilizers.
14. They supply carbohydrates, organic acids, soluble proteins, amino acids and insoluble cellulose, hemicellulose and lignin.
15. They improve soil structure and soil tilth.
16. They have deep rooting system, facilitating nutrient mining from sub surface soil.
17. They have low water and nutrient requirement.
18. They grow quick to produce abundant biomass.
19. They have low fibrous material to facilitate quick decomposition.
20. They are not invading or causing difficulties for the succeeding crop in crop rotation.
21. They are tolerant to low soil fertility and can grow to produce high biomass.

GREEN LEAF MANURE CROPS

Green leaf manuring consists of gathering green biomass from nearby location and adding it to the soil. In both, the organic material should be incorporated into the soil while they are fairly young for easy and rapid decomposition. Legumes are usually utilised as green manure crops as they fix atmospheric nitrogen in the root nodules through symbiotic association with a bacterium, rhizobium and leave part of it for utilization of the companion or succeeding crop. The important green leaf manure crop includes the following species.

Pongamia glabra- Pongam tree

Indigofera tinctoria-Indigo tree

Senna auriculata- *Tanner's Cassia*

Thespesia populnea- Portia Tree

Azadirecta indica- Neem tree

Lannea coromandelica- Indian ash tree

Calotropis gigantia-Madar tree

Gliricidia sepium - Gliricidia

Ipomoea cornea - Pink morning glory

Delonix elata - Vadanarayan

Leucaena leucocephala - Subabul

Vitex negundu - Chaste tree

Jatropa gossipifolia - Black physicnut

Peltophorum ferrugenum - Yellow flame tree

Sesbania grandiflora - Agathi

CHARACTERISTICS OF GREEN LEAF MANURE CROPS

1. Green leaf manure crops are mostly perennial trees or shrubs that are grown outside the cultivated field such as wastelands, field bunds and as live fences.
2. They supply green manure year around even during dry seasons.
3. They are a cheap and easily affordable source of green manure.
4. Their leaves and toppings are simply cut and brought to the crop field in bundles.
5. They supply green leaf manures two to three times in a year.
6. They release nutrients on a slow rate for a long time after their incorporation.
7. They provide additional economic products such as fuel wood and timber.
8. It act as a soil mulch and improve soil aeration and water holding capacity.
9. They add high quantity organic matter to the soil.
10. Once incorporated in the soil, it slowly decompose and release micro and macro nutrients into the soil.
11. Some of the green leaf manure trees are also grown for green forage for cattles.
12. They supply carbohydrates, organic acids, soluble proteins, amino acids and insoluble cellulose, hemicellulose and lignin.

13. Single green manure crop can fix 60 to 175 kg N/ha in a single season under favourable conditions.

14. They have deep penetrating well developed root system live for longer period.

15. They have resistance to pest and diseases and not act as a host.

16. They produce sufficient tender leaves and toppings for easy decomposition upon incorporation in the soil.

17. They can tolerate low soil fertility and adapted to degraded soils.

18. They have ability to reproduce through seeds or through cuttings to increase the area under the crop.

19. They are generally multipurpose in use such as being a forage crop, wind breaks, medicinal purpose, fuel wood or timber value.

20. They have the capacity to resprout in the event of coppicing and pollarding.

IMPORTANCE OF GREEN MANURES AND GREEN LEAF MANURES

1 They can be cultivated as a catch crop by utilizing the leftover moisture of the season by inter sowing in the main standing crop, a little before or after harvest.

2. Green manure crop can be grown as shade crop in young orchard or plantations with an objective of shading the soil surface and preventing the rise of soil temperature.

3. Green manure crops can be grown as cover crop clothing the soil surface to prevent soil erosion and run off especially on slopy lands

4. Most of the leguminous green leaf manure crops are grown for taking few cuttings of green fodder for cattle in every stages. The early growth supplies fodder for cattle and later growth is used for green manure purpose.

5. Green manure crops improve soil structure and improves soil tilth.

6. It promotes formation of crumps in heavy soils, thereby providing better aeration and drainage.

7. Green manures absorb nutrients from the sub surface layer of the soil profile and deposit them as available nitrate forms in the upper surface of the soil for use of succeeding crop.

8. Green manure crops prevent leaching of nutrients to lower layers of soil.

9. Green manure crops increase the solubility of lime, phosphate, trace elements *etc.*, through increasing the action of soil microorganisms by producing organic acid during composting.

10. Green manure crop can be used to ameliorate problem soils such as saline and sodic soils. Their organic acids help to leach out the harmful sodic salts in the soil.

11. Green manure crops increases the yield of succeeding crop to an extent of 15-20 per cent compared to no green manuring.

12. The nutrient content of succeeding crop were found to increase by growing green manure crop before the main crop.

13. They reduce the weed proliferation and weed growth during off season.

14. Some of the green leaf manure crops like Neam, Chaste tree and Pongam have insect control properties.

15. Root rot nematodes can be controlled by growing green manure crops.

16. Green manuring improves aeration in the rice soils by stimulating the activities of surface film of algae and bacteria.

17. They supply high quantity of organic matter to the cultivated field, thereby increasing the soil humus content to a greater extent.

18. Besides supplying nitrogen, it prevents loss of nitrogen by leaching and erosion.

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THE ASHWAGANDHA OPPORTUNITY: TAPPING INTO CONSUMER DEMAND FOR WELLNESS

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Abstract

In the holistic health space, the ashwagandha market is rising significantly due to consumer demand for natural medicines and wellness-focused lifestyles. Known for its adaptogenic qualities, this plant has attracted a lot of interest due to its possible health advantages, which have accelerated its market expansion. Demand for ashwagandha-based products has increased due to increased awareness of holistic health practices and the rise in stress-related illnesses, which indicates a move towards preventative wellness measures. Consumers' perspectives on wellness are far more nuanced and comprehensive than those of healthcare providers; they cover not just physical and mental well-being but also general attractiveness and fitness. Also, consumers are able to choose more readily between the kinds of goods and services they purchase as well as how they do so. Additionally, individuals have more options for the kinds of goods and services they purchase as well as how they do it. Due to the widening gap between supply and demand, the ashwagandha industry faces significant challenges. Low yields, seasonal production, and a lack of skilled labour are some of the factors that impede the industry's growth. To address these issues, the industry must establish a market intelligence system, identify superior cultivars, and invest in the development of skilled labour. By putting these strategies into practice, the industry can improve product quality, and increase production efficiency.

Introduction

The United Nations, third Sustainable Development Goal (SDG) is especially concerned with promoting and ensuring healthy living for people of all ages. Among all the SDGs, "ensuring a healthy life and promoting well-being for all ages" is one of the most universal and linked. This goal's objective is people's health and well-being; on the other hand, it is the outcome of other objectives that enable people to grow more effectively in many social, economic, and productive domains. Sustainable development policies, especially for the most impoverished nations, can be founded on the multifaceted and universal SDG 3, which can result in the long-term preservation of health and well-being.

The COVID-19 pandemic sparked a significant change in the objectives of society, with a strong focus on health and wellbeing being the most popular consumer trend. Physical and mental health are now of utmost significance, having previously been secondary to other lifestyle considerations. As people try to strengthen their immunity and resilience, proactive health management practices have clearly increased during this evolution. The worldwide wellness market is expected to increase by 5 to 10 percent annually, reaching a value of about $1.5 trillion. Companies can benefit greatly from rising consumer interest and purchasing power, especially as personal wellness spending has rebounded after stagnating or even falling during the COVID-19 pandemic. The wellness industry is becoming more and more saturated at the same time, so businesses need to be selective about where and how they compete.

Consumer Definitions of Wellness

Wellness has evolved from being solely about physical health to encompassing a holistic approach that prioritizes mental, emotional, and spiritual well-being. Consumers today view wellness as a dynamic process of achieving optimal health and happiness.Today consumer views wellness across five dimensions.

i. Better health-Probably the oldest area related to wellness, it includes consumer medical gadgets and personal health trackers in addition to prescription drugs and supplements. Customers are taking more control over their health: tailored, data-driven care is becoming more popular, as are apps that make scheduling doctor's appointments or getting necessary prescriptions easy, as well as gadgets that let patients keep an eye on their symptoms and overall health in-between visits.

ii. Better nutrition-One important factor influencing general wellness is nutrition. It includes consuming food and liquids to supply the nutrients required for good health and life sustenance. A healthy diet promotes both mental and physical well-being, lowers the risk of developing chronic illnesses, and improves quality of life.

iii. Better sleep-It is a relatively new product category that is well-liked by consumers; perhaps this is understandable given the strain the pandemic has caused. There's competition for conventional sleep aids like melatonin these days: app-enabled sleep monitors, sleep-improving devices, and medications if needed.

iv. Better Mindfulness-It is the practice of being fully present and aware of your thoughts, feelings, and surroundings without judgment. It's about focusing on the present moment rather than dwelling on the past or worrying about the future. The burnout from hectic work life can affect the daily working routines of the individuals. Anxiety, stress, and insomnia are some of the examples of concerning mental health conditions.

v. Better fitness-fitness has been challenging over the past year. Many consumers struggle to maintain pre-COVID-19 fitness levels when they can't go to their gyms as frequently or participate in sports in the same ways as before. Consumer perceptions of fitness have evolved significantly, extending far beyond the traditional metrics of physical appearance. Today's consumers view fitness as a holistic concept encompassing mental, emotional, and social well-being in addition to physical health.

Harnessing the Nature's Pharmacy: Ashwagandha

Ashwagandha, also known as *Withania Somnifera*, is an ancient plant that has a long history in the traditional Indian medical system, or Indian Ayurveda. It has been prized for generations for its multiple health advantages and has significantly contributed to the promotion of general well-being. The approximately 3,000-year-old Indian scriptures known as the Vedas Particularly Rigveda tell the narrative of Ashwagandha, describing it as a potent herb used for energy-fostering and revitalization. Historically, Ayurvedic practitioners have employed Ashwagandha in complex herbal formulations to address a variety of health concerns, underscoring the herb's holistic therapeutic potential. This traditional wisdom-highlights Ashwagandha's role as a cornerstone of Ayurvedic healthcare. Ashwagandha is revered in Ayurvedic medicine as a '*rasayana'*, a rejuvenating herb believed to nourish all bodily tissues and promote longevity. Central to Ayurvedic philosophy, the herb is considered to harmonize the three fundamental *doshas* - *Vata*, *Pitta*, and *Kapha* - thereby contributing to overall equilibrium.

Global Acknowledgement of Ashwagandha

As per studies, Clinical depression costs over 51 billion USD in absenteeism from work and loss of productivity at workplaces all around the globe. Stressful situations can increase the cortisol level leading to anxiety and later on depression. Globally, ashwagandha's appeal has increased as more people become aware of its benefits. Because it is easily accessible in a range of forms, including capsules, powders, teas, and tinctures, a wider audience can now use it. Because of its reputation as a herbal adaptogen and its potential to enhance general well-being and stress management It is a popular supplement that can reduce the morning cortisol level and enhancing the quality of sleep. The market expansion for ashwagandha can be attributed to multiple crucial elements. The growing popularity of holistic health practices among consumers has led to a rise in demand for natural supplements such as ashwagandha. To meet the varied demands and preferences of its customers, this market sector offers a wide range of products, such as capsules, powders, extracts, and infused beverages.

Geographically, the market is led by North America and Europe, although developing nations in Asia-Pacific are adopting formulations including ashwagandha as a result of customary medical practices and growing disposable incomes. The global ashwagandha market is expected to grow from its estimated USD 433 million in 2022 to USD 1,187 million in 2032. This market is expected to have the highest CAGR of 10.9% between 2023 and 2032. Because of its wide range of applications in the treatment and prevention of many medical conditions, the pharmaceutical sector is expected to grow at the fastest rate. North America led the market in 2022 with the most revenue share of 43.0%, and it is expected to continue to do so for the length of the forecast. Ayurvedic medicine is becoming increasingly popular in North America, and as a result, the market share of ashwagandha increased dramatically in 2022.

The Spectrum of Ashwagandha Products

There are many different ways to take ashwagandha; it can be found in capsules, tablets, soft gels, liquid shots, tinctures, chocolates, drinks, bars, gums, energy drinks, energy shots, functional waters, burgers, gummies, soft chews, and more. It is used in over 650 major supplement, sports nutrition, and food and beverage companies across the globe. It can be divided into broadly five segments

i. Dietary supplements- The concentrated form of ashwagandha root is the most widely used product. It can be used as an additive in several herbal and dietary supplement formulations, or as a stand-alone product. It flows easily and stays put on shelves. Therefore, being able to be combined with ease into beverages, soft gels, pills, and capsules.

ii. Food and Beverages- Customers are searching for "wellness benefits" in the ingredients they eat, and Ashwagandha meets this desire with its well-established, time-tested health benefits. With its high sensory qualities, nutrient-dense ashwagandha is perfect for food and dietary supplement formulations. It has been certified by a reputable panel of toxicologists as a GRAS (Generally Regarded as Safe) substance. It is not bitter, unlike other extracts, and tastes neutral. It is therefore a great option for usage in meals and drinks.

iii. Sports Nutrition-It increases stamina and energy, strengthens and sizes muscles, facilitates muscle repair, and optimizes the use of oxygen and mental clarity. Energy drinks, sports drinks, whey protein blends, nutrition bars, meal replacements, and pre and post-workout formulae have all included ashwagandha. Ashwagandha is a top-notch energy enhancer and a verified non-dope substance.

iv. Personal Care-its antioxidant, anti-inflammatory property, and hormone-stabilizing property contribute to hair care and skin care products. such as creams, gels, oils, lotions, serums, shampoos, face masks, and sprays.

Challenges

The herbal, pharmaceutical, cosmetic, and nutraceutical industries are seeing a daily rise in demand for ashwagandha. Therefore, it is essential to produce high-quality raw materials by utilising enhanced high-yielding cultivars and implementing enhanced agriculture and processing technology. There is an approximate 7000 t yearly demand for ashwagandha, but only 1500 t is thought to be produced in India. The difference between the supply and demand for ashwagandha is significant. The ashwagandha industry's high demand for roots, leaves, and seeds can be satisfied by increasing the plant's cultivation and utilizing its new, enhanced kinds that provide higher yields for commercial use. Another type of challenge associated with the supply chain of ashwagandha is that it is a six-month crop and its harvesting is done only once a year therefore supply of ashwagandha throughout the year is a major challenge. Lack of skilled manpower, Lack of technical know-how, Unavailability of proper marketing channels, etc are some of the major constraints.

Solution

i. Market Intelligence System- A proper market information system can help the various stakeholders associated with the business to make a best-suited decision as per the market situation. A common platform must be developed so that the buyers and sellers can quote their demands and requirements.

ii. Identification of best cultivars- the best-suited variety according to the agro-climatic zones can help the growers fetch the best price for their produce. There are various cultivars available but its commercialization is still lacking. The cultivation of ashwagandha is still done in different pockets of agro-climatic zones.

iii. Development of skilled labour: The production land needs skilled technical labour due to the rapidly changing market conditions. This labour force should know about seed variety, input supply sources, postharvest equipment, and agricultural machinery. The state should support skill development through various training initiatives to attain the same goals. Programs on crop planning, equipment and tool use, soil biology, composting, company planning and marketing, and business development strategies should be included in the training.

Conclusion

With a long history of usage in Ayurvedic medicine, ashwagandha is a versatile herb that is expected to play a major part in the expanding global wellness market. It has attracted a lot of interest because of its potential to treat contemporary health issues like stress, anxiety, and insomnia. Ashwagandha has numerous uses outside of traditional medicine, including dietary supplements, food and beverage goods, sports nutrition, and personal care items. This is due to the increased public interest in natural and holistic treatments. Ashwagandha has a considerable market opportunity and has the potential to make a substantial contribution to the trillion-dollar wellness business. To fulfill this promise, though, a methodical strategy for resolving present issues including supply chain management, standardization, and trained labour is needed. To close the gap between supply and demand, promote stakeholder engagement, and propel industry growth, a strong market intelligence system is necessary.The ashwagandha sector may set itself up for long-term success by investing in human capital development, standardizing quality control procedures, and optimizing cultivation methods.

References

Guégan, J. F., Suzán, G., Kati-Coulibaly, S., Bonpamgue, D. N., & Moatti, J. P. (2018). Sustainable Development Goal# 3,“health and well-being”, and the need for more integrative thinking. *Veterinaria México OA, 5*(2), 0-0.

Web Sources

https://www.business-standard.com/economy/analysis/national-health-mission-drives-standardisation-in-public-healthcare-system-124061700138_1.html

https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/feeling-good-the-future-of-the-1-5-trillion-wellness-market

https://ccsniam.gov.in/images/pdfs/NMPB_Report.pdf

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EXTENSION WORKERS AND FFS IN DISSEMINATION OF AGRICULTURAL TECHNOLOGIES.

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Introduction

To communicate effectively is not easy because to communicate effectively we have to think clearly is never easy. For effective communication we have to consider the message, medium and occasion. Message is the subject, medium is the local language and occasion is the special situation. The occasion contains sender, receiver and the relationship between the sender and the receiver.

Who is the Front-Line Extension worker?

Front line extension workers are the vital link in a chain which ensures two-way communication between research institutions and farmers. Research, Subject Matter specialists, Front Line Extension Staff and Farmers.

In Krishi Vigyan Kendra's nearby farmers are invited to view research results. Also, the researchers are also invited to have a meet with a group of farmers. In Krishi Vigyan Kendra's, it is important that the feedback or flow of information between farmers and researchers must pass through the Front-Line extension Staff and Subject Matter Specialists (SMS'S). Front line staff used to meet group of farmers in every two weeks. He is involved in crucial communication and social skills of extension. He creates relationship with farmers, and to achieve rapport with them and to help them with their care of crops and Livestock.

What are the skills to be possessed by the Front Line Extension workers?

a) Knowledge of a particular Language.

b) Knowledge of need based subjects.
c) Knowledge of Publication channels.
d) Skill in conducting research for relevant information.
e) Skill in selecting the most relevant material for a particular occasion.
f) Skill in organizing the material to form a logical sequence of ideas.
g) Skill in choosing an appropriate vocabulary for particular readers.
h) Ability to review in order to revise and modify the subjects.
i) Enthusiasm for the topic.
j) Empathy with the people.

Competency list of communication aspects of Front Line Extension worker

1) Knowledge about the organization in which the extension works.
2) Knowledge of the community in which he works: its social and economic characteristics.
3) Knowledge about the farmers: their aspirations and problems.
4) Knowledge of resources: Credit facilities, fertilizers, equipment, both within and outside the community that can be utilized in the promotion of efficient farming.
5) Skill in connecting with the people: the ability to express himself clearly and the ability to listen.
6) Skill in motivating and mobilizing people, the ability to encourage farmers to adopt and experiment with new methods.
7) Skill in working with people: establishing and facilitating meetings with farmers and participating in farmers activities.
8) Skill in demonstrating farming methods and procedures: using techniques that are graphic and have impact.
9) Skill in making and using educational aids: use of new ICT methods.
10) Respect for the existing knowledge and skill of farmers.
11) Empathy with people living on low incomes in rural areas.
12) Patience and tolerance when the recommendations are not readily taken up.
13) Readiness to listen and learn from those, farmers is also teaching.

The whole extension process is dependent upon the extension agent, who is the critical element in all extension activities. The effectiveness of the extension agent can often determine the success or failure of an extension programme. The extension agent has to work with people whose circumstances are different from his own. In this extension work; the agent basically intervenes in the life of the farmers in a particular area. The extension agent is a change agent: he intervenes to bring about change in order to help improve the lives of the farmers and their families. The basic role of extension ag4ent in bringing change into a rural area and what areas of knowledge and personal skills would be useful in performing his roles.

An agent must consider each situation individually and adopt a position or role suitable to the situation.

An extension agent tries to arouse people to recognize and take an interest in their problems, to overcome these problems, to teach them how to do so, to persuade them to act on his teaching, so that they ultimately achieve a sense of satisfaction and pride in their achievements. A change agent is a person whose primary role is to achieve a transformation of attitudes, behavior and social organization. Change agents are multipurpose agents serving as links between government and people. He sets, in motion a process of change after realizing that certain changes are necessary for the rural society. He is an activist whose main role is to help people from their own organizations in order to be able to tackle their problems.

He is a professional who influences the innovation-decision making process in a direction deemed desirable by the change agency.

A good extension agent will always try to enlist the support of local farmers in his extension work. Local leaders can be of invaluable assistance to an extension agents will work locally with both formal and informal leaders. The local leaders function as contact farmers who are expected to pass on the knowledge they have received from the agent.

Farmer Field School (FFS)

Field Schools are not new ideas, this is an effective idea in dissemination of information with referenced to farming technologies. For sustainable crop intensification this participatory method is used. The origin of Farmer Field Schools is by the end of 1980s a new approach to farmers training emerged in Indonesia called the "Farmer Field School (FFS). The broad problem which these field schools were designed to address was a lack of knowledge among Asian farmers relating to agroecology, particularly. The relationship between insect pests and beneficial insects.

In general farmers field schools (FFS) consists of groups of people with a common interest, who get together on a regular basis to study the "How and why" of a particular topic.

The FFS is meant for field study, where specific management skills and technologies are transferred. FFS can be defined as A platform for learning and experience sharing among farmers. Farmers group meet regularly during a season. This meeting is conducted with a help of a facilitator.

Usually the farmers are participting in weekly meetings during a full cropping season. Normally 25 – 30 farmers form and FFS that is facilitated by two trainers. FFS comprises of 25 – 30 people both male and female, meeting at least for an entire production cycle. Farmer Field Schools are designed to fulfill the objectives viz. grow healthy crop conserve natural enemies of crop pest, conduct regular field observations, make farmers compliant I n their own field, reduce production costs.

Farmer Field Schools possess certain elements. These elements are crop, field, facilitator, study Programme Co-ordinator, funding and synergy with anchorites. Group should be with 25 – 30 people, group should meet entire production cycle. Field is the true master. Field gives the study materials. We can see the real problems and solutions in the field.

Facilitator should be a skilled farmer in the same village. The subjects for FFS should be on crop production, animal husbandry, forestry and social issues. Co-ordinator should support facilitator’s training and co-ordinates them. He organizes all materials for this programme. Funding may vary with the sponsors, technology and situation.

The core activities of the FFS are weekly / biweekly meetings that run the entire length of the crop season for annual crops. Random locations are sampled and beneficial pests are counted. This observation is often done in small groups of 3 – 5 farmers, with adjacent fields. This involves drawing images on a large sheet of paper of the crop, pests, natural enemies, diseases, weeds and other visual components of the ecosystem.

Data on these components are listed in tables to enable other farmers to understand the results. The small group may write some brief comments, particularly on their conclusions regarding immediate action that is needed to momentane crop health. These activities usually be in force technical learning and they help the participants and facilitator to become more familiar with one another.

A special topic exercise is usually the last activity in a weekly FFS session. These exercises are used to introduce and demonstrate a number of IPM and plant health related issues, such as toxicity of pesticides to predators and parasitoids.

The facilitator and participants work together throughout the FFS process to achieve the learning objectives. Learning a acquired through experimental process. These experiments are direct – discovery-based experiments. Because of this, the facilitator does not have to explain everything. Due to the practical orientation of the teaching method, farmers can become very accomplished FFS facilitators. The chief skills required are the ability to lead others in carrying out and analyzing the field activities. The field becomes the teacher and not the facilitator.

Hence, through this farmer field schools, skill development, empowerment, will power and capacity of decision making will be achieved.

Field days

Field days, during the period of running the FFS, 1 – 2 field days are organized where the rest of the farming community is invited to share what the group has learned in the FFs Farmers themselves facilitate during this day. At the end of the programme, FFS farmer, now have the knowledge and confidence to run their own FFS.

This FFs involves the farmers in various dimensions with the guidance of the facilitators, the group meets regularly throughout the season and "Participatory Technology Developing" PTDs were implemented.

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GENOMICS IN CROP IMPROVEMENT

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Introduction

The word "genome" describes the total amount of DNA in a particular organelle. Genome refers to the basic set of chromosomes. Animals have one genome in the nucleus, and a second, very different genome in the mitochondrion. Plants have a third genome, in the chloroplast. All these are important, the nuclear genome is by far the largest of the three, and imparts the vast majority of characteristics to an organism. The term genomics was first used by Thomas Roderick in 1986. Genomics is the study of entire genomes, including the complete set of genes, their nucleotide sequence and organization, and their interactions within a species and with other species. In a genome, each type of chromosome is represented only one. Now genomics is being developed as a sub discipline of genetics which is devoted to the mapping, sequencing and functional analysis of genomics. The advances in genomics have been made possible by DNA sequencing technology.

Main points related to genomics are:

- It is computer aided study of structure and function of entire genome of an organism.
- It deals with mapping and sequencing of genes on the chromosomes.
- It is a rapid and accurate method of gene mapping. It is more accurate than recombination mapping and deletion mapping techniques.
- The genomic techniques are highly powerful, efficient and effective in solving complex genetic problems.
- Now use of genomic techniques has become indispensible in plant breeding and genetics

Types of Genomics

Two broad categories of genomic are structural genomics and functional genomics

1. Structural genomics:

Structural genomics is a field of genomics that involves the characterization of genome structures. It deals with the study of the genetic structure of each chromosome of the genome. It determine the size of the genome of a species in megabases (Mb) and also the genes present in the entire genome of a species. Understanding the genome structure involves constructing genome maps, sequencing genes, annotating gene features, and comparing genome structures. Structural genomics describes the 3-dimensional structure of each and every protein that may be encoded by a genome – when specifically analyzing proteins, this is more commonly referred to as structural proteomics.

2. Functional genomics: The study of function of all genes present in the entire genome is known as functional genomics. It also deals with the study of gene expression and the function of genes in a genome. It involves studying gene functions at the whole genome level using high-throughput methods. It deals with transcriptome and proteome. The transcriptome refers to complete set of RNAs transcribed from a genome and proteome refers to complete set of proteins encoded by a genome.

In addition to structural and functional genomics, there are other sub-fields of genomics, they are as follows

- **Epigenomics**: The Epigenome refers to these chromatin states at a whole genome level. A multicellular organism has a single genome but many epigenomes. It involves the study of epigenetic modifications or epigenome, which refers to the collection of chemical compounds that attach to DNA and influence its activity. The epigenome plays an important role in determining the differences between various cell types in the body. Epigenomic modifications include DNA methylation and histone modification.
- **Metagenomics:** It involves the study of genetic material from entire biological communities rather than just individual organisms. It is generally applied to microorganisms. It deals with the nucleic acids extracted from the environment, as opposed to genomics, which studies the nucleic acids derived from single organisms. Metagenomics can be used to study the diversity and function of microbial communities in diverse environments, such as the human gut, soil, or ocean.

- **Pharmacogenomics:** It is the subfield of genomics that uses an individual's genetic information to study and customize the choice and dosage of drugs in medical treatment. It deals with the genetic basis for the differences between individuals in responses to drugs in order to tailor drug prescriptions to individual genotype. It can be used to predict drug response or toxicity and to develop a more personalized approach to prescribing drugs.
- **Comparative genomics** involves the comparison of genomes from different species that can provide insights into evolutionary relationships, functional elements, and genetic variations among species. It uses various tools that help to identify and understand the similarities and differences in the genomes of various species.

Genomics in crop plants

The genome mapping was first completed in a free living bacteria *Haemophillus influenza* in 1995. Later on genome sequencing work was intensified both in prokaryotes and eukaryotes. In plants, genome sequencing was first completed in *Arabidopsi thaliana* followed by rice. Now genome sequencing work has been completed in more than 40 crop plants.

Genome mapping

Genome mapping is a widely-applicable approach to scanning the genetic information of an organism for genes that are responsible for a specific trait. Higher plants are thought to have 25,000 or more genes, the vast majority of which remain of unknown function (although rapid progress is being made toward their characterization in selected botanical models). A particular strength of genome mapping, is that it facilitates isolation of genes based simply on measurement of their effect(s) on phenotype -- requiring no a *priori* knowledge of the biochemical function performed by a gene. A "genome map" can be thought of much as a roadmap, reflecting the relative proximity of different landmarks to one another.

Two broad categories of genome mapping approaches are as follows,

i. **Genetic mapping:** A genetic map is an illustration that lists genes and their location on a chromosome. Genetic maps provide the big picture (similar to a map of interstate highways) and use genetic markers (similar to landmarks). A genetic marker is a gene or sequence on a chromosome that shows genetic linkage with a trait of interest. The genetic marker tends to be inherited with the gene of interest, and one measure of distance between them is the recombination frequency during meiosis. Early geneticists called this linkage analysis. Genome mapping is made possible by the fact that the nuclear genome in higher organisms is organized and transmitted as linear units, called chromosomes. Just as mileposts guide the motorist along a highway, "DNA markers" provide reference points that define specific places along each chromosome. Genetic mapping is based on recombination, literally the naturally-occurring ‘breaking and rejoining’ of chromosomes to determine the relative proximity of DNA landmarks to one another based on the frequency at which they co-occur on the same chromosome segment.

ii. **Physical mapping:** Physical maps get into the intimate details of smaller regions of the chromosomes (similar to a detailed road map). A physical map is a representation of the physical distance, in nucleotides, between genes or genetic markers. Both genetic linkage maps and physical maps are required to build a complete picture of the genome. Having a complete map of the genome makes it easier for researchers to study individual genes. Human genome maps help researchers in their efforts to identify human disease-causing genes related to illnesses such as cancer, heart disease, and cystic fibrosis, to name a few. In addition, genome mapping can be used to help identify organisms with beneficial traits, such as microbes with the ability to clean up pollutants or even prevent pollution. Research involving plant genome mapping may lead to methods that produce higher crop yields or to the development of plants that adapt better to climate change.

Genes to be mapped

In genome research, both types of genes viz., major genes (oligogenes) and minor genes (polygenes) can be easily mapped. The mapping of polygeneic traits is possible by genome mapping. Techniques which is not possible by conventional gene mapping techniques such as recombination mapping and deletion mapping. The geneome mapping is done for morphological, productivity, resistance, quality, and agronomic and some special traits as discussed below.

- **Morphological traits**: It includes highly heritable traits such as shape, size and colour of leaf, flower, calyx, corolla etc. It also includes surface of leaf and stem (hairiness and smoothness).
- **Productivity traits**: Such characters differ from species to species
- **Resistance traits**: Such characters include resistance to diseases, insects, drought, soil salinity, soil alkalinity, soil acidity, heat, frost, water logging, cold etc.,
- **Quality traits**: Such traits nutritional quality, market quality and keeping quality
- **Agronomic traits**: Such traits include earliness, plant height, plant type etc.,
- **Special characters**: Such characters include genes controlling male sterility, self compatibility, photo and thermo insensitivity, toxic substances, apomixes, adaptation etc.,

Genomics in crop improvement

Genomics can reduce the trials and failures involved in scientific research to a certain extent, which could improve the quality and quantity of crop yields. The linking trait to genes helps to improve crop breeding to generate hybrids with the most desirable qualities. The genomic data used to identify desirable traits, and then transfer those traits to a different organism to create a new genetically modified organism. Genome mapping could use desirable traits to create a useful product or enhance an existing product, such as making a drought-sensitive crop more tolerant of the dry season.

Genomics has several practical applications in crop improvement. Genome mapping is useful in several ways. It is useful or provides information about genome size, gene number, gene mapping, gene sequencing, evolution of crop plants, gene cloning, identification of DNA markers, marker assisted selection, transgenic breeding, construction of linkage maps and QTL mapping.

Achievements:

- It is used to identify the location of genes on chromosomes and determine the distance between genes, which helps in understanding recombination patterns.
- Gene mapping has been instrumental in discovering thousands of genes for both Mendelian and complex diseases.
- It is also used in diagnosing diseases accurately and predicting patient responses to specific treatments.
- In plant breeding, gene mapping allows for marker-assisted selection, which helps breeders select plants with desired traits.
- With the development of high-throughput sequencing technology, gene mapping can now be done through sequencing methods, such as direct sequencing of mutant genomes and sequencing of transcriptomes and partial genomes.

Limitations:

There are some limitations of genome mapping such high cost, high technical skill, laborious work, availability of limited and lack of proper markers.

- Genome research requires well equipped sophisticated laboratory with costly chemicals and glassware's. Lots of funds are required for carrying genomic research.

- It required trained scientists in the specialized field of genomic research. It also requires national and international collaboration with other leading genome research laboratories.
- It requires detection of various DNA markers, which is a laborious and time consuming work.
- Limited genes and promoters are available, that too they are protected under Intellectual Property Rights.

References

Prime Rose, S.B. and Twyman, R.M. 2003. Principles of Genome analysis and Genomics. Blackwell Publishing Co., Oxford.

Sensen, C.W. 2002. Essentials of Genomics and Bioinformatics. Wiley- VCH, Verlay, GmbH, Weinheim.

Singh Pundhan .2018. 4th Revised Edition. Plant Breeding. Molecular and New approaches. Kalyani Publishers, New Delhi

Varshney RK, Tuberosa R. 2007. Genomics-assisted crop improvement vol. 1: Genomics applications in crops. Springer, New York.

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CHANGES IN STATUS OF ZINC AND IRON IN SOIL AND ITS IMPACT ON CROP QUALITY AND HUMAN HEALTH : A REVIEW

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Abstract

Zn is a micronutrient that is required for the survival of humans, animals, and plants and it has emerged as the most widespread micronutrient deficiency in soils and crops worldwide, resulting in severe yield losses and nutritional quality. Almost half of the soils in the world are deficient in zinc and about 50 % soil samples analysed for available zinc were found deficient in India. The zinc deficiency in India is expected to increase from the present level of around 50 to 63 % in 2025 if the trend continues. Zinc plays a key role in plants as a structural constituent or regulatory cofactor of a wide range of different enzymes and proteins in many important biochemical pathways. Zinc deficiency in plants retards photosynthesis and nitrogen metabolism; reduces flowering and fruit development; prolongs growth periods, resulting in delayed maturity; results in lower yield and poor produce quality. Since cereal grains have inherently low concentrations, growing these on the potentially zinc-deficient soils further decreases grain zinc concentration.

Keywords: Crop yield, Human health, Nutritional quality, Zinc deficiency

Introduction

Soil resource provides humans with more than 90% of all the food we eat and its health through interactions with plant inputs creates a healthy environment. Meeting food, fruit, fodder, fibre, and fuel (5F) requirements of the humans is possible through further intensification of agriculture. As per one belief wise food choices, active exercise programme, good medical care, and proper sanitation are necessary components of human health while the other belief suggests a probable link with soil health. Though the idea that there is link between soils and human health has been recognized for thousands of years, however, the scientific study of how soils influence human health is a recent development (Singh, 2009 and Shukla *et al*., 2014).

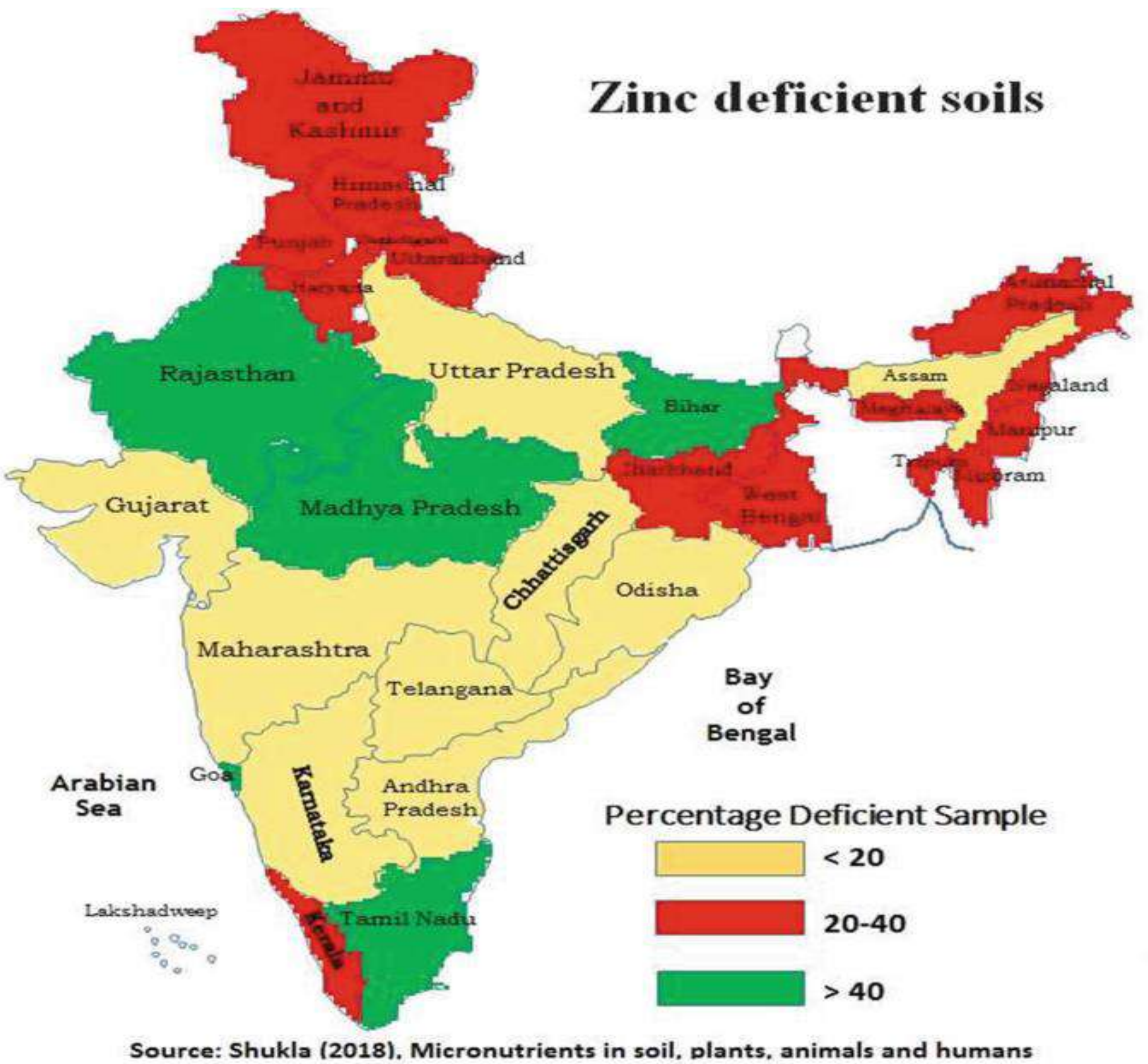
In an ideal situation agriculture must now focus on a new paradigm that will not only produce more food, but also deliver quality food. Indian diets mainly consisting of cereals are inherently low in micronutrients, and growing them micronutrient-deficient further reduces on soils their concentration in these crop plants (Cakmak *et al*., 2010 and Shukla *et al.*, 2014). Compared to pulses and millets, the whole cereal grains provide enough carbohydrates (calories) and proteins to stave off famine, but micronutrients (especially Zn and Fe) needed to sustain life. The exclusive focus on rice and wheat and little emphasis on pulses and horticultural crops have accentuated the problems of micronutrient malnutrition, particularly in infants, pregnant women and rural masser in the countryside. No other problem is of this magnitude afflicting such a huge portion of the world population. According to WHO (2002), deficiencies of zinc and iron occupy 5^{th} and 6^{th} places, respectively among top ten leading causes of illness and diseases in the low-income countries. Optimizing the level of trace elements, especially of Zn and Fe, in the diet by enriching food crops through different means is of paramount importance to human nutrition.

Zinc is one most importance micronutrients of the 17 essential elements necessary for the normal growth and developments of plants and also required for the survival of humans, and animals Zinc has emerged as the most widespread micronutrient deficiency in soils and crops worldwide, resulting in severe yield losses and nutritional quality. Deficiency of Zn in soil can therefore adversely affect not only crop production through reduced yields, but also affect the health of humans eating food produced from those soils, due to low content in food grain. in human Zn is also effective in antiviral immunity, being currently in use as supplement for COVID-19 treatment. However, nearly half of the world's population suffers from Zn deficiency mainly in rural communities and apparently the deficiency of this element in crops and humans is strongly interconnected (WHO, 2002) .

Status of Zinc and Iron deficiencies in the Indian Soils –

The total amount of zinc in soils is related to the parent material. Basaltic soils are high, whereas sandy soils are low in zinc. Ionic zinc is found on the exchange sites of clay minerals and organic matter. It may be adsorbed as the divalent cation Zn^{2+} and, as $ZnOH^{+}$ and $ZnCI^{+}$ to a lesser extent. Up to 60% of the total soluble soil zinc is associated with soluble zinc organic complexes which are held by organic matter is fairly immobile and very little is lost through leaching. Almost half of the soils in the world are deficient in zinc and about 50 % soil samples analysed for available zinc were found deficient in India (Fig-1). The zinc deficiency in India is expected to increase from the present level of around 50 to 63 % in 2025 if the trend continues. Deficiency of Fe is not as severe as is that of Zn. Around 12.6% of the Indian soils suffer from Fe deficiency.

Fig.1: distribution of zinc deficiency in different soils of India.



Zinc in Plants

Zinc is taken up by plant roots as Zn2+. Other cations, e.g., Ca^{2+}, Mg^{2+}, and Cu^{2+}, may depress zinc (Zn^{2+}) uptake. Factors which may affect zinc uptake include:

Restricted Root Growth: Any factor that affects root development or the rates of diffusion of zinc in the soil may cause zinc deficiency, e.g., soil compaction, high water tables, container grown plants.

VAM (Vesicular Arbuscular Mycorrhiza) is a beneficial fungi which infects the roots of most crops plants (canola is an exception). The mycelium (fungal threads) act like fine root hairs, effectively increasing the root surface area and greatly increasing plant uptake of immobile nutrients such as phosphorus and zinc.

Phosphorus : The application of phosphorus fertiliser may induce zinc deficiency by affecting the physiological availability of zinc in plant tissues. It was once thought that this was due to the precipitation of **zinc phosphate** in the soil, but this is now known not to be the case.

More recently, it has been found that VAM colonization of plant roots is reduced in crops growing in soils high in phosphorus. This may also contribute to the high incidence of zinc deficiency in these soils. Plants may be able to take up adequate phosphorus under lower VAM populations, but if soil zinc is low, plants may become zinc deficient.

Role of zinc in plant and human

Zinc is needed for a variety of functions in both plants and humans. It is required for a wide range of physiological and metabolic functions in all living things. It belongs to the six chemical classes

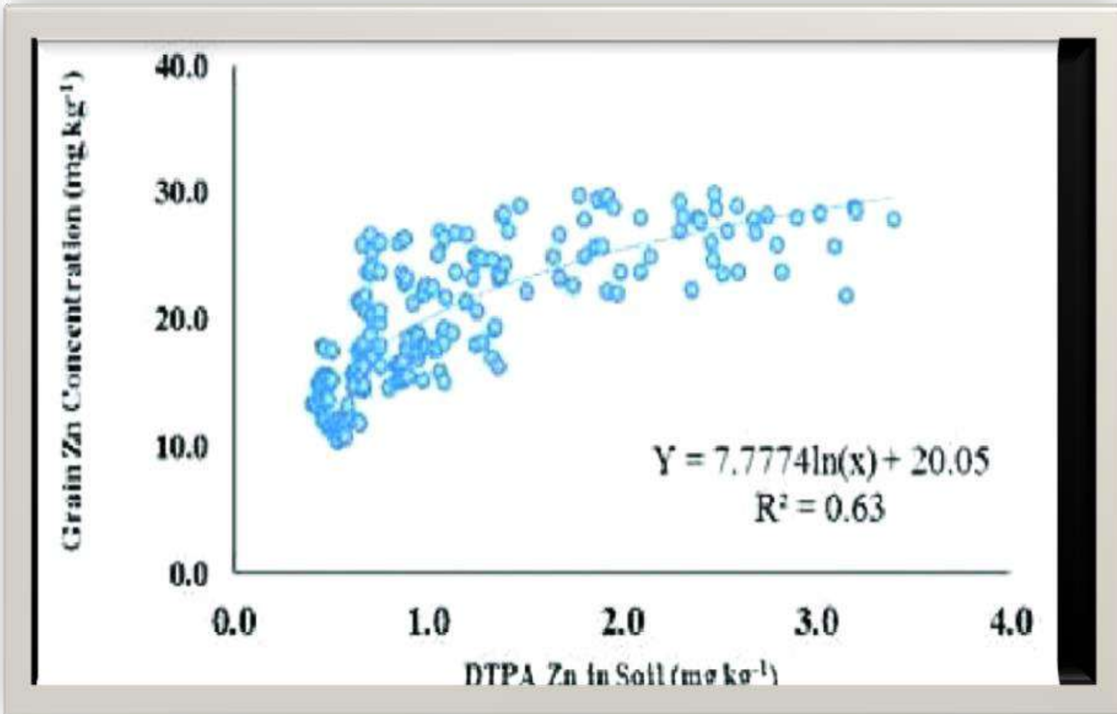
1. Oxido-reductase	2. Transferases	3.Hydrolases
4. Lyases	5. Isomerases	6. ligases

Zinc plays a key role in plants as a structural constituent or regulatory cofactor of a wide range of different enzymes and proteins in many important biochemical pathways. Zinc deficiency in plants retards photosynthesis and nitrogen metabolism; reduces flowering and fruit development; prolongs growth periods, resulting in delayed maturity; results in lower yield and poor produce quality. Since cereal grains have inherently low concentrations, growing these on the potentially zinc-deficient soils further decreases grain zinc concentration.

Relationship between DTPA soil Zn and grain Zn concentration in rice

Soil is the major source of micronutrient elements entering the food chain. Crops grown in Zn and Fe deficient soils also have low Zn and Fe content in their grains/ seeds. For example, significant correlation has been demonstrated between available soil Zn content and Zn content in rice grains (Fig. 2).

Fig. 2: **Relationship between DTPA soil Zn and grain Zn concentration in rice**

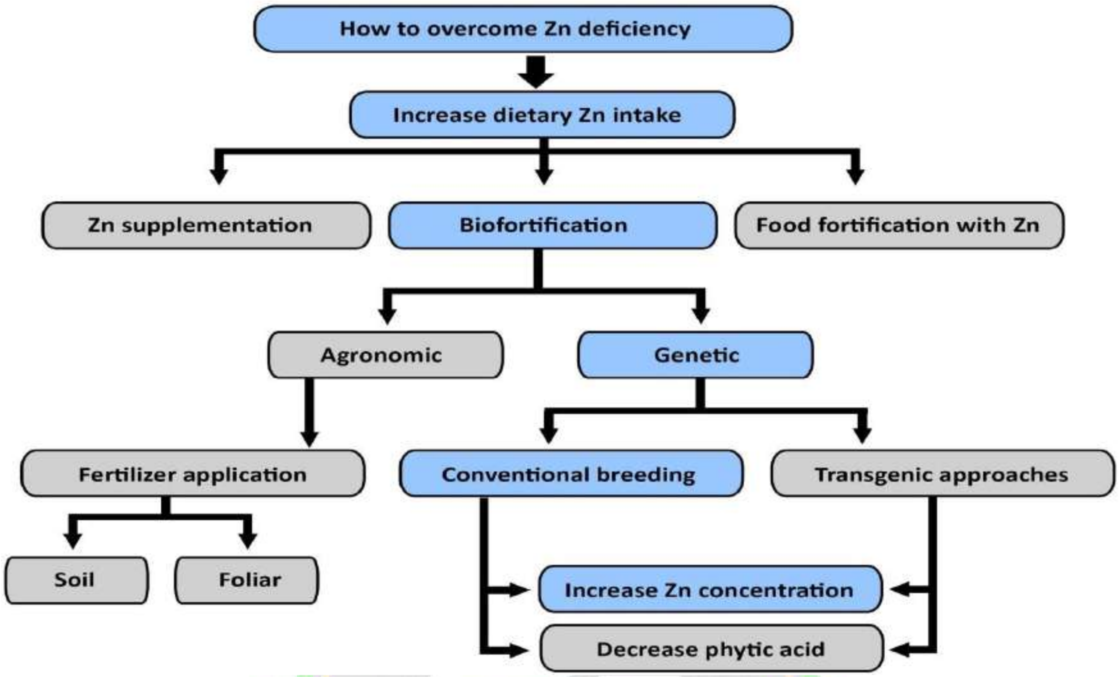


Zinc deficiency in soil and its impact on human health

Zinc and Iron deficiency in human is most prevalent in Indian population because Zn and Fe levels in humans depend on their diet. In India, staple food crops like rice, wheat and maize contribute to more than 80% of the total energy requirement. Normally cereals contain low Zn (15-30 mg Zn kg^{-1}) and Fe (10-15 mg Fe kg^{-1}) against the required adequate concentration of 40-60 mg Zn kg^{-1} and 20-25 mg Fe kg^{-1} for better nutrition (Cakmak, 2004).

Zinc is an essential nutrient for human health. There is no life without zinc. It is estimated that about one-third of the world's population suffers from zinc deficiency and it is the fifth leading cause of death and disease in the developing world particularly children under the age of five. Zinc is vital for many biological functions in the human body. The adult body contains 2–3 g of zinc. It is present in all parts of the body, including organs, tissues, bones, fluids and cells. It is vital for more than 300 enzymes in the human body, activating growth – height, weight and bone development, cell division, immune system, fertility, taste, smell and appetite, skin, hair and nails and vision.

How to overcome Zn deficiency



Conclusions

Zinc deficiency in crops and humans is a critical issue and a global challenge. The sustainable solution is increased use of zinc in balanced fertiliser use, so that the soil health, food security as well as nutritional security are ensured.

References:

Cakmak, I. (2004). Identification and Correction of Wide-Spread Zinc Deficiency in Turkey A Success Story: The International Fertilizer Society, London, UK.

Cakmak, I., Pfeiffer, W. H. and Mc Clafferty, B. (2010) REVIEW: Biofortification of Durum Wheat with Zinc and Iron. Cereal Chemistry 87(1): 10-20

Shukla, A.K., Tiwari, P.K. and Chandra Prakash. (2014). Micronutrients Deficiencies vis-avis Food and Nutritional Security of India. *Indian Journal of Fertilisers*; 10(12): 94-112.

Shukla, A. K. (2014). Understanding the mechanism of variation in status of a few nutritionally important micronutrients in some important food crops and the mechanism of micronutrients enrichment in plant parts, NAIP Funded Research Project. AICRP on Micronutrients, ICAR-IISS, Bhopal.

Singh, M. V. (2009). Micronutrients nutritional problems in soils of India and Improvement for human and animal health. *Indian Journal of Fertilisers*; 5(4): 11-26.

Takkar, P. N. (2011). Zinc in human and animal health, zinc special: Improving crop production and human health. *Indian Journal of Fertilisers*; 7(10): 46-69.

Takkar, P. N and Shukla, A. K. (2015). Management of Soil Fertility: Micronutrients, In: State of Indian Agriculture – Soil. (Eds) H Pathak et al. NAAS, New Delhi, India, pp. 121-152.

Welch, R. M. (2008). Linkages between trace elements in food crops and human health In: Micronutrient Deficiencies in Global Crop Production pp 287- 309.

WHO, World Health Organisation, (2002). Geneva, pp 72–104

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DISEASE MANAGEMENT IN PROTECTED STRUCTURES

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Introduction

- A greenhouse is typically enclosed with transparent materials like polythene or glass.
- These materials allow a significant portion of sunlight to penetrate, which is absorbed by vegetable crops and other objects within.
- As sunlight is absorbed, solar energy becomes trapped, leading to a rise in temperature inside the greenhouse.
- This phenomenon is commonly referred to as the greenhouse effect.

Need for disease management in protected structures?

- Diseases are a fact of life in most greenhouse vegetable operations.
- Effective disease management program- success or failure of a greenhouse business.
- Successful disease management program requires a good working knowledge of crop production requirements and an ability to recognize the key diagnostic symptoms and signs of diseases and pests.
- The main components of such a program are regular crop monitoring and the integration of cultural, chemical and biological control practices.
- Integrated Pest Management (IPM) is a term often used when referring to this holistic approach to disease and pest prevention and control.

Importance of Disease Management

- Diseases can reduce the quantity and quality of plants and their products.
- As a result, they can cause direct financial losses to producers.
- The cost of controlling plant diseases after they have become established can be high and, in some cases, may be prohibitive; therefore, preventative approaches may be necessary and may have to be applied to the next crop.
- Effective disease management can make the difference between success and failure in a greenhouse business.

General Strategies for Disease Management

- The management of non-infectious diseases focuses on providing optimal conditions for plant growth and on minimizing environmental stresses as much as possible
- For infectious diseases
- *Eliminating Pathogen Inoculum [Eradication]*
- *Helping Plants Escape Infection [Exclusion]*
- *Limiting Disease Spread [Protection]*
- *Planting Disease-Resistant Varieties [Host Resistance]*

Integrated Disease Management

- Utilizes a blend of cultural, biological, and chemical methods to effectively control and manage crop diseases.
- Cultural practices are employed to prevent *Pythium from reaching the roots, while biological and chemical controls work to inhibit or suppress Pythium within the root zone*

Cultural Controls

Sanitation

- Thoroughly clean and disinfect all interior surfaces and equipment within the greenhouse, including tools, hoses, walkways, carts, totes, troughs, tanks, and water supply lines. Dispose of dying plants by placing them directly into plastic bags for removal and disposal away from the greenhouse.

Disinfesting nutrient solutions

- Typically, greenhouse vegetables are cultivated using rockwool cubes and plastic sleeves or bags filled with a rooting medium such as rockwool slabs, sawdust, or coconut fibre.

- ❖ Recirculating nutrient solutions are regularly disinfected through physical, biological, or chemical treatments, as recommended by Marchuk (2006).

Physical treatments:

- ❖ Filtration: Methods include slow sand filtration, ultrafiltration using membrane filters, and micropore filtration with high-pressure rapid flow membranes or sediment filters.
- ❖ Energy-based techniques: These encompass heat pasteurization, typically conducted at temperatures of 95-97°C for 30 seconds or 85°C for 3 minutes, UV radiation with specific energy levels (e.g., Priva Vialux), sonic energy, magnetism, and aeration, which involves oxygenating water by bubbling air into it.
- ❖ 3. Biological treatments: Strategies like biofiltration using slow sand or lava rock filters and the utilization of water retention ponds promote water quality enhancement through natural biological processes.
- ❖ 4. Chemical treatments: Various chemicals are employed for water treatment, including ozonation, chlorine, chlorine dioxide, copper-based products like Aqua-Hort® from Aqua-Perl (Denmark), hydrogen peroxide, electrochemical methods like ECA®, surfactants like soaps acting as wetting agents, and iodine-based compounds.

Resistant varieties

- ❖ While there are currently no vegetable varieties resistant to Pythium, certain robust varieties may exhibit increased tolerance to this pathogen.

Integrated Production and Protection Management (IPPM)

IPPM components

- ❖ GH climate management
- ❖ Irrigation and fertilization management
- ❖ Argo-management & practices
- ❖ Mechanical protection
- ❖ Biological control
- ❖ Chemical control

Applications

- ❖ 80% reduction on agrochemical use in protected agriculture greenhouses in Yemen
- ❖ 61% increase in yield in Oman
- ❖ 45% increase in greenhouse grower incomes in Yemen

- ❖ 15% increase in grower cucumber production in Oman
- ❖ > 50% water saving in all AP countries.

Application of Integrated Production & Protection Management Program Total Yield (kg)

Disease Management for Vegetables and Herbs in Greenhouses Using Low Input Sustainable Methods

- ➢ Growers may find it necessary to use fungicides and nematicides sparingly in emergency situations to combat diseases effectively while minimizing ecological disruption.
- ➢ However, it's essential to prioritize crop management practices and integrated pest management (IPM) strategies to prevent disease outbreaks and minimize reliance on chemical treatments.
- ➢ Before constructing a greenhouse, careful consideration should be given to its location and design to optimize growing conditions and disease prevention measures.
- ➢ Key factors to consider include ensuring good soil drainage, avoiding shading from nearby buildings, trees, or greenhouse structures, providing easy access from office/living quarters, and maintaining good air and water quality within the greenhouse environment.
- ➢ These proactive measures can help mitigate disease risks and promote healthy plant growth in greenhouse vegetable or herb crops.

Management Strategies for *Pythium Diseases of* Greenhouse Vegetable Crops

- *Pythium* species, often referred to as water molds, are fungal-like organisms (Oomycetes) that naturally inhabit soil and water, functioning as saprophytes by feeding on organic matter.
- *Pythium* infection can result in damping off in seedlings and crown and root rot in more mature plants.
- In Canada, several *Pythium* species, including *P. aphanidermatum*, *P. irregulare*, and *P. ultimum*, are recognized for causing damping off and crown and root rot in greenhouse cucumber, pepper, and tomato crops. Although some varieties may exhibit disease tolerance, there are currently no Pythium-resistant varieties available.
- Factors such as overwatering, inadequate root aeration, root injury, and improper root zone temperatures can weaken crops, potentially leading to Pythium outbreaks.
- Therefore, proper crop management practices are crucial for mitigating Pythium-related issues.

Main Alternatives to Methyl Bromide

- Tomatoes face a multitude of soil-borne pathogens, including Fusarium (*Fusarium oxysporum f.sp. lycopersici, race 1 and race 2) and Verticillium wilts (Verticillium dahliae, races 1 and 2), Clavibacter michiganensis (causing bacterial canker), Pseudomonas syringae pv. tomato (causing bacterial speck), Orobanche (Orobanche crenata), and root-knot nematodes (Meloidogyne spp.)*.
- Historically, *these pathogens* were managed using Methyl Bromide.
- However, to reduce reliance on this chemical, an Integrated Pest Management (IPM) program for tomatoes, primarily based on local research findings, has been implemented in collaboration with farmers.
- This IPM program is now widely adopted across farms in Morocco.
- Crop rotation
- Resistant varieties
- Plant grafting
- Solarisation
- Soil-less culture

Crop rotation

- ❖ Consider rotating tomato with a succession of crops like squash, beans, melon, and hot pepper, or alternatively, try tomato with beans, melon, hot pepper, and squash. Another option is tomato with melon, hot pepper, beans, and squash.
- ❖ Crucially, ensure that each subsequent crop does not belong to the same botanical family as the preceding one.
- ❖ Hot pepper can be substituted with pepper to diversify the rotation further.

Resistant varieties

- ❖ Numerous tomato cultivars display resistance to various soil and airborne pathogens.
- ❖ However, resistance remains unavailable for certain pathogens such as *Clavibacter michiganensis subsp. michiganensis, Pseudomonas syringae pv. tomato, Xanthomonas campestris pv. vesicatoria, Sclerotinia sclerotiorum, and Fusarium wilt caused by Fusarium oxysporum f.sp. lycopersici.*
- ❖ Moreover, the emergence of new races, particularly within *Fusarium and Verticillium* species, poses a significant threat to tomato production, even for cultivars with existing resistance.
- ❖ While many high-yielding tomato varieties are currently susceptible to nematodes, there is currently no tomato variety resistant to *Verticillium race 2*.
- ❖ Additionally, resistant commercial cultivars of tomato against *Fusarium oxysporum f.sp. radicis, Pseudomonas lycopersici, and Fusarium oxysporum f.sp. lycopersici race 3* are not yet available, further complicating disease management strategies in tomato production.

Grafting

- ❖ Resistant rootstocks, such as KNVF types Daniella and Beaufort (interspecific hybrids of *Lycopersicon hirsutum* x *L. esculentum*), offer excellent control against numerous tomato diseases, particularly *Fusarium oxysporum* f.sp. *lycopersici*, *F. oxysporum* f.sp. *radicis*, and *Meloidogyne* spp.
- ❖ Previously deemed too costly, this technique is now widely adopted at a commercial scale in Morocco.
- ❖ Typically, without grafting, the tomato plant population per hectare is around 18,000 plants.

- However, when grafted plants are utilized, studies have shown that equivalent yields can be achieved with only half the plant population, amounting to approximately 9,000 plants per hectare.
- Grafted plants are usually trained with two stems, contrasting with non-grafted plants, which typically have only one stem.

Solarisation

- In Morocco, soil solarization is increasingly being employed as a method to control various tomato pathogens such as Colletotrichum coccodes,
- Fusarium oxysporum f. sp. lycopersici, Verticillium dahliae, Phytophthora lycopersici, Rhizoctonia solani, and Orobanche ramosa.
- However, it's worth noting that soil solarization may not effectively reduce the population of Meloidogyne spp. under Moroccan conditions.
- The efficacy of soil solarization can be influenced by factors such as weather conditions, soil type, and the specific pests or diseases targeted for control.

Soil-less culture

- In Morocco, soil-less culture is gaining traction as a method to combat various soil-borne pathogens affecting horticultural crops, including vegetables and fruit trees.

Disease management begins in the greenhouse (Mary Hausbeck,2007)

- Damping-off, caused by fungus such as *Pythium*, *Phytophthora*, and *Rhizoctonia*, can harm vegetable seedlings and blooming bedding plants.
- To reduce the impact, avoid excessive watering as damping-off fungi flourish in wet circumstances.

- In greenhouses, root rot pathogens can be found in soil particles and plant remnants on surfaces such as containers, benches, walkways, and equipment. If root rot occurs, the sick plants should be removed and disposed of immediately.
- Eliminate nearby healthy plants as the disease may have spread to them, even if symptoms are not yet present.
- Plug sheets with sick transplants should not be reused.
- To manage humidity, it's important to use huge exhaust fans with cooling pads on one side and introduce fresh air through small fans.
- Use a non-emitting heater to ensure uniform heating throughout the house.
- To germinate seeds and grow transplants, follow strict sanitation measures in a separate greenhouse that is well-screened and free of weeds.
- After harvesting the crop, thoroughly sanitise the greenhouse by removing plant material and roots, hosing down all surfaces, and solarizing the house by moistening the interior and closing it for two weeks during a hot, sunny period in summer. Aim for an interior temperature of at least 145°F daily.
- These measures attempt to reduce the danger of introducing plant infections, disease severity, and dependency on labelled fungicides and nematicides among greenhouse vegetable and herb growers.

Biological control of fungal diseases on greenhouse vegetable crops

The greenhouse environment

- The controlled environment of the greenhouse provides suitable conditions for the establishment of biological control agents
- Paradoxically, it can also provide conducive environmental conditions for the build-up of fungal plant pathogens on greenhouse crops

Cucumber

- Powdery mildew (*Sphaerotheca fuliginea)* (= *Podosphaera (Sect. Sphaerotheca) xanthi)*
- Pythium root and crown rot (*Pythium aphanidermatum, P. ultimum)*
- Fusarium root and stem rot (*Fusarium oxysporum f.sp radicis-cucumerinum)*

Gummy stem blight (*Didymella bryoniae* (= *Phoma cucurbitacearum)*

Powdery mildew

Pythium and crown rot

Fusarium root and stem rot

Gummy stem blight

Pepper

Fungal diseases on greenhouse crops

- ✓ Powdery mildew (*Leveillula taurica)*
- ✓ Fusarium stem and fruit rot (*Fusarium solani) (= Nectria haematococca)*
- ✓ Root rot (*Pythium spp., Rhizoctonia solani)*
- ✓ Gray mould (*Botrytis cinerea)*

Tomato

Fungal diseases on greenhouse crops

- ✓ Gray mould (*Botrytis cinerea)*
- ✓ Fusarium crown rot (*Fusarium oxysporum f.sp. radicis-lycopersici)*
- ✓ Powdery mildew (*Erysiphe orontii) (=Oidium lycopersici)*

Disease management strategies

- ✓ Resistant or tolerant cultivars, if available
- ✓ Fungicides as seed treatments, drench,foliar spray, vapours
- ✓ Cultural control – environmental monitoring, plant health management
- ✓ Sanitation – removal of diseased plants,hygiene and clean-up, disinfectants
- ✓ Biological control – as preventative applications, or potentially curative,depending on the disease

Biological control of diseases

- ✓ At present, there are 3 microbial agents registered in Canada for control of fungal diseases

  1) Mycostop (*Streptomyces griseoviridis)* - for control of root-infecting fungi (*Pythium,Fusarium, Rhizoctonia)*

  2) Root Shield (*Trichoderma harizianum)* - for control of root-infecting fungi (*Pythium,Fusarium, Rhizoctonia) or foliar fungi* (mildew, *Botrytis) as PlantShield*

  3) Sporodex (*Pseudozyma flocculosa)* – in order to control powdery mildew on cucumber and roses

- ❖ An additional biological control agent, Prestop WP (Prestop Mix) containing *Gliocladium catenulatum) may be considered for registration* in Canada for control of *Pythium, Rhizoctonia, Fusarium* (Prestop Mix)
- ❖ For control of *Botrytis and Didymella (Prestop* WP)

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INTEGRATED PEST MANAGEMENT OF MAJOR PEST'S OF GROUNDNUT

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Introduction

Integrated Pest Management (IPM) is a sustainable approach to controlling pests in groundnut cultivation. It emphasizes a combined use of cultural, biological, and chemical methods to minimize economic, health, and environmental risks. Unlike traditional methods relying heavily on pesticides, IPM aims to create a balanced ecosystem where pest populations are managed below economically damaging levels. By incorporating crop rotation, resistant varieties, habitat manipulation, and natural enemies, IPM reduces the need for chemical interventions. When pesticides are necessary, they are used judiciously and selectively based on rigorous monitoring and economic thresholds. This approach enhances crop yield, quality, and farmer profitability while safeguarding the environment.

White Grub: *Holotrichia consanquinea, H. serrata., H. insularis (*Melolonthidae: Coleoptera)

White grubs inflicting serious damage to groundnut cultivation in rainy season. *H. consanguinea* is pre-dominant in Rajasthan, Gujarat, Haryana, Punjab, Bihar and Uttar Pradesh whereas, *H. serrata* is most destructive in states like, Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra. In endemic areas, the damage to groundnut crop ranges from 20-80%. White grub larvae cause severe damage to groundnut as well as other commercial crops like potato, sugarcane, pea, maize etc., whereas for plants like bajra, sorghum and maize have adventitious root system can withstand much.

Favorable environmental condition

There are two major white grub pest species on groundnut in India viz., *Holotrichia consanguinea* Blanchard and *H. serrata*. Of these *H. consanguinea* is the key white grub pest in the northern parts of the country and finds loose sandy, well-drained soil to be quite suitable for its survival and multiplication.

Damaging symptom

Damage is caused by grubs where young grubs feed on fine rootlets while mature grubs feed on both roots and pods. The affected plants show varying degrees of wilting, which ultimately die and died plants can easily be pulled out. The grubs cause infestation in patches leading to 'patchy appearance' of field. The adult beetles feed on the leaves at night, first by making holes and later feed on the entire leaf leaving mid ribs only.

Cultural management

- Early sowing i.e. mid-June may be useful in reducing the incidence.
- Deep summer ploughing to expose the egg and pupae to solar radiation and predation by birds.
- Trim off bunds and remove shrubs in and around the fields.
- Collect and destroy the adults fallen near the base of trees.
- Use well-decomposed organic manures.
- Crop rotation with jowar/sorghum and bajara/pearl millet.

Physical method

- Place light traps @ 1 trap/ha during first monsoon rains.
- Keep 3 pheromone (synthetic pheromone-Anisole) traps at 15-meter radius for three consecutive evenings after the first monsoon rains.

Biological control

- Release *Trichogramma Chilonis* @ 50000/ha twice (7-10 days interval).
- Conserve the natural bio control population of spiders, long-horned grasshoppers, praying mantis, robar fly, ants, green lace wing, damsel flies/dragon flies, flower bugs, shield bugs, ladybird beetles, ground beetles, predatory cricket, earwig, braconids, trichogrammatids, NPV, green muscular fungus.
- Mulching with rice straw causes reduction in leaf miner incidence and increase in percentage parasitism.

- Intercropping groundnut with *Pennisetum glacum* enhanced the parasitoid *Goniozus spp*. on leaf miner.

Chemical method

- Incorporate carbofuran 3CG @ 33.0 kg/ha or phorate 10CG @ 25.0 kg/ha in soil before sowing.
- Seed furrow application of insecticides such as, thiamethoxam 25 WS @ 1.9 lt/ha or fipronil 5FS @ 2.0 lt/ha.
- Seed treatment with chlorpyriphos 20EC @ 6.5-12.0 ml/kg or imidacloprid 17.8SL @ 2.0 ml/kg seed.
- Drenching with chlorpyriphos 20 EC @ 4.0 lt/ha or quinalphos 25EC @ 3.2 lt/ha.
- Spray insecticides such as imidacloprid 17.8SL @ 1.5 ml/lt or monocrotophos 36SL @ 1.6 ml/lt.

Leaf Miner: *Aproaerema modicella* Deventer (Gelechiidae: Lepidoptera)

This species is the key pest of groundnut in many parts of India (particularly the southern states) and in some other Asian countries. It has a limited range of hosts, among which soybean (Glycine max) is the most favored alternative to groundnut. Epidemics can result in total crop loss.

Favorable condition and insect character

The adult is a brownish-gray moth, only 6 mm long, with a 10 - mm wingspan. Shiny white eggs are laid singly, usually on the underside of the leaflets, close to the midribs, and are just visible to the naked eye. Each female moth lays about 200 eggs. The young larvae mine into the leaves as soon as they hatch. This means that an infestation is usually detected by the presence of small brown blotches on (or in) the leaf. The mines are about 1 mm long when first noticeable. If a mine is opened, the minute caterpillar can be seen inside. The mines enlarge as the larvae grow. When they become too large to occupy the mine, the larvae emerge and web adjacent leaflets together, and continue to feed on leaf tissue from inside the webbed leaves. Pupation takes place in the webbing. A severely attacked field looks 'burnt' from a distance. Epidemics can result in total crop loss. In southern India this species completes 3 - 4 generations in a crop season. Leaf miners are favored by the hot dry conditions of the post rainy season.

Symptom of damage

- Young larvae initially mine into the leaflets, feed on the mesophyll and form small brown blotches on the leaf
- Later stages larvae web the leaflets together and feed on them, remaining within the folds
- Severely attacked field looks "burnt" from a distance

Management

Cultural

- Collect and destroy the egg masses and voracious early instar larvae.
- Deep summer ploughing to expose the egg and pupae to solar radiation and predation by birds.

Mechanical method

- Showing of cowpea and soybean as trap crop.
- Set up light traps @12/ha.

Chemical

- Dimethiate 30 EC 660 ml/ha.
- Methyl demeton 25% EC 1000 ml/ha.

Red Hairy Caterpillar: *Amsacta albistriga*, *A. mooreii*. *Diacrisia oblique* (Erebidae: Lepidoptera)

Red hairy caterpillar is a regionally significant insect pest (Tamil Nadu, Andhra Pradesh and Karnataka). This Insect pest plays a vital role in yield losses ranging from 23% to 31.4%. Red hairy caterpillar *Amsacta albistriga* Walker (Lepidoptera: Arctiidae) is the most devastating insect pest (Baig et al., 2015) in Asia.

Symptom of damage

Young larvae feed in a gregarious manner by scraping the underside of the leaves. A full grown larva consumes the entire leaf (Pandiarajan et al., 2014) leading to yield loss ranges 25-100%.

Identification of pest

In India *A. albistriga*, found in southern India, and *A. moori* in the northern states. Both can be devastating but are highly sporadic. Both species have one generation a year. The adults emerge from the soil at the onset of the southwest monsoon (usually in June). They are brownish-white moths with a 40 - 50 mm wingspan. The forewings are completely white in *A. moori* and brown in *A. albistriga*. Females lay 800 - 1000 eggs in clusters of 50 - 100 on the host plants. The larvae are initially light brown, but turn reddish as they grow. Their 'hairiness' makes them conspicuous, especially the larger ones, which are up to 5 cm long. They are gregarious and often migrate from field to field in search of food after devastating the foliage in the field where they hatched. The larval period lasts for about a month and pupation takes place in the soil. The adults from these pupae do not emerge until the next rainy season.

Cultural method

- Collect and destroy the egg masses and voracious early instar larvae.
- Deep summer ploughing to expose the egg and pupae to solar radiation and predation by birds.

Mechanical method

- Set up bonefires or light trap 12 /ha in endemic areas.
- Vegetative trapping of migratory larvae by keeping twigs of Jatropa or Calotropis on bunt.
- Dig the trench around the field at 30 cm depth and 25 cm width to check the movement of migrating larvae.

Biological method

- Spray A-NPV (2X 10^5 PIB/I) and *Bacillus thuringiensis* (*Bt*).
- Release of *Bracon hebetor* @ 5000/ha. two times at 7-10 days intervals.
- Conserve dominant predators like Coccinella sp. and *Minochilus sexmaculata* and parasitoids like *Chelonus* spp.
- Conserve the biocontrol population of spiders, long-horned grasshoppers, praying mantis, robar fly, ants, green lacewings, damsel flies/dragonflies, flower bugs, shield bugs, ladybird beetles, ground beetles, predatory cricket, earwig, braconids, Trichogrammatids, NPV, green muscular fungus.

- Use 5% neem seed kernel extract on need basis.
- Inter cropping with pigeon pea, mung bean and soybean provides increase in population of spiders.
- Population of *coccinellids* is higher on groundnut with maize, mung bean and soybean and *Chrysoperla* spp. is higher with maize and soybean intercrops.

Chemical method

- To check early instar larvae spray phosalone 35 EC at 300 ml/ac.
- For grown-up caterpillars spray fenitrothion or chlorpyriphos at 600 ml/ac in 300 lt of water.

Tobacco Caterpillar: *Spodoptera litura* (Noctuidae: Lepidoptera)

Symptoms of damage:

- Freshly hatched larvae feed gregariously, scraping the chlorophyll, soon disperse.
- Sometimes the feeding is so heavy that only petioles and branches are left behind (Natikar and Balikai, 2017).

Identification of the pest:

- **Egg:** Egg masses appear golden brown.
- **Larva:** Pale greenish with dark markings. Gregarious in the early stages.
- **Adult:** Forewings are brown colour with wavy white marking, Hind wings are white colour with a brown patch along the margin.

Management:

ETL: 8 egg masses/100 m row.

Cultural

- Collect egg masses and destroy.

Biological control

- Grow castor as border or intercrop in groundnut fields to serve as indicator or trap crop.
- Monitor the emergence of adult moths by setting up light and pheromone traps.
- Apply Nuclear Polyhedrosis Virus 3 x 10^{12} POBs/ha.
- Intercrop lab lab with groundnut 1:4 ratio.

- Neem oil (2%) 20 lit /ha.

Chemical

- Apply anyone of the following insecticides to control the early instar (1st to 3rd instar) larvae
    - ✓ Quinalphos 25 EC 750 ml/ha
    - ✓ Dichlorvos 76 WSC 750 ml/ha
    - ✓ Diflubenzuron 25 WP 300-400g/ha

For adult management

- ✓ Imidacloprid 17.8% SL 100 -125 ml/ha
- ✓ Quinalphos 25% EC 1400 ml/ha

Termites: *Odotetermes obesus, Odontotermes sp, Trinervitermes biformis* (Termitidae: Isoptera)

Symptoms of damage:

- Wilting of plants in patches
- Termites penetrate and hollow out the tap root and stem thus kill the plant.
- Bore holes into pods and damage the seed.
- It removes the soft corky tissue from between the veins of pods causing scarification, weaken the shells, make them liable to entry and growth of *Aspergillus flavus* that produces aflotoxins.

Identification of the pest:

- The termites are endemic in red and sandy soils.
- These are social insects, live in termataria, in distinct castes, workers, king and queen.
- Workers are small (4 mm) and have a soft, white body and a brown head.

Management:

Cultural

- Digging the termataria and destruction of the queen is most important in termite management.
- Use well-rotten organic manure.
- Harvest the groundnut as soon as they are matured, early removal of the produce from the field will reduce the chances of termite damage to pods.

Chemical

- Apply chlorpyriphos 20 EC to control termites.
- Dust chlorpyriphos @ 30-40 kg/ha in soil before sowing in endemic areas.
- Seed treatment with chlorpyriphos @ 6.5ml /kg of seed may reduce termite damage.

Thrips: *Caliothrips indicus*, *Frankliniella schultzei*, *Scirtothrips dorsalis* (Thripidae: Thysanoptera)

Identification of pest

Thrips are small insects that live in the flowers and folded leaflets of groundnut. They are only about 2 mm long, pale cream in color, and are usually hidden. For these reasons they are not conspicuous. The most important ones on groundnut are *Scirtothrips dorsalis*, *Thrips palmi*, and *Frankliniella schultzei*. It is virtually impossible to distinguish between species with the naked eye, although their damage symptoms are slightly different. The eggs are inserted into young groundnut tissues. The nymphs pass through four instars before becoming adults. Under optimal conditions, the immature stages last about 15 days. Adults live for 20 days and lay 40 - 50 eggs. They can be present at any time of the year but are most numerous in the post-rainy season. They have a wide host range.

Symptom

Nymphs and adults suck s a p from the surface of the leaflets with their rasping and sucking mouth parts. This results, initially, in white patches on the upper and necrotic patches on the lower surface of the leaves. It consists of distortions of the young leaflets and patchy areas of necrotic tissue that puncture and split as the leaflets grow. Injury is normally seen in seedlings.

In severe infestations, particularly in the winter crop (November - sown in southern India), leaf distortion causes stunted plants. The effect of such damage on yield is not precisely known, but is not serious. *Thrips palmi* transmits peanut bud necrosis virus.

Management

Biological control

Resistance to thrips (Robut 33-1, Kadiri 3, and ICGS 86031), which should be grown in endemic areas to reduce the risk of thrips damage and bud necrosis disease.

Chemical

- Apply dimethoate 200 - 250 mL a.i. /ha
- Apply Quinalphos 25%EC 1400 ml/ha

References

Baig, F., Ayyaz, M., & Javed, H. (2015). Screening of different groundnut, *Aarachis hypogaea* L.(Fabaceae: Fabales) cultivars against red hairy caterpillar, *Amsacta albistriga* W.(Arctiidae: Lepidoptera) population in relation to leaf infestation, physico-morphic characters, abiotic factors and yield. *Pakistan journal of Zoology*, *47*(6).

Natikar, P. K., & Balikai, R. A. (2017). Present status on bio-ecology and management of tobacco caterpillar, *Spodoptera litura* (Fabricius)-an update.

Pandiarajan, J., Suganya, T., & Krishnan, M. (2014). Gut resident microbes in groundnut pest *Amsacta albistriga* (Red Hairy Caterpillar). *Current Research in Microbiology and Biotechnology*, *2*(2), 340-346.

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HYDROPONICS IN ORNAMENTAL PLANTS

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Introduction

Ornamental plants add beautification to garden by flowering and foliage. Since the dawn of civilization, ornamental plants have been employed for decorative purposes and they still play a significant role in modern society. They are notable for their beautiful leaves and flowers, their distinct shapes and scents, and their ability to calm people spiritually.

The technique for cultivating decorative plants in nutrient solutions that provide all the nutrients needed for optimal plant growth with or without the addition of an inert medium like gravel, vermiculite, rock wool, peat moss, sawdust, coir dust, coconut fibre, etc. is known as hydroponics or soil-less culture. Using this system we can grow ornamental plants in a media less culture. Initial it was started with cut flowers later expanded to growing various kinds of ornamental plants and plants suitability depends on growth response. In the horticulture industry for ornamental plants, production methods such as seasons for growing varieties, without soil or soil-based cultivation systems, may influence quality metrics including the flowering period of cut flowers, flower yield per plant, stem length, and flower diameter.

It has been recognized that hydroponics is a feasible technique for growing ornamental plants like foliage plants, herbs, roses, and freesia. We can grow ornamental plants by using different systems of media less culture followed by its advantages and disadvantages of media less culture.

Systems of Soilless culture: Hydroponics culture is classified according to the kind of substrate and container used the plant's nutrient delivery system, and drainage.


Gerbera


Orchids


Marigold


Pansy

1. Solution culture or Liquid hydroponics:

a. Circulating methods (closed system): Growing plants in entirely liquid media inside of a pipe or other appropriate container is referred to as solution culture, also referred to as liquid hydroponics.

i. Nutrient Film Technique (NFT): In the case of the Nutrient Film Technique (NFT) hydroponics system, the plant roots are in direct contact with a 0.5 mm-thick nutrient solution thin film that runs through the channel. The developing media-filled seedlings inside custom-made pots are securely fastened within a flexible PVC or plastic sheet tube.

ii. Deep Flow technique (DFT): A hydroponics system called Deep Flow Technique (DFT) uses pipes made of PVC for moving fertilizer solution between two and three centimetres below the surface. The plants are housed in plastic pots that have PVC pipes installed at desired or regular intervals.

b. Non-Circulating Open system: Not circulating depends on the EC and pH of the nutrient solution, an open system uses the solution of nutrients only once and for a longer period of time rather than circulating it.

i. Root Dipping Technique: Plants are grown in tiny pots with growing material inside them using the root-dipping technique. The fertilizer solution is submerged in the bottom centimetres of the pots. The roots are submerged in the nutritional solution as well as suspended in the air. This method is very easy to make, inexpensive, and straightforward.

ii. Floating Technique: This method has similarities to the box method and employs shallow vessels (10 cm deep). This method involves starting plants in tiny pots, fixing them to a Styrofoam sheet or other comparable light plate, and letting them float on the nutrient solution inside the container. The solution requires artificial aeration. iii. Capillary Action Technique: The capillary Action Technique uses a variety of shaped and sized planting pots. Sand or gravel is mixed with a very porous substance, such as old coil dust, to fill pots. Through capillary action, the nutrient fluid rises to the pots filled with porous material. This method works well for houseplants and decorative flowers. The solution requires artificial aeration.

2. Solid media culture (Aggregate systems): For growing plants, sterile solid media with high porosity, improved aeration, high water and air holding capacity, and effective drainage is utilized. The most typical ones include sawdust, peat moss, coco-peat, perlite, vermiculite, vermin compost, gravel, tur, and rock wool.

a. Hanging bag Technique: This method involves growing plants in thick, one-meter-tall, UV stabilized polyethylene bags packed with coconut fiber or coco peat. The bags are held aloft with support from above, while a nutrient solution collection route is positioned below.

b. Grow Bag Technique: Using this method, plants are grown in grow bags composed of UV stabilized polyethylene sheets that are one meter long, 15-20 cm wide, and 8–10 cm high. Depending on the type of crop, single or paired rows can be employed, with a plant spacing of 30 to 60 cm. Fertigation is carried out using specialized stake drippers that have lateral pipes and poly tubes installed.

c. Trench or trough technique: Using this method, plants are cultivated in troughs or trenches constructed out of local materials such as bricks, concrete, or UV-stabilized PVC/HDPE sheet. Depending on the type of crop, a trench or trough may be filled with inert organic, inorganic, or a combination of materials such as coco-peat, sand, perlite, and vermiculite.

d. Pot technique: Using this method, plants are grown in premade plastic pots with diameters ranging from 4 to 12 inches. Inert organic, inorganic, or a combination of materials like as sand, coco-peat, perlite, vermiculite, etc. are placed within pots.

Aeroponics technique: In order to encourage growth, this method involves growing plants in suspended air on Styrofoam panels with the roots hanging inside a dark chamber. Custom-made holes in Styrofoam panels support plants. Plants suitable for hydroponics: The ideal EC and pH, ideal temperature and aeration, buffering effects of water and nutrient solution on the growing media, and provision of all micro and macronutrients to the plants via the growth media are the fundamental needs of every hydroponics system.

Optimal pH and EC requirements for plant growth:

S.No	Name of the plant	Optimum PH	Optimum EC
1	Anthurium	5-6	1.6-2.0
2	Begonia	6.5	1.4-1.8
3	Caladium	6-7.5	1.6-2.0
4	Chrysanthemum, Marigold	6-6.2	1.8-2.5
5	Carnation	6	2.0-3.5
6	Cymbidium	5.5	0.6-2.5
7	Dahlia	6-7	1.5-2.0
8	Gerbera	5-6.5	2.0-2.5

Conclusion

In conclusion, by providing effective and sustainable growing techniques, hydroponics has revolutionized the floriculture industry. The next advances in technology, research, and development in floriculture will determine the success of hydroponics. These techniques provide long-term substitutes for conventional soil.

References

Anon., (2009). Hydroponics. Soil-less Culture Book. Department of Agriculture. Ministry of Agriculture. 1-45.

Carlo Nicoletto *et al.,* (2019). Hydroponic Technologies, University of Padova, Campus of Agripolis, Legnaro, Italy.

Savva, D. and H. Passam. (2002). Hydroponic production of vegetables and ornamentals. Embryo Publications. Athens, Greece.

Seerat Jan *et al.,* (2020). Hydroponics. International Journal of Current Microbiology and Applied Sciences. 9(8): 1779-1787.

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ECO-FRIENDLY AGRICULTURE THROUGH GREEN CREDITS: BUILDING A SUSTAINABLE AND RESILIENT FUTURE

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Introduction

The impact of climate change on various aspects of human life is increasingly evident, with scientific evidence linking greenhouse gases (GHGs) to global warming. In 2023, Earth's temperature rose by approximately 1.36 degrees Celsius compared to the late 19th century preindustrial average, making the past decade the warmest on record. Human activities have significantly increased atmospheric carbon dioxide (CO_2) levels by 50% in less than 200 years, from 365 parts per million (ppm) in 2002 to over 420 ppm currently. Concentrations of CO_2, CH_4 and N_2O have also markedly increased by 30%, 145% and 15%, respectively, since the Industrial Revolution.

Climate change is an escalating threat to the global environment, impacting ecosystems, weather patterns and human livelihoods. Rising temperatures cause melting glaciers, rising sea levels and more severe weather events. These changes disrupt ecosystems, leading to biodiversity loss and species extinction. Additionally, climate change worsens food and water insecurity as agricultural productivity declines and water resources dwindle.

Agriculture and Environmental Degradation

Agriculture, while essential for providing food, fiber and livelihoods to billions, is also a significant contributor to environmental degradation. Unsustainable farming practices, such as intensive chemical use, deforestation, soil erosion and water mismanagement, have led to biodiversity loss, soil degradation, water scarcity and increased GHG emissions. In India, agriculture contributed 17.6% of the total net CO_2 equivalent emissions in 2007, equating to 334.41 million tons of CO_2 equivalent. The primary sources of emissions within the agricultural sector include enteric fermentation, rice cultivation, manure management, agricultural soils, crop residue burning and unscientific crop cultivation.

India has committed to reaching net-zero emissions by 2070. Under the 'LiFE' initiative announced at COP26, India has set ambitious targets to achieve this goal, emphasizing a transition to sustainable lifestyles and enhanced environmental conservation efforts. Agriculture plays a critical role in this transition through low-carbon practices, which prioritize carbon sequestration over emissions. The management practices adopted largely determines the carbon footprint of agricultural activities.

The Concept of Green Credits

The concept of Green Credits has emerged as a promising strategy to incentivize and reward sustainable agricultural practices. Inspired by mechanisms like carbon credits, Green Credits quantify and monetize the environmental benefits of practices that enhance ecosystem health, conserve natural resources and mitigate climate change. By assigning economic value to these ecological services, Green Credits create a market-based incentive system that encourages stakeholders to adopt environmentally sustainable practices. These programs incentivize practices such as organic farming, agroforestry, efficient water management and waste recycling, which reduce environmental impact while enhancing productivity and profitability. Integrating environmental stewardship with agricultural development, Green Credits contribute to national goals of sustainable development, biodiversity conservation and climate resilience.

Activities under Green Credit Programs

Green credit programs encourage various sustainable activities, including:

1. Tree Plantation Initiatives: Expanding green cover through tree planting.
2. Water Conservation Efforts: Water conservation, harvesting and reuse, including wastewater treatment.
3. Sustainable Agriculture Practices: Promoting natural and regenerative farming and land restoration.
4. Waste Management Improvements: Enhancing sustainable waste management practices.
5. Air Pollution Reduction Measures: Actions to reduce air pollution.

6. Mangrove Conservation and Restoration: Efforts to conserve and restore mangrove ecosystems.
7. Ecomark Certification: Encouraging 'Ecomark' labeling for products and services.
8. Sustainable Building and Infrastructure: Supporting sustainable construction technologies and materials.

Benefits of Green Credits in Agriculture

Green Credits play a crucial role in mitigating the environmental impact of agriculture by:

1. Reducing Emissions: Incentivizing practices that reduce GHG emissions, such as improved manure management and efficient water use.
2. Enhancing Carbon Sequestration: Promoting agroforestry, cover cropping and conservation tillage to increase carbon storage in soils and vegetation.
3. Promoting Biodiversity: Reducing chemical inputs and enhancing soil health for greater biodiversity.
4. Conserving Water Resources: Implementing efficient irrigation and water management techniques.
5. Improving Soil Health: Enhancing soil organic matter and reducing erosion for better soil fertility and productivity.

How Farmers Can Adopt and Benefit from the Green Credit Program

Farmers can benefit from the Green Credit Program by adopting sustainable practices such as organic farming, agroforestry, efficient water management, improved manure management and cover cropping with reduced tillage. Organic farming enhances soil health and reduces reliance on synthetic inputs, while agroforestry integrates trees to sequester carbon and provide additional income. Efficient water management techniques, like precision irrigation, conserve water and reduce emissions. Improved manure management through anaerobic digesters reduces methane emissions and produces renewable energy. Cover cropping and reduced tillage enhance soil fertility and carbon storage.

Participation in the Green Credit Program offers farmers financial incentives along with multiple ecological benefits including improved soil health, increased biodiversity and enhanced resilience to climate change. By adopting these practices, farmers contribute to national and global climate goals, positioning themselves as key players in environmental stewardship and sustainable agriculture. The program supports their transition to greener practices, helping them achieve both economic and ecological gains.

Challenges Associated with Green Credit Programs

Green credit programs, designed to incentivize environmentally friendly practices through financial mechanisms, can face several challenges:

1. Implementation Complexity: Designing and implementing a green credit program requires navigating complex regulatory and financial frameworks. Ensuring that the program effectively aligns with environmental goals while maintaining economic feasibility can be difficult.
2. Measurement and Verification: Accurately measuring the environmental impact of projects financed through green credit programs can be challenging. Establishing reliable metrics and verification processes is crucial but can be resource-intensive.
3. Market Adoption: Businesses and individuals may be hesitant to participate in green credit programs if they perceive the financial or operational benefits as insufficient compared to traditional credit options. Overcoming this resistance often requires significant outreach and education.
4. Risk Assessment: Assessing the risk associated with green projects can be more complex than traditional projects. Green technologies and practices might carry uncertainties or longer payback periods, which can make financial institutions wary.
5. Regulatory Uncertainty: Green credit programs often operate within a shifting regulatory environment. Changes in policies or incentives can impact the stability and attractiveness of these programs.
6. Access and Equity: Ensuring that green credit programs are accessible to a broad range of participants, including smaller businesses and low-income communities, can be a challenge. There is a risk that such programs may disproportionately benefit larger, well-established entities.
7. Integration with Existing Systems: Green credit programs need to be integrated with existing financial systems and practices. This can require adjustments and coordination between various stakeholders, including banks, regulatory bodies and borrowers.

8. Fraud and Misuse: There is a risk of fraud or misuse if the criteria for qualifying for green credit are not well-defined or monitored. Ensuring that funds are used for their intended environmental purposes requires robust oversight mechanisms.

Way Forward for Green Credit Programs in Agriculture

1**. Strengthening Regulatory Frameworks**

Developing and enhancing regulatory frameworks is essential for the success of green credit programs. Governments need to establish clear, supportive policies that incentivize sustainable agricultural practices and provide stability for green credit initiatives. This involves:

- Creating Incentives: Policies that provide tax breaks, subsidies, or grants for sustainable farming practices can motivate farmers to participate in green credit programs.
- Standardizing Criteria: Establishing consistent guidelines for what constitutes sustainable practices ensures uniformity and trust in the program. This can include defining metrics for carbon sequestration, biodiversity conservation and water management.
- Collaboration with Financial Institutions: Working closely with banks and other financial bodies to align regulations with green credit objectives ensures that these programs are economically feasible and attractive to stakeholders.

2. **Enhancing Measurement and Verification Processes**

Accurate measurement and verification of the environmental benefits generated by green credit programs are crucial for their credibility and success. This requires:

- Investing in Technology: Utilizing advanced technologies such as satellite imaging, blockchain for transparent tracking and artificial intelligence for data analysis to monitor and measure the environmental impacts accurately.
- Third-Party Verification: Engaging independent organizations to verify the environmental benefits claimed by participants. This adds an extra layer of credibility and ensures that the program's objectives are being met.
- Developing Robust Metrics: Establishing reliable and consistent metrics to quantify environmental benefits such as carbon sequestration, water conservation and biodiversity enhancement.

3. **Promoting Market Adoption**

Increasing the adoption of green credit programs among farmers and agribusinesses is vital. This can be achieved through:

- Education and Outreach: Conducting extensive educational campaigns to inform farmers about the benefits of green credits and how to implement sustainable practices. Workshops, seminars and field demonstrations can be effective.
- Financial Incentives: Offering attractive financial incentives such as lower interest rates on loans, grants, or direct subsidies for sustainable practices. This makes participation more economically viable for farmers.
- Building Partnerships: Forming alliances with agricultural extension services, farmer cooperatives and NGOs to promote green credit programs and provide on-ground support to farmers.

4. **Ensuring Equity and Accessibility**

Green credit programs must be inclusive and accessible to all farmers, particularly small-scale and marginalized farmers. Steps to ensure this include:

- Inclusive Program Design: Tailoring programs to meet the needs of smallholders and marginalized communities. This might include simplifying application processes and providing additional support.
- Technical and Financial Assistance: Offering technical support to help farmers adopt sustainable practices and providing financial assistance to those who may not have the upfront capital needed.
- Leveraging Local Networks: Utilizing local cooperatives, farmer groups and community organizations to disseminate information and facilitate access to green credits. This ensures that even the most remote farmers are aware of and can participate in the programs.

5. **Enhancing Oversight and Accountability**

Maintaining the integrity of green credit programs through strong oversight and accountability mechanisms is essential. This involves:

- Transparency in Allocation and Utilization: Regularly reporting and publicly disclosing how green credits are allocated and used ensures transparency. This builds trust among participants and stakeholders.
- Auditing and Compliance: Implementing strict auditing and compliance mechanisms to monitor the use of funds and ensure they are being used for their intended environmental purposes.

- Feedback Mechanisms: Establishing channels for participants to provide feedback and report issues. This helps in continuously improving the program and addressing any concerns promptly.

By focusing on these five detailed strategies, green credit programs in agriculture can become more effective, equitable and impactful, contributing significantly to sustainable development, climate resilience and environmental conservation.

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THAR DESERT A BOON FOR SOLAR ENERGY

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Introduction

The Thar Desert of Rajasthan is an ideal ecology which is well known as ***Great Indian Desert***, bestowed by nature to the state. It falls under North-western parts of Rajasthan state and covers an area of 208,211 sq. km. The desert is known for sand dunes, sandy winds and Low & high temperature. The average rainfall of this region is of 327 mm on long term average basis. The South-West Monsoon brings almost 85 per cent of total rain fall and monsoon arrives in the end of June and starts departing in second fortnight of September. That means monsoon remains active for a smaller period than rest of country. So clouds cover the sky for the minimum days. It is well reported that 325 days (89%) are sunny in a year. The available solar radiation, here actually near about 6-7kWh/sqm/Day/ and that offers great scope of solar energy. It is appropriately called the Jodhpur as Sun City (***Surynageri)*** which is second largest city of Rajasthan, is located in the thar desert region. As the city gets for the larger period direct bright sunlight per day and for maximum number of days in year than any other city in the India.

The population density of the thar region is also lowest, 85 heads per sq. Km against the state average population density of 201 head per Sq.Km as per census of 2011. The most of land is undulating with low and high sand dunes, low barren hills and larger area is remains unsown. The cropping intensity is around 104 per cent and mainly Kharif crops like Bajra, Seasmum, Gowar, moong , moth, urd, Groundnut and Castor (Figure 1) are grown. Any crops which mature in about 60 days is best suited for region. Here and there in some of the pockets sweet ground water is being tapped. However, availability of sweet water is too low and deep. The farming largely depends on monsoon rains and occasionally gets rains from western disturbance arises from the Arabian sea. The animal husbandry is main source of income from farming in this region. The small ruminants – goat and sheep predominant over castles and camel. In general, the climate in Thar Desert is harsh as frequent sandy winds and extreme low and high temperature. No doubt winter are relative calm and pleasant.

In some areas like Phalodi, underground water is brackish and used for salt production. The underground water being hogh in salt concertation, is pumped out for salt production (Figure 2) on large scale and having decent income. In summary, the region has low density of population, vegetation and a few stone crushers here and there but not big establishments. The region gives deserted look no much human human and vehicular movements. Further, the most of the land owned by Government. So, site selection for establishing Solar Parks in regions is best suited place. Secondly, the farmers give their land on lease for Solar Park establishment have better return than having farming or any other activity. Thirdly, renewal energy production at cheaper rate and environment friendly.

With this foresighted vision for anticipated demand of energy in future, unutilized large land resources, the Government of Rajasthan formulated Rajasthan Solar Energy Policy 2011.This policy was further amended in 2014 and 2019, keeping in view ease of doing business and amenability to stakeholders. As per information of electronic media, more than 20 small solar projects have been completed till 2018. The journey of solar power production started 5 MW power plant installation in 2011 and this capacity enhanced to 1786.9MW MW in 2016-17. The pace of capacity enhancement continued to achieve target of 5672.2 MW in 2020-21. As per Web site of Department of renewal Energy, Government of Rajasthan had a commissioned capacity of solar power production touched 16098.02 MW and become number one state in solar energy production in the India.

The credit of this extra-ordinary achievements are resultant of favorable Government policy and its will. The policy envisages to establish Solar Parks and accordingly change in land use pattern of agriculture land to establishment Solar Parks. It is worth to mention that two Projects, one at Bhadla village of Bap tehsil of New District Phalodi (Figure 3) and other at Nokh village, Pokhran tehsil of Jaisalmer District.

The Bhadla Solar Park Phase I

The Bhadla Solar Park Phase I having seven solar power plants of total 75 MW capacity and phase II having solar power plants of total 680 MW have been developed. Besides, all necessary infrastructures like Road, Street lights, availability of water, EVH System for power Evacuation and Office building and other supporting amenities. The Bhadla Solar Park is world's largest solar park spread over a total of 14,000 acres area. Second solar park at Nokh, a 980 MW capacity at village Nokh, Tehsil Pokharan, Jaisalmer has been planned and developed under the Ministry New Renewal Energy (MNRE) scheme. The requisite infrastructure to support project has also been developed as at Bhadla village site.

Recently with the new government in power in state, has sanctioned four more Solar Parks which include three Solar parks with capacity of 2450 Megawatt, in Bikaner district and one Solar Park with capacity of 500 Megawatt in Phalodi district as per the News item published in the Dainik Joyoti dated June 17, 2024. It is proposed these Solar Parks will be installed on 4780 hectares land in Bikaner and 910 hectares land in Phalodi districts.

It is really very enthusiastic and foresighted project to produce the solar energy to augment the much needed energy demand of various sectors of the state. With implementation of these project new jobs will be created for the locals and environment will be conserved with the reduction of carbon emission to the tune of thirteen lakh ton estimated with all the projects in operation. Besides, efficiency of solar energy production will be enhanced as new solar panels and grid technology to be used.

I have visiting sight of Badla Solar Park of Phalodi district, already in operation and in new projects following components to be added to made them green projects and job provider

A. Environment Protection and Natural Resource Management

1. **Harvesting of rain water-** since large area is being covered with solar panels and rain water can be harvested depending upon the natural slope. The large quantity of water can be harvested in ponds. This will be meet the demand of water required for various purposes. I saw no step in this direction taken in Badla Project of Bap, Phalodi

2. **Tree Plantation:** Along the boundary of the solar Park two row of trees of region to be planted. Rain water harvested to be used for raising the plants, as well. Plants will help in environment protection. Secondly, minimize soil dusting of panels from outside and slow down wind speed to reduce the soil erosion between the panels. Thirdly, trees will help in to reduce excessive temperature rise which slow down the energy production incase temperature go above 45C^{o}.
3. **Job creation:** Virtually, there is no job for locals but in case the panel cleaning to be done manually rather than use of robotics., good number of jobs can be created additionally. Here also rain water harvests can be used for washing of panels as and when required to improve the efficiency of panels.
4. **Long Term Study:** The government also to be institute the research projects to study long term effects of solar parks on surrounding ecology.

   There is large scope to further commissioned more solar projects in the region to tap the god gifted energy to made available for the welfare of mankind and save the planet to warming up due to less dependence on fossil energy.

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ENSURING GLOBAL FOOD SECURITY: CHALLENGES AND SOLUTIONS

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Abstract

Global food security remains a critical issue as the world's population is projected to approach 10 billion by 2050. The challenge of providing sufficient, safe, and nutritious food is compounded by factors such as climate change, resource scarcity, economic inequality, and political instability. This paper examines the primary challenges to global food security and explores potential solutions, highlighting the crucial role of agriculture in feeding a growing population. By adopting sustainable agricultural practices, leveraging technological innovations, improving water management, and enhancing policy frameworks, the agricultural sector can address these challenges. Through international collaboration, education, and reducing food waste, we can work towards a more food-secure future.

Keywords: Food security, Climate change, Population growth and Sustainable agriculture

Introduction

Global food security is a pressing concern as the world's population continues to grow, projected to reach nearly 10 billion by 2050. Ensuring that everyone has access to sufficient, safe, and nutritious food is a complex challenge influenced by various factors, including climate change, economic instability, and agricultural productivity. Traditional agricultural practices are often ill-equipped to cope with these rapid environmental changes, necessitating a shift towards more resilient and sustainable approaches. This paper explores the key challenges to global food security and potential solutions, emphasizing the critical role of agriculture in feeding a growing population. By examining sustainable agricultural practices, technological innovations, improved water management, and effective policy measures, we aim to highlight pathways to enhance global food security and ensure a stable food supply for future generations.

Global food security is a pressing concern as the world's population continues to grow, projected to reach nearly 10 billion by 2050. Ensuring that everyone has access to sufficient, safe, and nutritious food is a complex challenge influenced by various factors, including climate change, economic instability, and agricultural productivity. This paper will address the key challenges to global food security and explore potential solutions, emphasizing the critical role of agriculture in feeding a growing population.

Challenges to Global Food Security

Global food security faces numerous challenges that threaten to destabilize the global food supply. The rapid growth of the global population exerts immense pressure on food production systems, necessitating a continuous increase in food output to meet the rising demand. Compounding this issue is climate change, which alters weather patterns, increases the frequency of extreme weather events, and shifts agricultural zones, all of which negatively impact crop yields and livestock production.

Additionally, resource scarcity, particularly the limited availability of arable land and water, imposes significant constraints on agricultural productivity. Economic inequality further exacerbates the problem, as disparities in income and resource access lead to uneven food distribution, leaving many regions with chronic food shortages. Political instability and conflicts disrupt food production and distribution systems, worsening food insecurity in affected areas.

Moreover, a substantial portion of food is lost or wasted due to inefficient harvesting, storage, transportation, and consumption practices. Addressing these challenges requires a focus not only on the quantity but also on the quality of food, as malnutrition and micronutrient deficiencies remain persistent issues that must be tackled to ensure global food security.

Potential Solutions

Addressing the multifaceted challenges to global food security requires a comprehensive approach that includes several potential solutions. Sustainable agricultural practices, such as conservation agriculture, agroforestry, and organic farming, can enhance productivity while conserving resources. Technological innovations, including advances in biotechnology, precision agriculture, and digital tools, offer significant potential to improve crop yields, pest management, and resource use efficiency. For example, genetic engineering can create crops more resistant to pests, diseases, and adverse weather conditions. Improved water management is crucial, with efficient irrigation systems like drip and sprinkler irrigation, as well as rainwater harvesting techniques optimizing water use.

Smart irrigation systems that utilize sensors and data analytics to monitor soil moisture and adjust water application are also promising. Climate-smart agriculture practices, such as using drought-resistant crop varieties and diversified cropping systems, help increase resilience to climate change and reduce greenhouse gas emissions. Policy and governance play a vital role as well, with the development and implementation of policies that support sustainable agricultural development, equitable food distribution, and food waste reduction. Government subsidies for sustainable farming and investments in rural infrastructure can enhance market access.

Global collaboration is essential, with international partnerships and initiatives like the Global Alliance for Climate-Smart Agriculture (GACSA) promoting sustainable practices worldwide. Education and capacity building, through training and extension services, enhance farmers' knowledge and skills in sustainable practices and new technologies. For instance, farmer field schools offer practical training in sustainable farming techniques and resource management.

Finally, reducing food waste at every stage of the supply chain is critical, with measures to improve post-harvest storage facilities and supply chain logistics helping to minimize spoilage and loss. Implementing these solutions collectively can help address the pressing challenges of global food security.

Role of Agriculture in Feeding a Growing Population

Agriculture is pivotal in addressing the challenge of feeding a growing global population by ensuring a stable and sufficient food supply. One of the primary strategies involves increasing productivity through the development of improved crop varieties, the adoption of better farming practices, and the efficient use of resources. This focus on productivity aims to produce more food from the same or fewer inputs. Additionally, diversification plays a crucial role in enhancing dietary diversity and building resilience against market and environmental shocks. By promoting a variety of crops and livestock, agriculture can reduce dependency on single commodities and buffer against fluctuations in supply and demand.

Sustainability is another critical aspect, as environmentally sustainable agricultural practices are essential for preserving soil health, water resources, and biodiversity for future generations. Ensuring that farming methods do not degrade natural resources supports long-term food security. Furthermore, improving market access for smallholder farmers is vital, as it enables them to sell their produce effectively and secure a sustainable livelihood. This involves addressing barriers to entry and creating better infrastructure for distribution and sales.

Finally, investing in innovation and research is key to advancing agriculture. By focusing on agricultural research and development, new technologies and practices can be discovered and implemented, enhancing both productivity and sustainability. This continuous drive for innovation ensures that agriculture can adapt to changing conditions and continue to meet the food demands of a growing population.

Conclusion

Ensuring global food security is a multifaceted challenge that requires a comprehensive approach, integrating sustainable agricultural practices, technological innovations, effective policies, and global cooperation. By addressing these challenges and implementing potential solutions, the agricultural sector can play a pivotal role in feeding a growing population and achieving food security for all.

References

FAO. 2021. The State of Food Security and Nutrition in the World 2021. Rome: Food and Agriculture Organization of the United Nations. Retrieved from FAO.

Godfray H. C. J., Beddington J. R., Crute I. R., Haddad L., Lawrence D., Muir J. F. et al. 2010. Food security: the challenge of feeding 9 billion people. *Science* 327(5967): 812-818. DOI: 10.1126/science.1185383

IPCC. 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Nelson G. C., Rosegrant M. W., Koo J., Robertson R., Sulser T., Zhu T. et al. 2009. Climate change: Impact on agriculture and costs of adaptation. International Food Policy Research Institute (IFPRI). IFPRI Report.

Pretty J., Toulmin C., Williams S. 2011. Sustainable intensification in African agriculture. *Int. J. Agric. Sustain.* 9(1): 5-24. DOI: 10.3763/ijas.2010.0583

World Bank. 2015. Agriculture Global Practice: Enhancing Agricultural Resilience through Climate-Smart Agriculture. Washington, DC: World Bank. Retrieved from World Bank.

Food and Agriculture Organization of the United Nations (FAO). 2020. Climate-Smart Agriculture Sourcebook (2nd edition). Rome: FAO. Retrieved from FAO CSA Sourcebook.

Lipper L., Thornton P., Campbell B. M., Baedeker T., Braimoh A., Bwalya M. et al. 2014. Climate-smart agriculture for food security. *Nat. Clim. Change* 4(12): 1068-1072. DOI: 10.1038/nclimate2437

United Nations. 2015. Transforming our world: The 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015. New York: United Nations. Retrieved from UN Sustainable Development Goals.

United Nations. 2021. The Millennium Development Goals Report 2021. New York: United Nations. Retrieved from UN Millennium Development Goals Report.

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GENES CONTROLLING FLOWER DEVELOPMENT IN PLANTS

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Introduction

Molecular geneticists owe a great deal to geneticists who studied genes at the phenotypic or Mendelian level. Careful observations of traits at the phenotypic level often gives clues about how a gene might function in a genetic cascade involving other genes. Molecular geneticist rely upon these observations to form hypotheses regarding how a gene interacts with other genes to control a specific phenotype. The example that we will discuss regards the genes which control the development of flowers. Because the Mendelian and molecular genetics of *Arabidopsis* flower development has been extensively analyzed, we will use that system as our basis of discussion. For comparative purposes will be mention the genes from *Antirrhinum* (snapdragon).

Plants have two basic growth modes during their life cycles --- vegetative growth and flower and seed growth. The above ground vegetative growth of the plant develops from theapical meristem. This vegetative meristem gives rise to all of the leaves that are found on the plant. The plant will maintain its vegetative growth pattern until the apical meristem undergoes a change. This change actually alters the identity of the meristem from a vegetative to aninflorescence meristem. The inflorescence meristem produce small leaves before it next produces floral meristems. It is the floral meristem from which the flower develops.

The floral meristem under goes a series of developmental changes that eventually give rise to the four basic structures of the flower --- sepals, petals, stamens and carpels. Each of these structures is derived sequentially from a whorl that develops from the floral meristem. Whorl 1 is the first to appear, and it develops into the sepals of the plant. The second whorl develops into petals. The third and fourth whorls define the stamen (male reproductive organs) and carpel (female reproductive organs), respectively. If you move from the base of the flower upwards and inwards you will encounter the four organs in the same order in which they are developed.From a genetic perspecitive, two phenotypic changes that control vegetative and floral growth are programmed in the plant. The first genetic change involves the switch from the vegetative to the floral state. If this genetic change is not functioning properly, then flowering will not occur. The second genetic event follows the commitment of the plant to form flowers. The observation that the organs of the plant develop in a sequential manner suggests that a genetic mechanism exists in which a series of genes are sequentially turned on and off. This switching is necessary for each whorl to obtain its final unique identity.

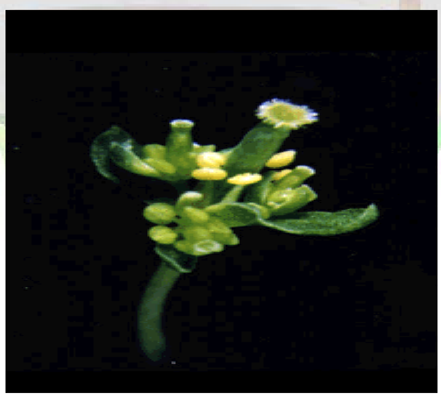
Mendelian Genes Define the Committment to Flowering

A series of *Arabidopsis* mutants have been identified in which normal flowers are replaced with structures that resemble inflorescence meristems and the shoots that normally develop from them. One such mutant is *LEAFY*. This mutant does not contain any normal flowers. Instead, the early flower structures that develop appear as infloresence shoots, whereas the later flowers partially resemble normal flowers. These later developing flowers contain sepal and carpel-like structures; that is they lack petals and stamens. This suggests that *LEAFY* has two functions --- committing the plant to floral meristem development and defining petals and stamens.

How is this conclusion regarding the function of the gene reached? If we believe that a gene defines a phenotype, when that gene is not functioning normally, that is when the gene is mutated, its phenotype is not expressed. When we are considering genes involved in development, then the developmental stage that is altered is controlled at least partially by the gene that is mutated. *LEAFY* mutants often do not develop floral meristems, and when the committment to a floral meristem is made the flowers lack petals and stamens. From these observations we conclude that the*LEAFY* gene is necessary for the conversion of the inflorescence meristem to a floral meristem. Likewise, because later flowers of *LEAFY* mutant lack petals and stamens, this gene must be involved in the development of these flower organs.

Snapdragon mutants have also been quite helpful in defining the steps involved in normal flower development. The analagous gene in snapdragon to *LEAFY* is *floricaula* (*flo*).*flo* mutants also fail to undergo the transition from inflorescence to floral meristem, and the flowers have the appearance of an inflorescence shoot. Clearly this gene is absolutely necessary for the conversion of the inflorescence meristem into a floral meristem. *flo* does differ from *LEAFY*with regards to organ development in that it does not appear to affect petal and stamen development. Therefore, two genes can share one function, in this case the committment to floral mersistem development, but not necessarily all functions. This clearly shows a functional deviation during the evolution of the two species.

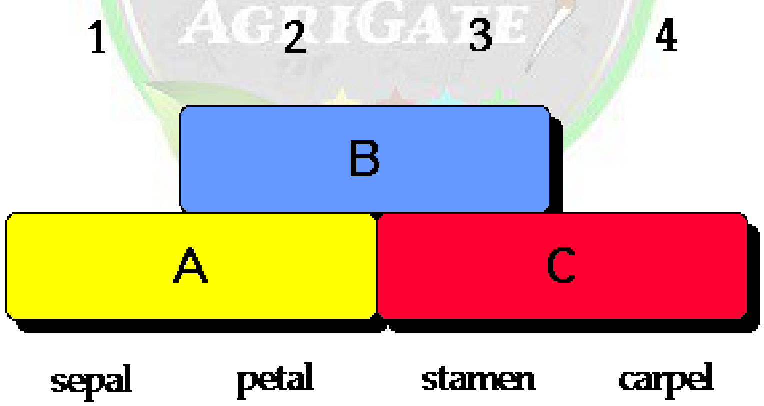
Flowers of *APETALA1* mutants are not altered as dramatically as *LEAFY* mutants. These mutants express a partial inflorescence meristem phenotype where secondary floral meristems appear in the axis region of the sepal. But when the *APETALA1* and *LEAFY* mutants are combined, the flowers appears as an inflorescence shoot. The snapdragon analog to the *APETALA1* gene, *SQUAMOSA*is much more severe, and the flowers appear as inflorescence shoots. *APETALA1* also affects the normal development of sepals and petals. The image below shows the phenotype of the *APETALA1* mutant.



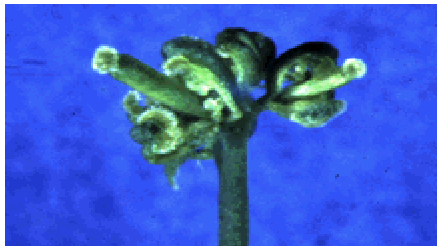
Another gene, *CAULIFLOWER*, does not express its effects unless coupled with another mutant. *CAULIFLOWER* and*APETALA1* double mutants have inflorescence meristems developing in place of floral meristems. Because the*CAULIFLOWER* phenotype only appears when it is coupled with *APETALA1*, it can be concluded that the phenotypic functions maintained by the *CAULIFLOWER* gene are duplicated by *APETALA1*. Conversely, the observation that*APETALA1* floral meristems are generally normal suggests that *CAULIFLOWER* contains *APETALA1* functions. But not all *APETALA1* functions. Remember, *APETALA1*mutants also have abnormal sepal and petal development, and these functions are not rescued by the wild type*CAULIFLOWER* gene. Therefore, *APETALA1* has two genetic functions, but only one of these is duplicated by the*CAULIFLOWER* gene. The image below shows the phenotype of the *APETALA1 CAULIFLOWER* double mutant.

Mendelian Genes Define Floral Organ Identity

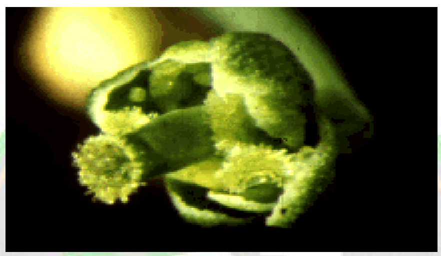
A model was developed that attempts to explain the interactions of the different genes that control floral organ identity. All the genes are classified as expressing one of three activities, A, B, or C. The A gene activities control the development of the sepal and petal, B gene activities control petal and stamen development, and C gene activities control stamen and carpel development. The following diagram depicts these interactions.



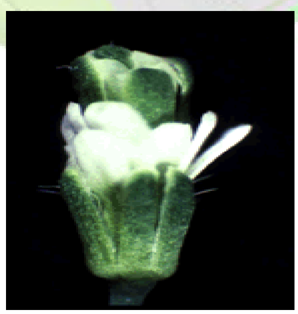
The two A function genes are *APETALA2* and *APETALA1*. Alleles of these two genes have been isolated that show varying degrees of effect, but in general if an A function gene is mutated, the first whorl develops as a carpelc and the second whorl develops as a stamen.*ovulata* is an A function gene of snapdragon similar to *APETALA2*. The following image shows the *APETALA2* mutant.



The B gene functions are defined by the genes *APETALA3* and*PISTILLATA*. The net effect of B gene mutations is that whorl 2 develops as a sepal rather than a petal, and whorl 3 develops as a carpel not a stamen. *deficiens* and *globosa* are snapdragon genes that have homologous functions to the *Arabidopsis* B function genes. The following image shows the *APETALA3* mutant.



Finally, C gene functions are defined by the gene *AGAMOUS*. Mutants of this gene have the third whorl stamen replaced by a petal, and the fourth whorl develops into a new flower with the sepal-petal-petal pattern. Furthermore, flower development in *AGAMOUS* mutants is indeterminate, not determinate. A snapdragon gene similar to*AGAMOUS* is *pleniflora*. The following image shows the *AGAMOUS*mutant.



The following table summaries the phenotypic effects of mutations in each of the three functions.

Phenotypic Effects of Mutations in A, B or C Function Floral Identity Genes				
	Phenotype			
Mutation	Whorl 1	Whorl 2	Whorl 3	Whorl 4

Wild Type	Sepal	Petal	Stamen	Carpel
A Function	Carpel	Stamen	Stamen	Carpel
B Function	Sepal	Sepal	Carpel	Carpel
C Function	Sepal	Petal	Petal	New Flower

Several conclusions can be drawn regarding the functions of these genes by studying single and double mutants. Because a mutation of an A function gene results in the expression of organ phenotypes controlled by C function genes, it appears that A gene functions repress the expression of the C gene functions in the whorls giving rise to sepals and petals. Likewise, the appearance of the petal in the third whorl of C gene mutants, suggest that C genes repress the activities of A genes in the organs that they control.

These conclusions are based on single mutants. For example,*APETALA2* A function mutants develop C function organs, carpels and stamens, in the first two whorls, respectively. What would be expected from an A and C double mutant? This mutant would not be expected to have any functions exclusively controlled by the the A and C function genes. And indeed this is what was seen when the*APETALA2*/*AGAMOUS* double mutant was developed. The first whorl develops as a leaf and the second whorl has stamen-like petals. This second whorl phenotype of this mutant is the result of the activities of the B gene functions.Finally what would be expected with an A, B and C function triple mutant? This mutant would have no genes functioning that determine normal floral organ development. As expected, the triple mutants lack any floral organs, and the flower essentially consists of leaves developing form each of the whorls.

References

Lohmann, J. U. & Weigel, D. Building beauty: the genetic control of floral patterning. *Dev. Cell* **2**, 135–142 (2002).

Morel, P. et al. Divergence of the floral A-function between an asterid and a rosid species. *Plant Cell* **29**, 1605–1621 (2017).

Hong, Y. & Jackson, S. Floral induction and flower formation-the role and potential applications of miRNAs. *Plant Biotechnol. J.* **13**, 282–292 (2015).

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THE MIRACLE FODDER TREE (*LEUCAENA LEUCOCEPHALA*) TRANSFORMING LIVESTOCK FARMING

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Abstract

Leucaena leucocephala, commonly known as the Miracle Fodder Tree, has emerged as a transformative resource in livestock farming, particularly in tropical and subtropical regions. This versatile, fast-growing leguminous tree offers a high-protein feed source that significantly enhances livestock nutrition and productivity. It serves as a sustainable and cost-effective supplement to traditional fodder, especially during periods of scarcity. Beyond its role as a feed source, Leucaena contributes to sustainable agriculture through its ability to fix atmospheric nitrogen, enrich soil fertility, and stabilize degraded lands. Its integration into agroforestry systems supports biodiversity, improves ecosystem services, and enhances the resilience of farming systems to climate change. However, the tree's potential invasiveness and the presence of mimosine, a compound toxic to non-ruminants, necessitate careful management practices. This abstract highlights the multifunctional benefits of *Leucaena leucocephala* in livestock farming and underscores its critical role in advancing sustainable agricultural practices, improving farm profitability, and contributing to global food security.

Keywords: Tree fodder, Protein Nitrogen Fixation, Agroforestry, Green Manure and Organic Matter

Introduction

Leucaena leucocephala, commonly known as Leucaena, Lead Tree, or White Popinac, is a versatile and fast-growing tree that has gained popularity worldwide, particularly in tropical and subtropical regions. Native to Central and South America, this leguminous tree has become a staple in sustainable agriculture due to its wide range of uses, from high-protein fodder for livestock to soil improvement and erosion control.

High-Protein Fodder

Leucaena's most celebrated feature is its high protein content. The leaves, young shoots, and pods of the tree are rich in protein, with levels ranging from 18% to 30% crude protein. This makes it an excellent feed supplement for a variety of livestock, including cattle, goats, sheep, and even poultry. Protein is essential for growth, reproduction, and overall health in animals, and the high protein content in Leucaena helps enhance these vital functions, leading to better productivity and higher yields in livestock farming.

Beyond its impressive protein content, *Leucaena leucocephala* is exceptionally palatable to livestock. Animals eagerly consume its tender leaves and pods, which are not only flavorful but also easily digestible. This high palatability becomes particularly valuable during times when other forage is scarce, such as during dry seasons or in regions with limited grazing land. The excellent digestibility of Leucaena ensures that its nutrients are efficiently absorbed, thereby supporting optimal health and growth in livestock.

Balanced Nutrient Profile

The balanced nutrition provided by *Leucaena leucocephala* can substantially reduce the dependence on additional feed supplements, thereby lowering costs for farmers and promoting more sustainable farming practices. By supplying a high-quality source of protein and essential nutrients, Leucaena effectively meets the dietary requirements of livestock, cutting down on the need for expensive external feeds. This not only improves the economic efficiency of farming operations but also supports environmental sustainability by decreasing the reliance on synthetic supplements and their associated ecological impacts.

Considerations for Use

While Leucaena is a valuable feed source, it does contain a compound called mimosine, which can be toxic to non-ruminant animals if consumed in large quantities. However, ruminants like cattle have microorganisms in their digestive systems that can break down mimosine, allowing them to safely consume Leucaena. Farmers should be aware of this and manage feeding practices accordingly, ensuring that Leucaena is used as part of a balanced diet.

Nitrogen Fixation: Natural Fertilizer

One of the most remarkable attributes of *Leucaena leucocephala* is its ability to fix atmospheric nitrogen into the soil. As a member of the legume family, Leucaena forms a symbiotic relationship with nitrogen-fixing bacteria in its root nodules. These bacteria convert nitrogen from the air into a form that plants can use, enriching the soil with this essential nutrient.This natural fertilization process significantly reduces the need for synthetic nitrogen fertilizers, which can be costly and environmentally damaging. By planting Leucaena, farmers can enhance soil fertility naturally, promoting the healthy growth of crops and reducing their reliance on chemical inputs.

Green Manure and Organic Matter

Leucaena is also highly effective as green manure. Farmers can cut and incorporate the leaves, branches, and other biomass of Leucaena directly into the soil. This practice not only adds valuable organic matter but also improves soil structure, increases water retention, and boosts microbial activity. The decomposition of Leucaena's biomass releases nutrients slowly over time, providing a sustained source of fertility for crops. The addition of organic matter from Leucaena helps create a rich, well-structured soil that supports robust plant growth. Improved soil structure enhances root penetration and water infiltration, reducing the risk of soil erosion and improving crop resilience to drought and other stressors.

Soil Stabilization and Erosion Control

In areas prone to erosion, especially on slopes and degraded lands, Leucaena's deep and extensive root system plays a crucial role in soil stabilization. The roots bind the soil, reducing the risk of erosion caused by wind and water. This is particularly valuable in regions with heavy rainfall or steep terrain, where soil erosion can lead to significant land degradation and loss of agricultural productivity. By planting Leucaena on slopes, along riverbanks, or in other erosion-prone areas, farmers can protect their land from erosion while simultaneously improving soil health. This dual benefit makes Leucaena an essential component of sustainable land management practices.

Agroforestry and Ecosystem Services

Leucaena is a key component of agroforestry systems, where trees are grown alongside crops or livestock. In these systems, Leucaena provides multiple ecosystem services that contribute to farm sustainability. For example, Leucaena can be planted as a windbreak, protecting crops from wind damage and reducing soil erosion. Its deep root system stabilizes soil, preventing erosion on slopes and degraded lands. The shade provided by Leucaena can also benefit shade-tolerant crops or provide shelter for livestock. In mixed farming systems, Leucaena improves biodiversity by creating habitats for beneficial insects, birds, and other wildlife, enhancing the overall resilience of the farm ecosystem.

Supporting Climate Resilience

As climate change brings about more extreme weather events, sustainable farming practices that enhance resilience are becoming increasingly important. Leucaena's deep root system makes it more drought-tolerant than many other crops, allowing it to thrive in regions with variable rainfall patterns. Its ability to improve soil structure and water retention further contributes to the farm's resilience to droughts and floods. In addition, Leucaena's rapid growth and ability to sequester carbon make it an effective tool in climate change mitigation. By storing carbon in its biomass and the soil, Leucaena helps reduce the overall carbon footprint of farming operations.

Economic Benefits

Leucaena not only contributes to environmental sustainability but also offers significant economic benefits for farmers. By providing a reliable source of high-quality fodder, fuelwood, and timber, Leucaena can diversify farm income streams. The reduced need for synthetic fertilizers and external feed sources also lowers production costs, improving farm profitability. Moreover, Leucaena's ability to enhance soil fertility and support higher crop yields can lead to increased food production, contributing to food security in regions where agriculture is a primary livelihood

Conclusion

Leucaena leucocephala is a powerful ally in the quest for sustainable farming. Its ability to improve soil health, provide high-quality fodder, support agroforestry systems, enhance climate resilience, and offer economic benefits makes it an indispensable resource for farmers. By integrating Leucaena into their farming practices, farmers can create more sustainable, productive, and resilient agricultural systems that benefit both the environment and their livelihoods.

References

D'Mello, J. P. F., & Acamovic, T. (1989). *Leucaena leucocephala* in poultry nutrition—a review. Animal Feed Science and Technology, 26(1-2): 1-28.

Babu, C., Iyanar, K., & Kalamani, A. (2017). Tree fodder production and management technology. Forestry Technologies-A Complete Value Chain Approach, 343.

Sharma, P., Kaur, A., Batish, D. R., Kaur, S., & Chauhan, B. S. (2022). Critical insights into the ecological and invasive attributes of Leucaena leucocephala, a tropical agroforestry species. Frontiers in Agronomy, 4: 890992.

Garcia, G. W., Ferguson, T. U., Neckles, F. A., & Archibald, K. A. E. (1996). The nutritive value and forage productivity of *Leucaena leucocephala*. Animal Feed Science and Technology, 60(1-2): 29-41.

Alemán-Ramirez, J. L., Okoye, P. U., Torres-Arellano, S., Mejía-Lopez, M., & Sebastian, P. J. (2022). A review on bioenergetic applications of *Leucaena leucocephala*. Industrial Crops and Products, 182: 114847.

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THE EMPOWERMENT OF RURAL WOMEN THROUGH COOPERATIVES: DIMENSIONS AND PROSPECTS

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Abstract

The empowerment of rural women in India is increasingly seen as a crucial element in the nation's development agenda, with cooperatives playing a pivotal role in this process. Given the persistent gender disparities highlighted by the 2023 Gender Gap Report, cooperatives provide a vital platform for rural women to achieve economic independence, social inclusion, and political participation. These member-driven organizations enable women to engage in income-generating activities, access resources, and take leadership roles, fostering both individual and community development. This paper examines the multifaceted dimensions of empowerment through cooperatives, explores their impact on rural women's lives, and highlights the challenges they face. By analyzing case studies, this study underscores the importance of cooperatives in promoting gender equality and sustainable development in rural India.

Introduction

The 2023 gender gap report highlights the grim situation that Indian women find themselves in. India stood at 127th position out of 146 surveyed countries. This report by World Economic Forum indicated that women and men still have an overall gap of 131 years. Women are behind men in terms of education, politics, job opportunities and the like. The condition of women in general is grotesque, let alone rural women. Therefore, the empowerment of rural women has become a focal point for development policies and initiatives across the country. Among the various mechanisms to foster this empowerment, cooperatives have emerged as a powerful and effective tool. These member-driven organizations provide rural women with opportunities to enhance their economic, social, and political status within their communities. By participating in cooperatives, rural women gain access to resources, training, and support systems that are otherwise often out of reach. This, in turn, promotes gender equality and boosts the overall development of rural areas.

The dimensions of empowerment through cooperatives are multifaceted, encompassing economic independence, social inclusion, and political participation. Economically, cooperatives enable women to engage in income-generating activities, secure fair prices for their products, and access credit and financial services. Socially, they provide a platform for women to network, share knowledge, and build solidarity, thereby fostering a sense of community and mutual support. Politically, cooperatives encourage women to take on leadership roles and participate in decision-making processes, thus giving them a voice in shaping policies that affect their lives.

The cooperative sector in India is the largest globally (Ashtankar, 2015), with 854,355 registered cooperatives as of March 2017 (Satyanarayana, Hasan, and Singh, 2018). Cooperatives play a crucial role in the rural economy, particularly in areas where private businesses are either absent or have a minimal presence. They are also essential for generating employment and income in rural regions. Numerous studies (Singh and Pundir, 2000) have shown that cooperatives have a positive impact on members' income and employment opportunities. "Cooperatives have often emerged as a response from small-scale producers seeking protection from more powerful market players" (Gertler, 2001). As widely recognized, a cooperative is a voluntary association of individuals formed to achieve specific objectives, including business activities. The ownership, profit, and loss of the business are shared equally among the members. In essence, it represents a collective effort by a group of individuals working towards a common goal. The International Labour Organisation (ILO) defines a cooperative as “an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly owned and democratically controlled enterprise” (Smith, 2011).

Since the early 1970s, numerous women-only cooperatives have emerged in India. These cooperatives differ in structure (non-profit versus for-profit), purpose (production, services, training, advocacy, etc.), and type (production versus non-production). Within the current development paradigm focused on economic growth, cooperatives as economic enterprises face competition from two types of organizations promoted by the Indian government: Self-Help Groups (SHGs) established in the late 1980s, and producer organizations or companies (PCs), commonly referred to as Farmer Producer Companies (FPCs) or Farmer Producer Organisations (FPOs), which are registered under the Companies Act, 2013.

Empowerment of the women

The concept of empowerment is closely linked to terms like agency, autonomy, self-direction, self-determination, liberation, mobilization, and self-confidence, encompassing a wide range of definitions and interpretations across various socio-economic contexts. It has deep roots in social change theory. When applied to gender issues in contemporary development discourse, the discussion of women's empowerment brings both public and private spheres into the political domain, highlighting women's struggles against systemic and structural injustices.

Women's empowerment is intrinsically tied to gender inequality, institutions of dominance, and the lack of resources available to women. In India, cultural gender dynamics may hinder women from accessing resources without male approval. When women do gain access to resources, it can drive economic development, with the concept of 'agency' playing a crucial role. Agency, in this context, refers to the capacity to make effective choices and translate those choices into desired outcomes (World Bank, 2012).

Need for women cooperatives

- **Economic Empowerment:** Cooperatives provide women with a collective platform to engage in economic activities, enabling them to pool resources, share risks, and access markets that might otherwise be inaccessible. This collective approach helps women gain financial independence and improve their economic standing.
- **Access to Resources:** In many contexts, women face barriers in accessing resources such as credit, land, technology, and training. Cooperatives can negotiate better access to these resources, offering women the tools they need to succeed in their businesses or agricultural practices.
- **Collective Bargaining Power**: Individually, women may have limited influence in markets dominated by larger players. Through cooperatives, women can enhance their bargaining power, secure better prices for their products, and negotiate more favorable terms with suppliers and buyers.

- **Social Support and Networking**: Cooperatives create a supportive community where women can share knowledge, skills, and experiences. This network can provide essential support in overcoming challenges and barriers, fostering a sense of solidarity and mutual aid.
- **Overcoming Gender Discrimination:** In many societies, women face systemic discrimination that limits their opportunities. Cooperatives can help women collectively challenge these barriers, providing a space where they can assert their rights, gain confidence, and participate more actively in economic and social life.
- **Enhancing Decision-Making Power:** Being part of a cooperative gives women a say in decision-making processes that affect their work and livelihoods. This democratic structure empowers women to take leadership roles and influence decisions that impact their lives and communities.
- **Sustainability and Long-Term Impact**: Cooperatives often focus on sustainable practices and long-term goals, which can lead to more stable and resilient communities. By participating in cooperatives, women can contribute to and benefit from sustainable development initiatives.
- **Advocacy and Policy Influence**: Cooperatives can amplify women's voices in advocating for policy changes that address their specific needs and challenges. As a collective, they have a greater ability to influence local, regional, and national policies.

Cooperatives offer women a powerful tool to overcome economic, social, and cultural barriers, enabling them to work together towards shared goals, improve their livelihoods, and achieve greater empowerment and equality.

SOME CASE STUDIES RELATED TO WOMEN EMPOWERMENT THROUGH COOPERATIVES

Geeta and Murthy (2022) on their study on the women cooperatives of Eastern dry zone of Karnataka worked out the Women Empowerment in Livestock Index (WELI) for women in Women dairy cooperatives (WDCs), General dairy cooperatives (GDCs) and Private sellers (PSs). It was found that WLEI for WDC, GDC and PS was 0.64, 0.54 and 0.51, respectively indicating a positive impact of WDC on empowering women. It was also found that decisions related to nutrition and agricultural operations were important for these WDCs. The study emphasized that there was a need for bringing more rural women under WDCs to improve their social participation and to strengthen the existing policies of encouraging rural women for self-employment.

Kakati and Kakoty (2022) conducted a study on GGPSSCSL cooperative which comprises of tribal women of Jharkhand and is promoted by Professional Assistance for Development Action (PRADAN) and JWSSPCL. It was found out that the GGPSSCL women cooperative plays an active role in empowering the tribal women of the area. It has become on eof the major agents for empowering women because of its pivotal role in promoting awareness about various aspects of empowerment among the women members. The study revealed that the cooperative was fully managed by women members which contributed for its exceptional performance. The results showed that majority of the women felt that the cooperative's impact was highest at the level of 'self', followed by empowerment within household and at society's level. Traditional norms and patriarchy are the major hinderances to women empowerment. The study highlights that women empowerment through cooperatives is not a linear but multi-dimensional and depends on various factors.

Nair and Moolakkattu (2015) focused on the challenges faced by the women cooperative societies (WCSs) in Kottayam District of Kerala and found that most of the women cooperatives function by limiting their operations to small scale banking activities and enlisting men's participation in various ways which hinders the women to utilize and exploit their potential to the fullest.

Conclusion

Cooperatives have proven to be a powerful tool for the empowerment of rural women in India, offering them opportunities for economic advancement, social integration, and political participation. As evidenced by various case studies, cooperatives not only enhance women's income and decision-making power but also contribute to broader community development. However, the path to empowerment is complex and influenced by multiple factors, including cultural norms and systemic barriers. Despite these challenges, cooperatives remain a crucial mechanism for addressing gender disparities in rural areas, promoting sustainable development, and enabling women to achieve greater autonomy and agency in their lives. Continued support and policy interventions are essential to expanding the reach and impact of women's cooperatives across the country.

References

Ashtankar, O. (2015). Importance of cooperative movement for Indian agriculture sector. *International Journal of Applied Research*, **1**(11): 557-561.

Geeta, R. S. and Murthy, P. S. S. (2022). Assessment of women empowerment through women dairy cooperatives in eastern dry zone of Karnataka. *Mysore Journal of Agricultural Sciences*. **56**(1): 122-129.

Gertler, M. (2001). Rural Co-operatives and Sustainable Development. *Saskatoon SK: Centre for the Study of Co-operatives, University of Saskatchewan.*

Kakati, B. K. and Kakoty S. (2022). Role of women's cooperatives in empowering women: A study in Jharkhand. *Purushartha*, **15**(1): 118-132.

Nair, N. V. and Moolakkattu, J. S. (2015). Why do women’s cooperative societies languish? A study of selected societies in Kottayam, Kerala. *Asian Journal of Women Studies*, **21**(2): 105-125.

Satyanarayana, N.; Hasan, B. and Singh, T. (2018). Indian Cooperative Movement: A Statistical Profile 2018. *National Cooperative Union of India, New Delhi*.

Singh, K. and Pundir, R. S. (2000). Co-operatives and Rural Development in India. *Institute of Rural Management*. *Anand*.

Smith, S. (2011). Promoting co-operatives: A guide to ILO recommendation 193. *International Labour Organisation, Geneva.*

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CLIMATE CHANGE AND WHEAT PRODUCTIVITY

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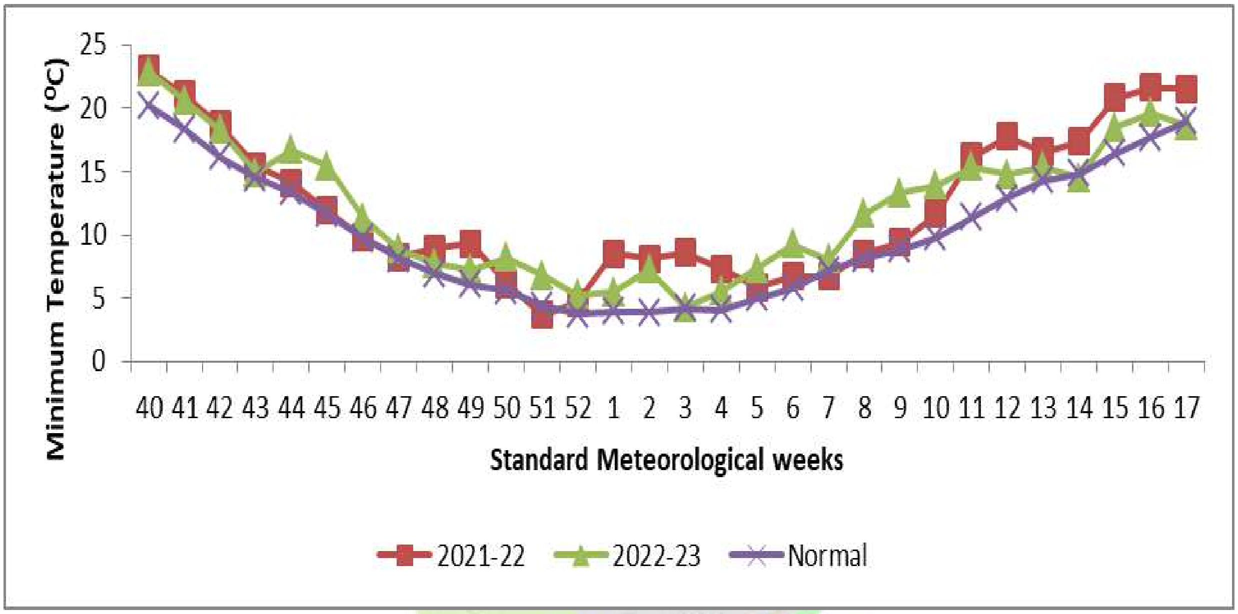
Abstract

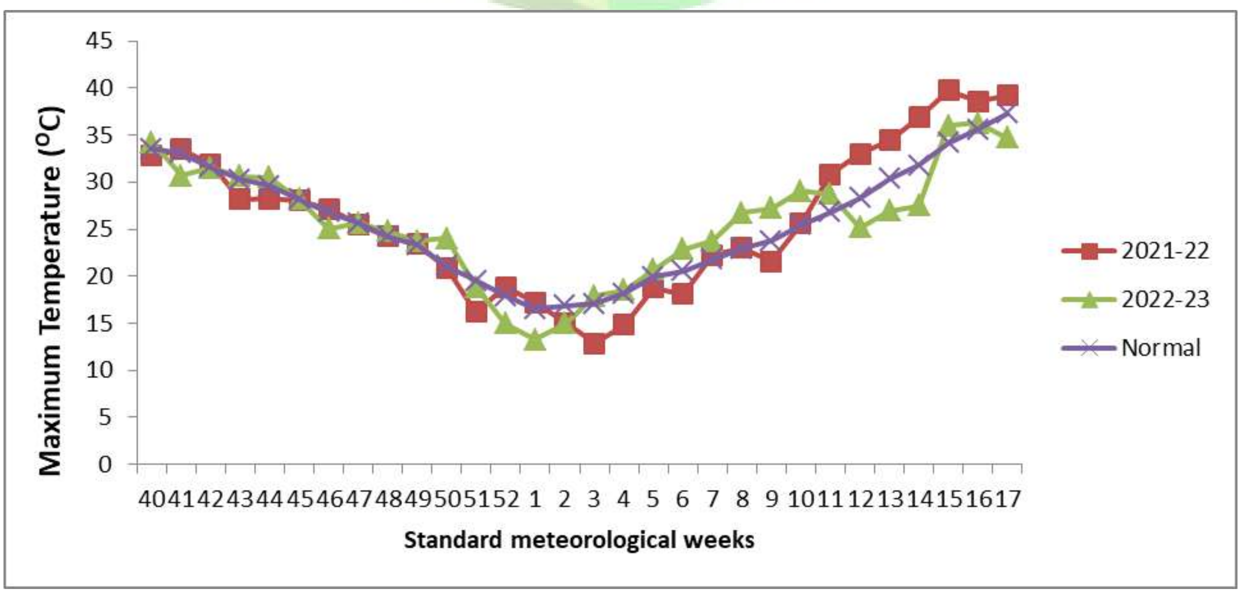
Weather plays a critical role in agriculture production, influencing crop growth, yield, and overall farm management. The impact of weather patterns, however, is increasingly being altered by global warming and climate change, leading to both challenges and opportunities for agriculture. Weather conditions such as temperature, precipitation, humidity, and sunlight directly affect crop development and agricultural operations. In conclusion, weather variability and the impacts of global warming significantly influence agricultural production and pose challenges for food security. Adapting to these changes requires a combination of innovative farming practices, technological interventions, and policy measures aimed at building resilience in agriculture systems. Thus, it is high time to critically analyse climatic impacts on crop yields so that effective mitigation / adaptation strategies can be explored to ensure food security for burgeoning population.

Key words: Wheat yield, Heat stress, Climate change

Introduction

Climate change poses formidable challenges for agriculture at a worldwide level. Climate change leads to alterations in weather patterns, including shifts in temperature, precipitation, and extreme weather events such as droughts, floods, and storms. Temperature plays a significant role in wheat yield as it affects various stages of wheat growth and development. High temperature can significantly impact wheat yield by disrupting crucial growth stages. Heat stress during flowering can result in poor pollen viability, reduced fertilization and impaired grain set, ultimately lowering yield potential. Additionally, elevated temperature during grain filling can accelerate plant senescence and shorten the grain-filling period, limiting the accumulation of biomass and reducing grain size and weight, furthermore, high temperature exacerbate water stress in wheat plants, as they increase evapotranspiration rates and water demand while potentially limiting water availability in the soil. The combination of heat and water stress further diminishes wheat yield potential by reducing overall plant productivity and exacerbating yield losses.





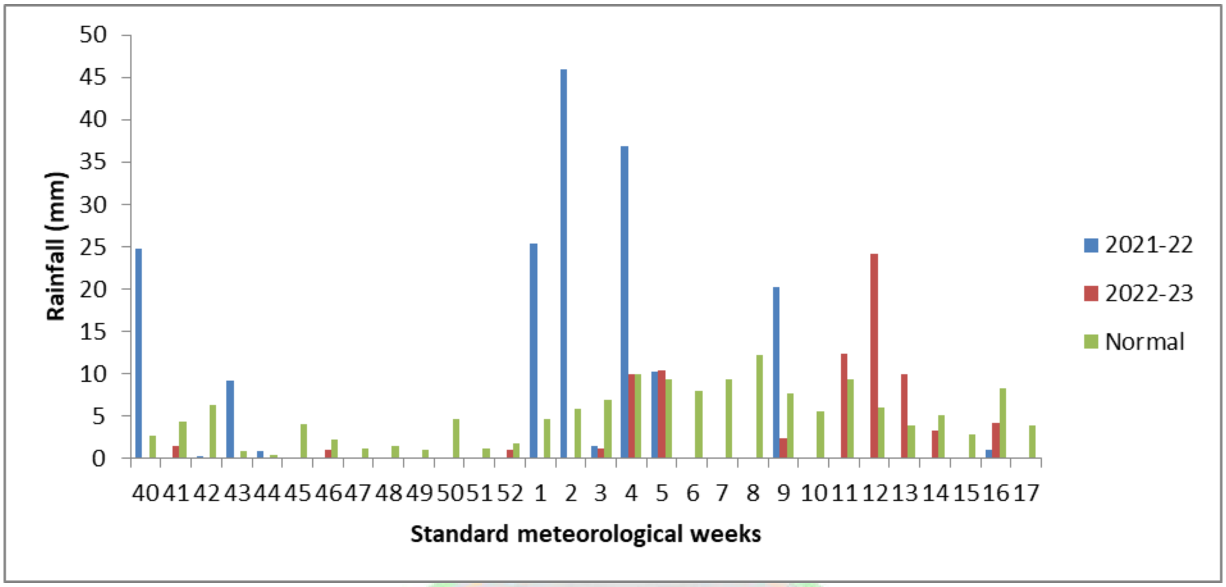


Fig 1. Actual and normal weather conditions at Amritsar during *rabi* season 2021-22 and 2022-2023

Critical analysis of wheat yield

A critical analysis of wheat yield for Amritsar district during the recent years 2021-22 and 2022-23 indicates that the lowest wheat yield was observed during 2021-22 (4451 Kg/ha) as compared to the 2022-23 (4788 Kg/ha). The analysis indicated that meteorological conditions during the month of March are of utmost importance for determining wheat yield, especially lower temperature along with lesser number of rainy days in March have positive effect on wheat productivity was observed during 2022-23, but higher night time temperature and no rainfall during 2021-22 significantly reduced grain yield. If the night temperatures is more than 20 ◦C, which results in reduce spikelet fertility, grain number and size. Elevated night temperatures also linearly decrease the duration of grain filling stage.

In addition, chlorophyll biosynthesis is inhibited under exposure to heat stress. This happened in 2021-22 crop season, when sudden rise in day as well as night time temperature to the extent of 4^{o}C in March 2022 was observed. This resulted in severe terminal heat stress, which was further aggravated by absence of rain and it resulted in record lowest wheat yield.The analysis of meteorological conditions during 2021-22 wheat season further indicated that lower daytime temperature and sunshine hours during vegetative growth and abrupt rise in both day and night time temperature during grain filling and maturity along with absence of western disturbance system during this period resulted in severe heat stress (Fig.1) and these unusual weather conditions resulted in record lowest wheat yield of 4451 Kg/ha.

Weather variability

Thus, weather variability during March has great impact on wheat yield. However, the result of climate change triggered increased intensity and frequency of extreme weather events, such climatic shocks can be expected quite frequently in future. In order to achieve food security under climate change scenarios, it is imperative that heat stress-tolerant cultivars be developed using modern breeding methods. Finding suitable management techniques that can prevent or lessen the crop's head load and increase its resilience to shifting climatic conditions is also extremely important. Some strategies like application of nitrogen, phosphorus and potassium to improve plant growth under heat stress conditions should be adopted to minimise the effect of high temperatures. When nitrogen, phosphorous and potassium are applied at the stage of post anthesis, more protein accumulates in the grain at day/night temperatures of 24/17◦C, but not at 37/28◦C. Application of some micronutrients like zinc, can also improve heat tolerance in wheat crop. In some regions sowing time of wheat crop is also an another important management strategy. Elevated temperature may occur during the grain filling stage, which can be avoid by early sowing of crop Although periods of elevated temperature may occur during the growing season, grain filling stage usually coincide with high temperature which leads to terminal heat stress. Early planting may avoid terminal heat stress so that grain filling occurs during cooler temperatures.

Conclusion

The study indicates that the abrupt and untimely changes in weather parameters are taking a toll on wheat productivity in Punjab. The elevations in both minimum and maximum temperatures during the wheat season seem to be responsible for decline in wheat productivity in the state, which otherwise is the zone of highest wheat productivity in the country.

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DENGUE: A GLOBAL HEALTH CONCERN

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Abstract

Dengue fever, a mosquito-borne viral infection, has become a significant public health challenge worldwide, particularly in tropical and subtropical regions. Even in India, it is considered as a very serious and challenging disease. The disease is transmitted primarily by *Aedes aegypti* mosquitoes, which thrive in densely populated urban areas. It is predominently observed in the areas of primary sanitation concerns such as stagnant water, local garbage containers and surrounding of the households. Combating dengue in the later stages of the disease symptoms can be very difficult and hence preventive measures play a very important role in fighting this life-threatening disease. Precautionary measures can include keeping the environment clean, ayurvedic and allopathic remedies, domestic measures and community cooperation. Understanding dengue's impact, symptoms, prevention and treatment is crucial in combating its spread and protecting communities.

Key words: Dengue, *Aedes aegypti*, public health, sanitation.

Introduction

Historical Background

Dengue-like illnesses have been described in Chinese medical texts dating back to the Jin Dynasty (265-420 AD). The term "dengue" is believed to originate from the Swahili phrase "kadinga pepo," describing a sudden cramp-like seizure caused by an evil spirit. The first confirmed dengue epidemics occurred almost simultaneously in Asia, Africa, and North America in the 1770s. The disease was initially known as "breakbone fever" due to the severe pain it caused. The spread of dengue increased with the growth of global shipping and urbanization. Outbreaks became more frequent in port cities across the world. Post-World War II, rapid urbanization, increased travel, and ineffective mosquito control measures led to the worldwide spread of the disease.

What is Dengue?

Dengue fever is caused by the dengue virus, which has four distinct but closely related serotypes (DENV-1, DENV-2, DENV-3, and DENV-4). An individual infected with one serotype gains lifelong immunity to that specific serotype but only partial and temporary immunity to the others. This means a person can be infected with dengue up to four times during their lifetime.

Dengue in India (2024):

As of 2024, dengue remains a significant public health challenge in India. The country has reported a substantial number of dengue cases across various states, with marked increases in some regions compared to previous years.

- **Karnataka:** From January 1 to June 18, 2024, Karnataka reported 4,886 dengue cases, a significant increase from the 2,003 cases reported during the same period in 2023. The most affected districts include Mysore, Chikkamagaluru, Haveri and Kalaburagi.
- **Kerala:** In 2023, Kerala reported a high number of dengue cases, reaching 17,426, with 153 deaths. This trend has continued into 2024.

- **Maharashtra:** Maharashtra saw 19,034 cases and 55 deaths in 2023. The state remains vigilant in 2024, with proactive measures to control the spread.
- **Punjab and Rajasthan:** Both states reported significant dengue activity in 2023 with thousands of cases and numerous fatalities. They continue to monitor and manage dengue cases in 2024.

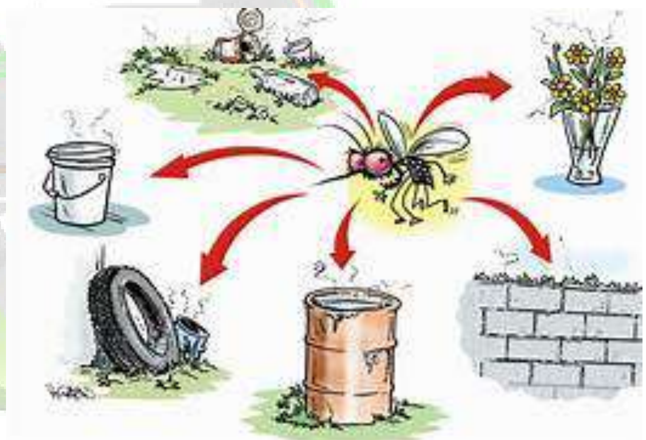
Economic Impact:

Dengue's economic burden is considerable, affecting healthcare systems and families, especially those reliant on daily wages. Hospitalization and associated medical costs can drive many families into poverty. The disease also impacts productivity due to absenteeism from work, particularly in labor-intensive industries.

Symptoms of Dengue:

Dengue fever can range from mild to severe. Symptoms typically appear 4-10 days after being bitten by an infected mosquito and can last for 2-7 days. Common symptoms include:

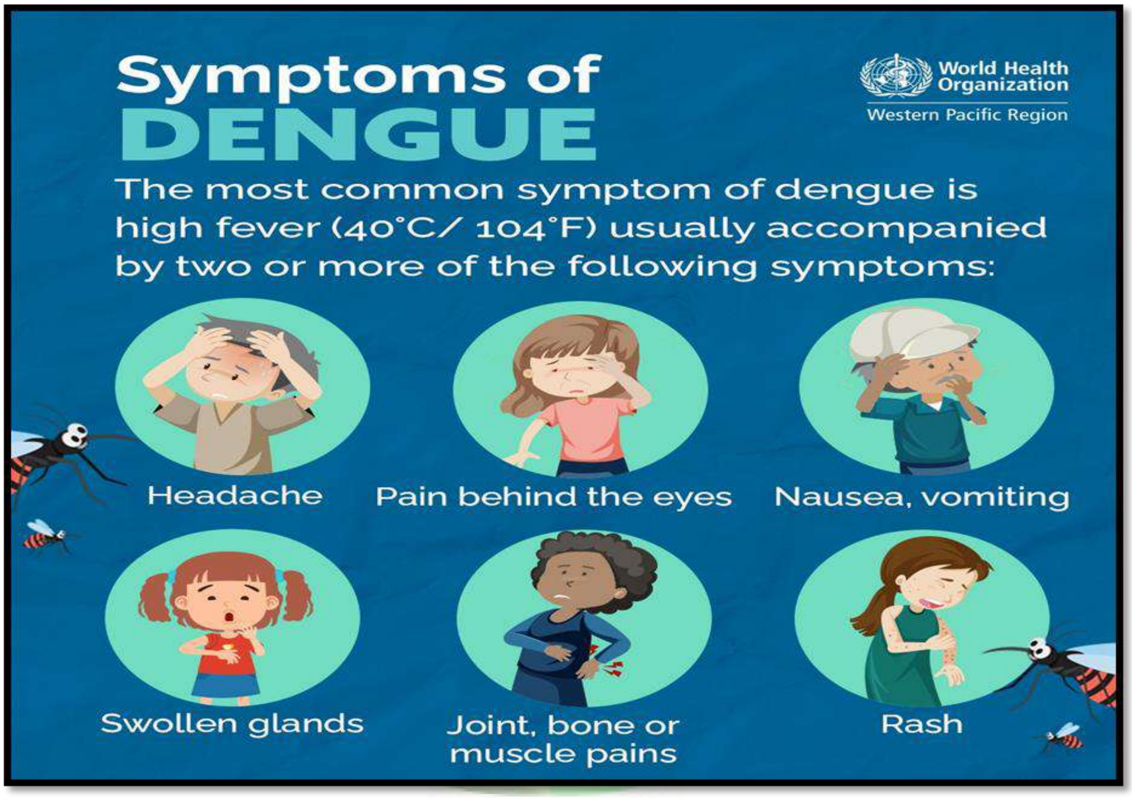
- Decrease in the platelets count
- High fever
- Severe headache
- Pain behind the eyes
- Joint and muscle pain
- Fatigue
- Nausea and vomiting
- Skin rash



In severe cases, dengue can develop into dengue hemorrhagic fever or dengue shock syndrome, both of which can be fatal if not properly treated. Warning signs of severe dengue include severe abdominal pain, persistent vomiting, rapid breathing, bleeding gums, and fatigue.

Global Impact:

Since the start of 2024, over 10 million dengue cases and more than 5,000 dengue-related deaths have been reported across 80 countries. This represents a dramatic increase compared to previous years. The Americas have reported the highest number of cases, with a significant rise observed in several countries. The Pan American Health Organization (PAHO) has declared a Grade 3 outbreak in the region, highlighting the severity and widespread nature of the epidemic. As of epidemiological week 26, in 2024, over 10.5 million suspected cases have been reported, marking a 233% increase compared to the same period in 2023. The cumulative incidence is 1,121 per 100,000 population. Dengue is endemic in over 100 countries, with the World Health Organization (WHO) estimating that 390 million dengue infections occur annually. Asia accounts for about 70% of the global burden of the disease. Rapid urbanization, population growth, and increased travel have contributed to the widespread reach of dengue, posing a significant health threat in many regions.



Prevention:

The Indian government and health authorities emphasize the importance of preventive measures, including eliminating mosquito breeding sites, using mosquito repellents, and community education. Public health campaigns and vector control programs are critical to mitigating the spread of dengue.

Preventing dengue primarily involves controlling mosquito populations and minimizing mosquito bites. Key preventive measures include:

- **Eliminating Standing Water:** Mosquitoes breed in stagnant water, so regularly emptying and cleaning water containers, flower pots, and bird baths is crucial. Dispose of old tires, cans, and other items that can collect rainwater.

- **Using Mosquito Repellents:** Apply DEET or picaridin-based repellents on exposed skin and clothing. Essential oils such as neem oil, eucalyptus oil, citronella oil, or tea tree oil can also be used.
- **Wearing Protective Clothing:** Long-sleeved shirts, long pants, and socks to minimize exposed skin, especially during dawn and dusk when mosquitoes are most active.
- **Installing Screens:** Using window and door screens can help keep mosquitoes out of homes.
- **Using Mosquito Larvicides:** Introduce fish like guppies in water tanks and ponds to eat mosquito larvae, or use larvicidal chemicals in stagnant water.
- **Maintaining Gardens:** Keep gardens tidy by trimming plants and grass to reduce mosquito hiding spots. Use environmentally friendly insecticides to treat plants and garden areas.
- **Indoor Measures:** Use electric fans and air conditioners, as mosquitoes are less active in cooler environments. Mosquito traps can also be used indoors to capture and kill mosquitoes.
- **Herbal and Natural Remedies:** Plant basil (Tulsi) around homes, use garlic spray, burn camphor, consume papaya leaf juice to increase platelet count, drink guava juice for its Vitamin C and fiber content, and consume methi seeds for their vitamins.

Community Efforts:

Participating in community clean-up campaigns and supporting local mosquito control programs can help reduce the mosquito population.

Treatment:

There is no specific antiviral treatment for dengue. Supportive care is the primary approach, focusing on relieving symptoms and preventing complications. Patients are advised to:

- **Stay Hydrated:** Drink plenty of fluids to avoid dehydration.
- **Rest:** Get adequate rest to help the body recover.
- **Manage Pain and Fever:** Use acetaminophen (paracetamol) to relieve pain and reduce fever. Avoid aspirin and nonsteroidal anti-inflammatory drugs (NSAIDs) as they can increase the risk of bleeding.

Severe dengue requires hospitalization, where patients can receive intravenous fluids, blood transfusions, and careful monitoring to manage symptoms and prevent complications.

The Road Ahead

Efforts to combat dengue include vaccine development, with the first dengue vaccine, Dengvaxia (2015), approved in several countries. However, it is only recommended for individuals who have had a previous dengue infection. Research is ongoing to develop more effective vaccines and treatments. Public health education and community engagement are vital in raising awareness about dengue prevention and control. By understanding the risks and taking proactive measures, we can reduce the impact of dengue and protect vulnerable populations from this debilitating disease.

Conclusion

Dengue fever is a pressing global health issue that requires coordinated efforts to manage and mitigate its spread. Through prevention, early detection, and supportive care, we can work towards a future with fewer dengue infections and healthier communities worldwide.

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BIOFORTIFICATION OF CROPS: ENHANCING NUTRITIONAL VALUE FOR GLOBAL HEALTH

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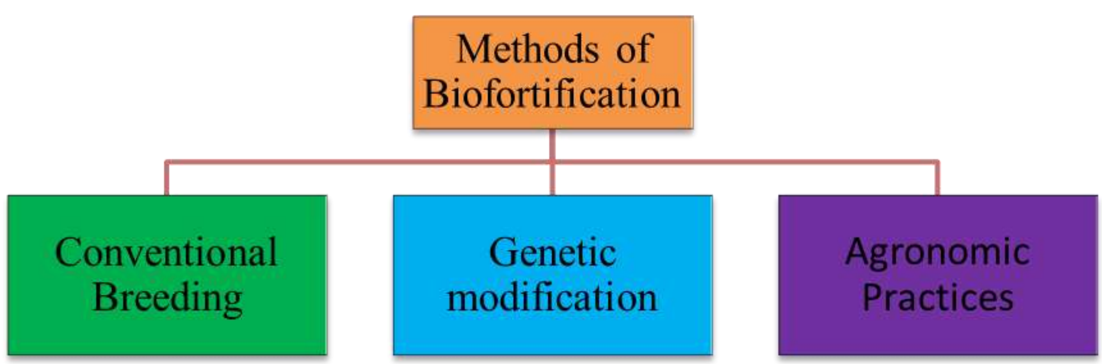
Introduction

Biofortification is an innovative agricultural approach aimed at improving the nutritional quality of food crops. Unlike traditional fortification, which involves adding nutrients during food processing, biofortification enhances the nutrient content of crops while they are growing. This method has the potential to combat micronutrient deficiencies, particularly in regions where people rely heavily on staple crops for their daily nutrition. Biofortification is the process of increasing the concentration of essential vitamins and minerals in crops through conventional breeding, genetic modification, or agronomic practices. The goal is to produce crops that are naturally richer in nutrients like iron, zinc, vitamin A, and folate, which are crucial for human health but often lacking in the diets of populations in developing countries (Bouis et al. 2011).

Methods of Biofortification



1. **Conventional Breeding**: This method involves cross-breeding plants with naturally higher nutrient levels with high-yielding varieties to produce offspring with enhanced nutritional content. For example, iron-rich beans and vitamin A-enriched sweet potatoes have been developed through conventional breeding techniques (Singh et al. 2016).
2. **Genetic Modification**: Genetic engineering allows for the direct modification of a plant's DNA to increase its nutrient content. One well-known example is "Golden Rice," which has been genetically modified to produce beta-carotene, a precursor of vitamin A. This approach can be faster than conventional breeding but is often subject to regulatory and public acceptance challenges (Beyer et al. 2002)
3. **Agronomic Practices**: This involves applying nutrient-rich fertilizers or soil amendments to increase the nutrient content of crops. For example, adding zinc or selenium to soils can result in crops with higher levels of these essential micronutrients.

Benefits of Biofortification

1. **Combatting Micronutrient Deficiencies**: Micronutrient deficiencies, often referred to as "hidden hunger," affect billions of people worldwide, leading to serious health problems like anemia, impaired immune function, and developmental issues. Biofortified crops provide a sustainable way to deliver essential nutrients to populations at risk.
2. **Sustainable and Cost-Effective**: Once biofortified crops are developed, they can be grown and consumed year after year without requiring significant additional inputs. This makes biofortification a sustainable and cost-effective strategy for improving public health, especially in low-income regions.
3. **Improving Agricultural Productivity**: Biofortification not only enhances the nutritional quality of crops but can also improve their resilience to pests, diseases, and environmental stresses. This can lead to higher yields and greater food security.
4. **Addressing Global Health Challenges**: Biofortified crops have the potential to address global health challenges by providing essential nutrients in a natural form, integrated into the diets of those who need them most. For example, iron-rich beans can help reduce anemia rates, while vitamin A-rich crops can prevent blindness and boost immune function.

Challenges and Considerations

1. **Acceptance and Adoption**: Farmers and consumers may be reluctant to adopt

biofortified crops due to unfamiliarity, taste preferences, or concerns about genetically modified organisms (GMOs). Effective communication and education are essential to promote the benefits of biofortified crops.

2. **Biodiversity and Ecosystem Impact**: The focus on biofortification could potentially reduce crop diversity if certain biofortified varieties are overly promoted at the expense of others. It is important to balance biofortification with the maintenance of agricultural biodiversity.
3. **Regulatory Hurdles**: Genetically modified biofortified crops often face strict regulatory scrutiny, which can delay their deployment and limit their availability to those in need.
4. **Scaling Up**: Scaling up biofortification efforts to reach large populations requires coordinated efforts between governments, agricultural institutions, and international organizations. Infrastructure, market access, and distribution channels must be in place to ensure that biofortified crops reach the people who need them most.

Examples of Biofortified Crops (Tang et al. 2009)

Golden Rice	Engineered to contain beta-carotene, Golden Rice is designed to combat vitamin A deficiency, which is a leading cause of blindness and child mortality in developing countries.
Iron-Rich Beans	Developed to address iron deficiency, these beans are particularly beneficial in regions where beans are a staple food.
Zinc-Enriched Wheat	Zinc deficiency is linked to stunted growth and weakened immune systems. Biofortified wheat varieties with higher zinc content have been developed to combat this issue.
Vitamin A Sweet Potatoes	Orange-fleshed sweet potatoes rich in beta-carotene have been promoted in parts of Africa to help reduce vitamin A deficiency.

Refrences

Beyer, P., Al-Babili, S., Ye, X., Lucca, P., Schaub, P., Welsch, R., & Potrykus, I. (2002). Golden rice: introducing the β-carotene biosynthesis pathway into rice endosperm by genetic engineering to defeat vitamin A deficiency. *The Journal of nutrition*, *132*(3), 506S-510S.

Bouis, H. E., Hotz, C., McClafferty, B., Meenakshi, J. V., & Pfeiffer, W. H. (2011). *Biofortification: A New Tool to Reduce Micronutrient Malnutrition. Food and Nutrition Bulletin, 32(1_suppl1), S31–S40.*

Singh, S. S., Hazra, K. K., Praharaj, C. S., & Singh, U. (2016). Biofortification: pathway ahead and future challenges. *Biofortification of food crops*, 479-492.

Tang, G., Qin, J., Dolnikowski, G. G., Russell, R. M., & Grusak, M. A. (2009). Golden Rice is an effective source of vitamin A. *The American journal of clinical nutrition*, *89*(6), 1776-1783.

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EFFICACY OF GA_3 ON SEED GERMINATION

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Abstract

Germination is the process by which a plant grows from a seed to a seedling. Seeds remain latent until the conditions are appropriate for germination. To germinate, all seeds require water, oxygen, and an appropriate temperature. When a seed is exposed to the right conditions, the seed coat absorbs water and oxygen. The cells of the embryo begin to expand. The seed coat then splits open, allowing the root to emerge first, followed by the shoot containing the leaves and stem. Sunlight encourages germination by warming the soil. Some seeds, although unusual, require direct sunshine to germinate. Once leaves have emerged, sunlight serves as the principal energy source for plant growth via photosynthesis. Gibberellin, often known as GA, is a naturally occurring tetracyclic diterpenoid carboxylic acid. Currently, 126 GA_3 have been found in higher plants, fungi, and bacteria. Some GAs has biological action in higher plants, and a small number of them function as endogenous regulators of plant growth and development, modulating developmental and environmental signals. A seed contains everything required to begin a new life. Inside the seed coat is an embryonic (baby) plant made up of a root, stem, and leaves. The seed includes endosperm, a nutrient-rich food source that nourishes and promotes growth. The embryonic plant's seed leaves, known as cotyledons, absorb food and nourish the plant as it grows. Once the leaves develop, the plant begins to produce its own food via photosynthesis. Seeds are distinctive structures because of their seed coverings, which protect the delicate plant embryos inside. Many seeds can tolerate long periods of drought, heat, or freezing

weather, yet are ready to leap to life when favourable.

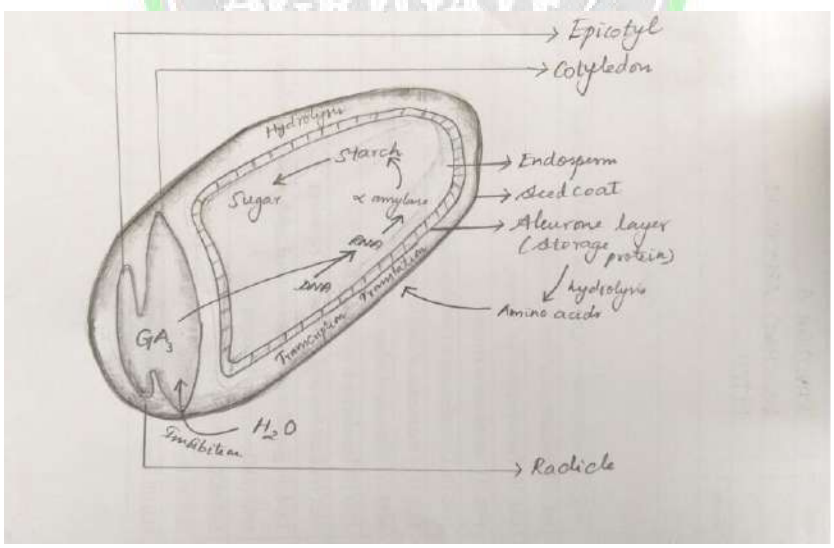
Keywords: Development, Embryo, Germination and Seed Physiology.

Introduction

Seed germination is the embryo's restart of active growth, which results in the rupture of the seed coat and the formation of a young plant. Physiologists frequently define seed germination as the period from imbibition until "embryo growth is initiated and the embryo protrudes through any covering tissue". Seed quality analysts, on the other hand, do not consider germination complete until the seedling has grown sufficiently to allow for observation and evaluation of the root, hypocotyl, and cotyledons (ISTA, 1999). The seed analyst defines germination as "the emergence and development from the seed embryo of those key structures which, for the kind of seed in question, are indicative of the ability to generate a normal plant under appropriate condition".

Gibberellic Acid

Tetracyclic di-terpenoid chemical in nature gibberellic acid (GA) is a plant hormone which aids plant growth and development. Along with the interaction of several environmental elements, including light, temperature, and water, GAs drive seed germination, trigger transitions from meristem to shoot growth, juvenile to adult leaf stage, vegetative to flowering, and determine sex expression and grain formation. (Dhekney,*et al*.2000) Stamens are the primary location of bioactive GA, which affects pedicel growth and male flower output. However, since regulatory mechanisms/organisms other than those in male flowers are required, this raises the question of how female flowers control growth and development. The right location for bioactive GA in plants as well as the tissues that bioactive GAs target to start acting have not yet been established. Understanding the proper mechanism of GA transport in plant growth, floral development, sex expression, grain development, and seed germination is currently a major challenge for the scientific community. Proper clarification of the GA transport mechanism is necessary for plant species survival and productive crop cultivation. The GA signalling system and mechanism are critical for the germination of seeds, stem elongation, meristematic tissue growth, and floral organ differentiation. In order for a seed to germinate, its dormancy must be broken by GA. The intricate process of seed germination is governed by both internal and external regulatory elements. When it comes to regulating and encouraging germination in cereal grains and other crop species, GA is crucial. It has been established that in the absence of exogenous GA, GA deficit mutants were unable to germinate. Nonetheless, it has been demonstrated that a very small number of known GA signalling factors mediate the control of seed germination. GA biosynthesis was hampered by physiological research and the phenotypic characterization of mutants. It was discovered that GA is crucial for the elongation of the stem or internode. However, gibberellic acid can be used to accelerate growth, shorten the time it takes for sprouting, and increase the germination rate of early crop establishment. Gibberellic acid (GA) is produced by the embryo. Imbibition transports gibberellic acid from the embryo to the endosperm. This gibberellic acid affects the aleurone cells (protein storage cells) on the exterior of the endosperm. GA is classified as a plant hormone since it is produced in one cell, transferred, and responded to by another.GA promotes the transcription and translation of alpha-amylase in aleurone cells. Storage proteins provide amino acids for the translation process. The completed amylase is exported to cells in the endosperm's interior (Reshmi, *et al.*2016). This is a secretion (exocytosis) process. There, amylase catalyses the hydrolysis of starch to maltose. By treating barley seeds with a gibberellic acid solution (rather than ordinary water), the higher level of hormone signal stimulates more amylase production. This leads in a significant acceleration of maltose release. In parallel research, plant physiologists asked why people struggle with lettuce seed germination in their vegetable gardens.



GA_3 involvement in the process of seed germination.

Plant physiologists began to help with the understanding of seed germination as the brewing industry tried to increase alcohol yield in beer production. The industry was already aware of the importance of sprouting barley seeds (Singh, *et al.*2015) This was accomplished by immersing seeds in water and allowing the germination process to make sugar from starch. The sugar produced is maltose, hence the sprouting process is known as "malting." Increased maltose production was definitely the best strategy to increase alcohol yield per bushel of barley seed.

They were acquainted of the high rate of seed germination in laboratory Petri dishes. Photoactivation is a vital stage in activating seed germination in lettuce seeds, unlike in barley. The seeds must be exposed to light in order to germinate. I hope you are instantly asking how photon flux and light wavelength affect germination. The wavelength of light is crucial. The seeds germinate well in white light, but also in single "colours," particularly red light (660 nm). Far-red light (730 nm) inhibits lettuce germination.

It took a long time to recognize, isolate, and define the photoreceptor. It's called phytochrome (Anuradha, *et.al*.2017). Phytochrome comes in two separate chemical forms: Pr and Pfr. In its Pr form, phytochrome absorbs light more efficiently at red wavelengths, hence the name Pr. In its Pfr form, phytochrome absorbs light most efficiently at far-red wavelengths, hence the name Pfr. The form of phytochrome is named for the color of light it absorbs the most. The interconversion of the two types makes phytochrome characterization challenging. As Pfr absorbs far-red light, it chemically transforms into Pr! Similarly, Pr absorbs red light and chemically converts into Pfr.In the dark, the Pfr/Pr ratio controls whether each seed germinates. When exposed to red light, the phytochrome is transformed completely into Pfr, and the seeds germinate. When the seeds are exposed to far-red light, the phytochrome is completely converted to Pr, and the seeds do not germinate. Clearly, the active form of phytochrome is Pfr.

660 nm (Red light) →

Pr (Inactive form of phytochrome) ⇄ Pfr (Active form of Phytochrome)

← 730 nm (Far red)

No germination — **Germination**

GERMINATION and ITS TYPES

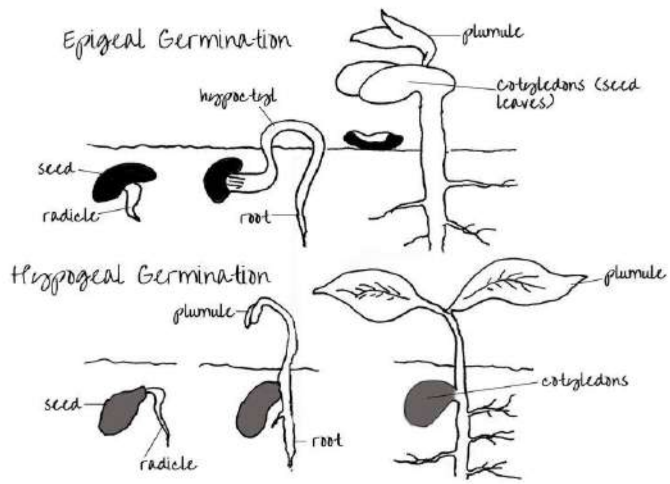
Based on the fate of the cotyledons or storage organs two kinds of seed germination occur.

Epigeal germination

Ground nut, black gram, and green gram seeds all germinate epigeal. During germination, the cotyledons rise above the ground and continue to offer nutritional support to the growing points. During root establishment, the hypocotyl elongates in an arch that penetrates the soil, drawing the cotyledons and enclosing plumule through the earth and thrusting them into the air. Following that, the cotyledons open, plumules grow, and the cotyledons wither and fall to the ground (Anburani.et *al*,2010).

Hypogeal germination

Pea seeds, as well as all grasses including bamboos, exhibit hypogeal germination. During germination, the cotyledons or similar storage organs remain beneath the soil while the plumule pushes forward and emerges above ground, continuing to offer nutritional support to the growing points. The coleoptile, a transitory sheath that encloses the plumule, is related with hypogeal germination in many species; it protects and rigidifies the forming plumule as it pushes.



PRE-REQUISITES FOR SEED GERMINATION

Water

Water is an essential element for germination. It is necessary for enzyme activation, breakdown, translocation, and the utilization of reserve store material. Low moisture levels may initiate early stages of germination, but they are insufficient for complete germination. High moisture levels prevent germination.

Air (Oxygen and Carbon dioxide)

Air is made up of around 20% oxygen, 0.03% carbon dioxide, and approximately 80% nitrogen gas.Oxygen is required for seed germination; carbon dioxide at amounts greater than 0.03% inhibits germination, whereas nitrogen has no effect.

Temperature

The response to temperature is determined by several elements, including species, variety, growth location, seed quality, and so on. Temperate seeds often demand lower temperatures than tropical seeds (Maitra, *et al.*2015). Wild species demand lower temperatures than domesticated ones. High-quality seeds may germinate at a broader temperature range than low-quality seeds. Most seeds grow best at temperatures between 15 and 300 degrees Celsius. The maximum temperature for most species is between 30 and 400 degrees Celsius. Some species will germinate at temperatures near the freezing point.

Light

Germination is most effective in the red area (660-700 nm), with a peak at 660 nm, followed by suppression in the far-red area above 700 nm.

Conclusion

Seed germination is an important process that affects crop yields and quality. Understanding the molecular features of seed dormancy and germination, therefore, is extremely important for improving agricultural output and quality. Significant progress has been made in unravelling the molecular mechanisms underlying the involvement of plant hormones, particularly ABA and GA, in the regulation of seed dormancy and germination in dicot species; however, this phenomenon has received little attention in cereals. As a result, more research is needed to determine the molecular features involved in regulating the metabolic and signalling aspects of various plant hormones, as well as seed dormancy and germination in crop diversity.

References

Anburani A. Vijay AA. Effect of growth retardants on growth and yield in nerium (Nerium odorum). J. Orn. Hort. 2010; 13(3):240-242.

Anuradha RW, Sateesh RP, Naveenakumar, Priyanka TK, Kulakarni BS. Effect of growth regulators on vegetative, flowering and flower yield parameters in African marigold cv. Culcatta Orange. Int. J. Pure and Applied Bio-sci. 2017; 5(5):636-640.

Dhekney SA, Ashok AD, Rangaswamy P. Effect of some growth regulating chemicals on growth and flowering of rose cv. First Red under greenhouse conditions. J. Orn. Hort. 2000; 3(1):51-53

Maitra S, Roychowdhury N. Effect of plant growth regulators on growth, development and flowering of carnation (*Dianthus caryophyllus* L.) Cv. chabaud super mix. J. Agric. Technol. 2015; 2(2):72-78.

Reshmi CR, Sheela VL. Effect of growth regulators on sucker production in exotic varieties of heliconia. J. Plant Agric. Res. 2016; 2(1):1-9.

Singh J, Nigam R. Effect of plant growth regulators and inorganic fertilizers on vegetative growth and flowering behaviour of Chrysanthemum Hort. Flora. Res. Spectrum. 2015; 4(3):273-276.

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MEDICINAL PLANTS - RAUWOLFIA SERPENTINA AND PIPER LONGUM

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Abstract

Medicinal plants are the most common reservoir of life saving drugs for the world. Botanical drugs play an important role in meeting the health needs of low and middle-income countries through traditional medical system. In addition, around 57% of top allopathic drugs are constituted from at least one medicinal plant-based active ingredient. India is one among the twenty-five 'mega-biodiverse' regions of Earth. The north eastern region of India forms a part of the eco- geographic area of South East Asia which is considered as the centre of origin of many herbs & medicinal plants and accordingly recognized as a mega biodiversity hotspot. 50% of India's entire plant biodiversity is contributed by the North Eastern States i.e., Manipur, Mizoram, Sikkim, Tripura including Assam.*R auvolfia serpentina* is an important medicinal plant in the pharmaceutical world due to the presence of its immense therapeutic properties. *Piper longum* known as long pepper is a native of northeast India and an important traditional medicinal plant. Piperine was the first amide isolated from *Piper* species and was reported to display central nervous system depression, antipyretic, and anti-inflammatory activity.Assam consists of rich varieties of medicinal plants and herbs, most of those plants and their medicinal uses are known only to the inhabitant and the tribes residing in various parts of Assam. Due to lack of knowledge of the potentialities of these plants, the common people destroy them wilfully for the purpose of fuel and fodder.Habitat of *Rouvolfia serpentina* is found in sandy loam soil of Arunachal Pradesh and Assam in North Eastern region.Forty species of Piper were already reported from this region.

Medicinal plants are the most common reservoir of life saving drugs for the world. They are still considered to be efficient in treating the diseases of mankind. Botanical drugs play an important role in meeting the health needs of low and middle-income countries through traditional medical system. In addition, around 57% of top allopathic drugs are constituted from at least one medicinal plant-based active ingredient. India is one among the twenty-five 'mega-biodiverse' regions of Earth. The ancient Indian scholars and saints, through their deep contemplation, realization, observation and research work have described the medicinal value of almost all the plants, different product of animal kingdom and mineral and their indications in different diseases. Though such medicinal plants were originally used by the practitioners of Indian system of medicine, nowadays the scientists and research workers of the world, working in the field of medicine, have established that there are numerous plants which have been proved to have excellent and positive effect on different critical diseases. That is why at present the pharmacopoeia of the advanced nations like Russia, U.S.A., Great Britain etc. have about 25 % to 40 % of drugs of plant origin.

The northeastern part of India including Eastern Himalaya is very rich in medicinal plants and one of the two centres of species diversity of Indian Piper (Piperaceae) (Gajurel *et al*., 2001). Forty species of Piper were reported from this region. Piper species are of great interest owing to their biological properties and a number of isolated bioactive molecules. The local people use 10 species of Piper as insecticidal, larvicidal, fungicidal, carminative, antidote etc. Piper longum L., a wildly abundant species in this region is a highly valuable drug and is essential ingredient in many ayurvedic formulations. Medicinal uses of P. longum essential oils, roots, fruits and whole plants were reported earlier (Zaveri, 2010). The bioactive compound present in the P. Longum commonly known as Pippali, Pipoli is the piperine which is Pyridine piperidine alkaloids. Systemic pharmacological studies on piperine have revealed that this compound elicited diverse pharmacological activities like analgesic, bioenhancer, anti-pyretic, anti-inflammatory, antioxidant, hepatoprotective, antithyroid, antihyper-tensive, antitumor, antiasthmatic & CNS-depressant activities. From ancient era the main source of piperine from *P. longum* are the Spikes and Roots. According to Mohapatra and Basak (2015), Piperine content was appraised to be the highest in the roots of plants grown through nodal vine cuttings. However the plants grown through Petiolar and apical cuttings also showed presence of Piperine content in a visible quantity that can be utilised by pharmacists for drug formulation.

Habitat of *Rouvolfia serpentina* is found in sandy loam soil of Arunachal Pradesh and Assam in North Eastern region. The root of the *Rauwolfia serpentina* Benth (N. O. Apocynaceae) has been in use in India for hundreds of years for a host of unrelated ailments. Since 1949, after the English publication of a clinical report by the author on *Rauwolfia serpentina* therapy in fifty cases of essential hypertension, the plant has gained universal acclamation as a useful therapeutic weapon in high blood pressure states.

Rauwolfia serpentina

Rauwolfia serpentina is an important medicinal plant in the pharmaceutical world due to the presence of its immense therapeutic properties. The plant is known for curing various disorders because of the presence of alkaloids, carbohydrates, flavonoids, glycosides, phlobatannins, phenols, resins, saponins sterols, tannins and terpenes. The plant parts, root and rhizome have been used since centuries in Ayurvedic medicines for curing a large number of diseases such as high blood pressure, mental agitation, epilepsy, traumas, anxiety, excitement, schizophrenia, sedative insomnia and insanity. About 80 alkaloids are isolated from *Rauwolfia* species; reserpine is most vital principal active constituent among them.The plant contains more than 50 different alkaloids which belong to the monoterpenoid indole alkaloid family. The major alkaloids are ajmaline, ajmalicine, ajmalimine, deserpidine, indobine, indobinine, reserpine, reserpiline, rescinnamine, rescinnamidine, serpentine, serpentinine and yohimbine. These alkaloids are employed for the treatment of several diseases such as cardiovascular disorder, hypertension, snake bite, rheumatism, insanity, epilepsy and ecema . Other alkaloids in the plant have also been identified to have biochemical medicinal actions, which include canescine, deserpidine, recanescine, and rescinnamine.

One of the major alkaloids identified from this plant is reserpine. The reserpine content is lower in the stems and leaves and is been found to be higher in the root. Scientists have believed that it is one of the most prevalent indole alkaloids in the plant; however, different assays have challenged that prediction. The concentration of reserpine in the plant has been found to vary from 0.03% to 0.14% of the dry weight of the plant. *R. serpentina* is also known for its antimicrobial, antifungal, anti-inflammatory, antiproliferative, antidiuretic and anticholinergic activities. The herbal medicine is still the basis of primary health care for 75–80% of the world population because of its cultural acceptability, better compatibility with the human body and lesser side effects. Indole alkaloids such as ajmaline, reserpine yochimbine and others, which are contained in plants of the *Rauwolfia* family, are biologically active substances, valuable drugs and semi products which can be extracted. Indole alkaloids are naturally occurring nitrogen-containing compounds present in Rauvolfia species. These alkaloids are mainly present in root bark of the plant. In recent years, there has been widespread development in biotechnological methods for obtaining indole alkaloids, apart from their isolation from natural plants

Piper longum

Piper longum L known as long pepper is a native of northeast India and an important traditional medicinal plant (Manjusha *et al*., 2018). It is found in various parts of India including evergreen forests from Konkanto Travancore regions of Western Ghats. The fruits of this plant are source of famous traditional drug pippali besides being used as spice and in the manufacturing of pickle. The plant has tremendous medicinal values and a known curing agent against cough, leprosy, diabetes, piles, cardiac diseases, chronic fever and to improve appetite to name a few various pharmacological activities including, anti-allergy, antibacterial, anti-hepatitis and anti-tubercular have been reported from long pepper. The principle bioactive compound found in *P. longum* is an alkaloid, piperine as chief constituent. Systemic pharmacological studies on piperine have revealed that this compound elicited diverse pharmacological activities. The extract of the root of *P. longum* L. and its major compound, piperine exert anti-oxidant activity and are protective in the myocardial ischemic condition. The alcoholic extract of the fruits of the plant *P. longum* L. and its component piperine showed significant immunomodulatory and antitumor activity. From ancient era the main source of piperine from *P. longum* are the Spikes and Roots.

Piperine was the first amide isolated from *Piper* species and was reported to display central nervous system depression, antipyretic, and anti-inflammatory activity. The *Piper longum* L. dried fruit's oil showed significant anti-inflammatory activity on carrageen an-induced rat paw edema. Isolates from *Piper longum* L. fruit extracts showed antimicrobial activity against Gram-positive bacteria and Gram-negative bacteria. The dried fruit was widely used in combination with other herbs to treat various diseases and disorders in Ayurvedic medicine. The analysis was done on the seeds and showed that they have the ability to treat idigestion, diarrhea, diabetes, cholera, obesity, skin problem and improves the bone strength.

Assam is a part of the Eastern Himalayan Biodiversity of India (Sharma and Das, 2018). Assam is a state of the North Eastern part of India. 50% of India's entire plant biodiversity is contributed by the North Eastern States i.e., Manipur, Mizoram, Sikkim, Tripura including Assam. There are varieties of plants distributed in various parts of the state. The Ministry of Environment and Forests (MoEF), Government of India in 1980s recorded two hundred and eighty-six (286) species of plants from Assam, used by the tribes of Assam. But, as the general people are not aware of their uses and potentialities, some are growing and dying unused, some are being destroyed wilfully by the people for the purpose of animal feeding, fuel etc. and some are being burnt and cut down to clear the jungle.

With its vast tract of hills and forests, Assam is the homeland of wonderful and precious medicinal herbs and plants such as Sarpagandha (*Rauvolfia serpentina* Benth.ex.Kur), Pippali (*Piper longum* Linn), Amlakhi (*Emblica officinalis* Gaertn), Hilikha (*Terminalia chebula* Retz.), Bhomora (*Terminalia belerica*), Arjuna (*Terminalia arjuna* Wight & Arn.) (Baishya and Begum, 2013).

About 900 types of such plants are known to exist in abundance in the forest area of the state, with the Brahmaputra valley itself, having 50 species of such plants is being of commercial value. It is estimated that only about 5-10% of the plants and herbs are currently utilized, and the rest hold a vast potential which are yet to be explored.

The active ingredients present in these plants may be used for designing some new drugs and pharmaceutical agents which can pave some new alleys in the world of pharmaceutical sciences and be a blessing for mankind. Plant-derived pharmaceutical formulations used to treat diseases. Plant derived pharmaceutical formulations used to treat diseases are termed as alternative medicine. Alternative medicine is better than our conventional allopathic medication and can enhance the impact of conventional drugs if used properly. Natural product derived from plants may not have any side effects till date if used in a specific dose. Some of the medicinal plants work unbelievably in certain diseased conditions according to the tribal people of Assam. May be while hunting for drugs in laboratories for certain deadly diseases day and night, researchers and scientists are missing some miraculous and potent phytochemical constituents which could be modified for formulating the drug, which are present in the plants grown in wild and ignorance on the roadside, backyards and valleys of Assam.

Though Assam consists of rich varieties of medicinal plants and herbs, most of those plants and their medicinal uses are known only to the inhabitant and the tribes residing in various parts of Assam. Due to lack of knowledge of the potentialities of these plants, the common people destroy them wilfully for the purpose of fuel and fodder. This decrease in medicinal plants natural stocks through deforestation leads to over-extraction of them as a result reduction in medicinal plants availability and increase in adulterated botanical drugs thereby affecting affordability of good quality botanical drugs. Moreover common people are not aware about the bioactive compounds and their health benefits of the medicinal plant found around their surroundings. Hitherto, only 1% of all identified plant species have been screened for active compounds useful for therapeutic purposes (CTA, 2002). With the changing life style and socio-economic values, the greed to over-harvest the valuable medicinal plants of the Himalaya for immediate cash by selling to any prospective buyer has superseded the traditional values. The ruthless and unscientific collection of these high value medicinal plants is one of the causal factors for their rarity and making an imbalance in the demand and supply.

Due to the following facts all those valuable plants are gradually going to extinct:-

(1) Lack of awareness about different medicinal plant species

(2) Some are being burnt down or cut down for clearing the jungle.

(3) Some are growing and dying unused due to lack of collection.

(4) Shifting cultivation on the vast areas of forest land which steadily extinct the natural resources.

(5) Rapid deforestation.

(6) Injudicious and unscientific collection of several rare plants by the agents of business concerns.

(7) Indiscrimate cutting down of trees by mischievous contractors enjoying political patronage.

(8) Cutting down of trees by the underground marketers for getting valuable essence or precious wood like Agaru, Nahar, Bhela etc.

(9) This depletion is due to high pressure for their unsystemic exploitation through expansion of urbanization, agricultural land and road development as well as some natural calamities like land sliding, etc. With escalating competition to collect large quantities of medicinal plants, influential people even hire labourers from outside. These labourers have no training in traditional collection techniques.

The main causes for these problems are:

1. Due to lack of knowledge of the potentialities of these plants,
2. The younger generation of herbal practitioners are not keen to adopt the tradition as a profession
3. The availability of medicinal plants in wild stock is decreasing because of maximum dependency on wild stock, encroachment by outsider and illegal collection from wild stock.
4. Lack of knowledge about the conservation and cultivation of these plants
5. Lack of awareness of the agencies procuring the planting material
6. Lack of awareness about the bioactive compounds present in these plants and their health benefits
7. Lack of suitable technologies for cultivation of these plants
8. Low prices of medicinal plants
9. Long gestation period of many medicinal plant species
10. The wrong choice of species and areas
11. Lack of research on high yielding varieties
12. Inefficient processing techniques
13. Poor quality control procedures
14. Lack of good manufacturers
15. Preference of wild medicinal plants by pharmaceutical companies
16. Poor marketing infrastructure
17. Lack of coordination among different stakeholders.
18. The precariousness of market forces also creates a fear among medicinal plants growers: a medicinal plant, which has a powerful market today may not have the same market tomorrow.
19. Improper sharing of benefits due to lack of awareness among farmers and herb collectors on the real prices of medicinal plants.

For centuries, Phyto-medicines have dominated the health scenario in India. Plants have been a source of natural medicines and drugs in traditional systems such as Unani and Ayurveda from ancient times. Since plant-based medicines have very few side-effects compared to the synthetically produced ones, people are more inclined towards the usage of the former. Also, Phyto-medicines are more affordable, especially in poor and developing countries.

The north eastern region of India forms a part of the eco- geographic area of South East Asia which is considered as the centre of origin of many herbs & medicinal plants and accordingly recognized as a mega biodiversity hotspot. North Eastern India has a wide stretch over with a hilly forest areas as well as plains of Assam. It covers the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The states of Sikkim and Arunachal Pradesh fall under Himalayan hills whereas Manipur and Nagaland covers Naga hill and Meghalaya occupied by Garo, Jayantiya and Khasi hills; State of Mizoram comes under Lusai hills. According to the name of the hills, each one has variable range of altitudinal and topographic variations which governs the occurrence and distribution of biodiversity covering medicinal plants distribution. Topographical range of the region varies from tropical foot hills up to snow cladalpine hills. According to variation of climatic zones, medicinal plants vary for their occurrence in different hills. Some of the medicinal plants are distributed in high potential whereas certain others go on depleting from their Natural habitat.

This depletion is due to high pressure for their unsystemic exploitation through shifting cultivation expansion of urbanization, agricultural land and road development as well as some natural calamities like land sliding, etc. Comparison to other part of the Country population density in the region shows it to be less and most of the land was unutilized by the public sector in the region as a whole which needs to be protected to enrich the medicinal plant flora (Mudaiya *et al*., 1987; Shankar *et al*., 1999; Website IUCN, 2009). Cultivation of medicinal plants in the region has also been undertaken in large scale for acclimatization of plants growing in one part to other part accordingly.

References

Baishya RA, Begum A (2013) Promotion of Rural Livelihood through Medicinal and Aromatic Plants Based Cottage Industries for Upliftment of Rural Economy of Assam. 2: 619 doi:10.4172/scientificreports.619.

CTA (2002) ‘Medicinal plants: pluck not plunder’, Spore, Vol. 99, pp.1–2.

Gajurel PR, Rethy P, Singh B, Kumar Y (2001) Importance of systemic investigation for proper utilization and conservation of Piperspecies of north-east India. Proceeding NEI National Seminar, pp 305–313

Manjusha, S., , Parameswaran, N.K. and Malar, R.S. (2018). Determination of bioactive compounds from Piper longum by using HP-LC analysis.Indo Am. J. P. Sci, 2018; 05(04).

Mohapatra, m and Basak, U (2015).Evaluation of piperine content from roots of piper longum Linn., originated from differet sources with comparison of zonal variation in Odisha, India.Int J Pharm Sci Rev Res.6:34-41.

Mudaiya RK, Sharma BN, Singh DN (1987). Threatened and rare medicinal plants from Sikkim. Bull. Medico Ethno Bot. Res. 8(3- 4):155-159.

Sharma, M. and Das, B. (2018).Medicinal plants of North-east Region of India: a small review. Int J Curr Pharm Res, 10 (4) : 11-12.

Shankar R, Singh VK, Rawat MS (1999). Some rare medicinal plants inArunachal Pradesh: Need for their conservation. Bull. Medico Ethno bot. Res. 20(1- 4):128-131

Zaveri M, Khandhar A, Patel S, Patel A (2010) Chemistry and pharmacology of Piper longum L. Int J Pharm Sci Rev Res 5: 67–76.

Website: IUCN (2009). IUCN IUCN Red list of threatened Species www. Iucnredlist.org.

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TRANSFORMING AGRICULTURE: CUTTING-EDGE TECHNOLOGIES REVOLUTIONIZING THE FUTURE OF FARMING

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Abstract

In recent years, agriculture has undergone a profound transformation driven by a surge of technological innovations that are revolutionizing the way we cultivate, manage, and harvest crops. These advancements are not only enhancing efficiency and productivity but also addressing critical challenges such as climate change, resource depletion, and the urgent need for sustainable practices. This exploration highlights the latest breakthroughs that are reshaping agriculture and defining the future of farming. Agriculture stands on the brink of a groundbreaking transformation, propelled by pioneering technologies that are fundamentally altering the industry. This abstract delves into the key advancements that are redefining modern farming practices and examines their far-reaching implications for efficiency, sustainability, and overall productivity.

Keywords: Precision agriculture, Global Positioning System, Variable Rate Technology, IoT sensors, Drone and AI

Introduction

Agriculture, a cornerstone of human civilization, is undergoing an unprecedented transformation driven by a wave of cutting-edge technologies. As the global population grows and environmental challenges intensify, the agricultural sector is embracing innovative solutions to enhance productivity, sustainability, and resilience. The integration of advanced technologies is fundamentally reshaping traditional farming practices, offering new methods to improve crop management, resource use, and overall farm efficiency. This era of transformation is characterized by the adoption of precision agriculture, which utilizes sophisticated tools such as GPS, IoT sensors, and data analytics to optimize farming practices with unparalleled accuracy. These technologies allow for precise application of inputs and real-time monitoring of field conditions, leading to increased yields and reduced environmental impact.

Precision agriculture represents a significant advancement in farming, leveraging technology to enhance field management with unparalleled accuracy. By integrating GPS, IoT sensors, and advanced data analytics, precision agriculture enables farmers to optimize their practices, improve crop yields, and reduce environmental impact. Here's an overview of how precision agriculture is revolutionizing modern farming

Global Positioning System (GPS) technology and remote sensing tools provide farmers with detailed information about field conditions. GPS guides machinery with high precision, ensuring accurate planting, fertilizing, and harvesting. Remote sensing technologies, such as satellites and drones, capture data on crop health, soil conditions, and pest activity, allowing for targeted interventions.

Data analytics plays a crucial role in precision agriculture by processing vast amounts of information collected from sensors and remote sensing technologies. Advanced software creates detailed maps that highlight variations in soil fertility, moisture levels, and crop health. This enables farmers to make data-driven decisions, applying inputs like water, fertilizers, and pesticides more precisely where needed.

Variable Rate Technology (VRT) allows for the adjustment of input application rates based on specific field conditions. For instance, VRT can be used to vary the amount of fertilizer applied according to soil nutrient levels, ensuring optimal growth while minimizing waste. This technology improves resource efficiency and reduces environmental impact by applying inputs more judiciously.

Internet of Things (IoT) sensors embedded in the field monitor real-time conditions such as soil moisture, temperature, and nutrient levels. Smart equipment, including automated irrigation systems and precision planters, utilizes this data to adjust operations dynamically. For example, smart irrigation systems can optimize water use by responding to real-time soil moisture readings, reducing water waste and ensuring crops receive the right amount of hydration.

Drones and Aerial Imagery: Drones equipped with high-resolution cameras and multispectral sensors provide aerial imagery that helps farmers assess crop health and detect issues such as pest infestations or nutrient deficiencies. This bird's-eye view of the fields allows for rapid identification of problem areas, enabling timely interventions that can improve crop performance and yields.

Machine Learning and AI: Machine learning and artificial intelligence (AI) enhance precision agriculture by analyzing complex datasets to identify patterns and trends. AI algorithms can predict weather patterns, detect disease outbreaks, and forecast crop yields based on historical and real-time data. These insights help farmers make proactive decisions, improving overall farm management and productivity.

Integration with Farm Management Software: Farm management software integrates various precision agriculture technologies into a cohesive system, allowing farmers to streamline their operations. These platforms consolidate data from GPS, sensors, and drones, providing a comprehensive view of field conditions and farm performance. Farmers can use these insights to plan, execute, and monitor agricultural practices more effectively

Autonomous machinery is revolutionizing the agricultural industry by automating traditional tasks and enhancing farm efficiency. With advancements in technology, self-driving tractors, harvesters, and other automated equipment are transforming how crops are planted, managed, and harvested. Here's an exploration of how autonomous machinery is shaping the future of farming:

Self-driving tractors are a cornerstone of autonomous farming. Equipped with GPS, sensors, and AI technology, these tractors can operate autonomously across fields, performing tasks such as plowing, planting, and fertilizing. By reducing the need for manual labor, self-driving tractors increase efficiency, precision, and productivity while allowing farmers to focus on other aspects of farm management.

Autonomous harvesters are designed to automate the complex and labor-intensive process of crop harvesting. These machines use advanced sensors and computer vision to navigate fields, identify ripe crops, and harvest them with minimal human intervention. Autonomous harvesters can work around the clock, optimizing the harvest window and reducing crop losses due to delayed harvesting.

Robotic weeders and planters represent another significant advancement in autonomous machinery. These robots use sensors and machine learning algorithms to identify and remove weeds without disturbing crops. Similarly, robotic planters can accurately place seeds at optimal depths and spacing, ensuring uniform crop emergence and maximizing yields. These technologies reduce labor costs and improve precision in planting and weeding.

Automated irrigation systems utilize sensors and weather data to optimize water use. These systems can adjust irrigation schedules and volumes based on real-time soil moisture levels, reducing water waste and ensuring crops receive the appropriate amount of hydration. Automated irrigation helps conserve water resources and improve overall farm efficiency.

Data Integration and Management: Autonomous machinery is often integrated with farm management software to provide a comprehensive view of field operations. Data collected by autonomous equipment, such as field maps and operational metrics, is analyzed and used to inform decision-making. This integration enables farmers to monitor performance, optimize equipment use, and make data-driven decisions that enhance farm productivity.

Vertical farming and controlled environment agriculture (CEA) are gaining traction as sustainable solutions to urban and indoor farming. Vertical farms use stacked layers to grow crops in controlled environments, minimizing land use and optimizing resource efficiency. CEA systems, which include hydroponics, aeroponics, and aquaponics, allow for precise control over environmental factors such as light, temperature, and nutrient levels. These technologies enable year-round production and reduce the carbon footprint associated with traditional farming.

Biotechnology and genetic engineering continue to advance the capabilities of modern agriculture. Genetic modification and CRISPR gene-editing techniques are used to develop crops with desirable traits such as drought resistance, pest resistance, and improved nutritional content. These innovations help address the challenges posed by climate change and food security, ensuring that crops can thrive in varying conditions and meet the nutritional needs of a growing global population.

Blockchain technology is increasingly being adopted to enhance transparency and traceability in the agricultural supply chain. By creating an immutable ledger of transactions, block chain enables farmers, suppliers, and consumers to track the journey of food products from farm to table. This technology improves food safety, reduces fraud, and builds consumer trust by providing verifiable information about the origins and quality of agricultural products.

Integrating renewable energy sources into agricultural operations is becoming more common. Solar panels, wind turbines, and biogas systems are being used to power farms, reduce reliance on fossil fuels, and lower operational costs. Renewable energy solutions also contribute to sustainability by minimizing the environmental impact of farming practices and supporting energy independence for rural communities.

Conclusion

The transformative technologies driving the future of agriculture are reshaping farming practices with greater efficiency, sustainability, and productivity. From precision agriculture and autonomous machinery to innovative growing methods and data-driven decision-making, these advancements are addressing contemporary challenges and paving the way for a more resilient global food system. As technology continues to evolve, the agricultural sector will benefit from enhanced resource management, improved crop yields, and reduced environmental impact, ensuring a sustainable and secure food supply for future generations.

Reference

Fountas, S., Espejo-García, B., Kasimati, A., Gemtou, M., Panoutsopoulos, H., & Anastasiou, E. (2024). Agriculture 5.0: Cutting-edge technologies, trends, and challenges. IT Professional, 26(1): 40-47.

Sharma, V., Tripathi, A. K., & Mittal, H. (2022). Technological revolutions in smart farming: Current trends, challenges & future directions. Computers and Electronics in Agriculture, 201: 107217.

Ahlawat, U., Naruka, A., Changdeo, W. B., Rehsawla, R., Sansanwal, R., Mishra, R., & Singh, V. K. (2024). A Review of Cutting-edge Biotechnological Solutions for Next-generation Farming. Journal of Experimental Agriculture International, 46(7): 1187-1204.

Srivastava, U. (2022). Disruptive technologies: shaping the future of agriculture: Disruptive technologies for agriculture. Journal of AgriSearch, 9(4): 282-289.

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WHY *SESUVIUM PORTULACASTRUM* IS GREAT FOR BOTH PEOPLE AND LIVESTOCK FEED

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Abstract

Sesuvium portulacastrum, commonly known as seapurslane, is a hardy plant that thrives in subtropical, Mediterranean, coastal, and warmer regions around the world. It's often used locally as a vegetable and as feed for animals in coastal areas. Ecologically, it helps reclaim saline soils in dry and semi-dry regions and can be a good option for challenging soil conditions. Research on *Sesuvium* collected from India has shown its potential for improving coastal and saline areas, providing valuable phytoecdysteroids for the silk industry, and being grown on a larger scale both for food and animal feed. This plant, which is still underused, has significant potential as a wild and cultivated resource.

Key words: *Sesuvium portulacastrum*, Human consumption, Cattle feed, Salt accumulation

Introduction

Sesuvium portulacastrum, commonly known as shoreline purslane, is a succulent halophyte found in coastal regions worldwide. Its adaptability to saline environments and nutritional profile have sparked interest in its potential use as both human and cattle feed. Mangroves are tall forests or shrubs that grow in coastal areas where the waves are gentle. They form a type of coastal wetland found in tropical and subtropical regions. Mangroves play an important role in coastal ecosystems by providing energy for the food chain and protecting against natural disasters like cyclones and tsunamis. They are also a source of various products like medicines, dyes, and tannins. One example of a plant found in mangrove areas is *Sesuvium portulacastrum*, commonly known as seapurslane or shoreline purslane. This plant is part of the Aizoaceae family and was first described in 1953. It was initially named Portulaca portulacastrum by Carl Linnaeus but was later reclassified into the Sesuvium genus. *Sesuvium portulacastrum* is a hardy, perennial plant that thrives in tough conditions like high salinity and drought. It is often found in the backshore zones of coastal beaches where sand movement is influenced by winds. This plant grows in sandy clay, coastal limestone, sandstone, tidal flats, and salt marshes across various regions of the world. The plant features thick, fleshy leaves on reddish-green, branching stems. Its leaves are spoon-shaped, ½ to 2 inches long, and have a smooth, fleshy texture. They are typically green but can have some red coloring, and the bases of the leaves have wing-like structures. This article explores the nutritional benefits, cultivation methods, and potential applications of *Sesuvium portulacastrum* in the food and agriculture industries.

Nutritional Profile and Benefits

Sesuvium portulacastrum is rich in essential nutrients, including proteins, vitamins, and minerals, making it a valuable addition to the diet of both humans and cattle. Its high protein content supports muscle development and overall health, while its abundance of vitamins A and C boosts immunity and improves skin health. Researchers have examined *Sesuvium portulacastrum* for various plant chemicals like alkaloids, saponins, tannins, terpenoids, and steroids. They used specific methods to do this. Gas chromatography showed that the plant has more saturated fatty acids compared to unsaturated ones. Tests on the stems and leaves of *Sesuvium portulacastrum* found terpenoids, alkaloids, and tannins. The plant is also a source of phytoecdysteroids, which are insect hormones that play a role in their development, as well as some ecdysone. (Figure.1) Key compounds in *Sesuvium portulacastrum* are trans-4-hydroxyprolinebetaine, praline, and 3,5,4'-trihydroxy-6,7-dimethoxyflavone 3-glucoside, which suggest its role in managing water balance.

The plant also contains ecdysterones, amino acids, minerals, flavonols, and flavonol glycosides. *Sesuvium portulacastrum* shows broad-spectrum activity against both gram-positive and gram-negative bacteria, along with strong antifungal and antioxidant properties. Analysis using GC-MS (Gas Chromatography-Mass Spectrometry) of the plant's ethanol extract revealed compounds like 22,23-dihydrostigmasterol, benzoic acid, epicatechin, and capsaicin. The essential oil from its leaves contains alpha-pinene, camphene, beta-pinene, and several other compounds. The presence of these secondary metabolites in *Sesuvium portulacastrum*'s leaves and stems makes it a promising subject for further research. For cattle, these nutrients can enhance growth rates, milk production, and overall vitality.

S.no	Nutrients	Composition
1	Palmitic acid	31.18%
2	Oleic acid	21.15%
3	Linolenic acid	14.18%
4	Linoleic acid	10.63%
5	Myristic acid	6.91%
6	Behenic acid	2.42%

Figure.1.Represents a nutritional composition of *Sesuvium portulacastrum*

Cultivation and Environmental Impact

Growing *Sesuvium portulacastrum* is relatively straightforward due to its resilience in harsh conditions. It thrives in saline soils where other crops might fail, offering a sustainable option for regions with degraded or salt-affected lands. *Sesuvium portulacastrum* can be grown in two main ways: from seeds or by taking stem cuttings. To germinate seeds, you need to provide varying temperatures, light, and salinity levels. However, because seeds are hard to produce and depend on environmental conditions, growing Sesuvium from stem cuttings is often preferred for large-scale cultivation. Stem cuttings grow roots easily. To do this, you plant a 3 cm long section of stem with two opposite leaves in the soil and water it with regular tap water. Within 7 to 10 days, new shoots and roots will start to grow. Sesuvium thrives well in salty conditions or soils with added salt (about 200 mM NaCl). Its cultivation can improve soil health by preventing erosion and increasing organic matter, making it an eco-friendly choice for farmers.

Human Consumption

In human diets, *Sesuvium portulacastrum* can be used in salads, soups, and as a garnish, offering a unique flavor and nutritional boost. Its antioxidant properties may also provide health benefits such as reducing inflammation and oxidative stress. *Sesuvium portulacastrum* is sometimes grown as a vegetable for cooking in India and Southeast Asia. It's valued for its food potential and is used as a wild vegetable in southern India due to its salty flavor and fleshy texture Culinary experimentation with this plant could lead to new and exciting dishes that cater to health-conscious consumers.

Cattle Feed

As cattle feed, *Sesuvium portulacastrum* can be integrated into regular feed to improve nutritional intake without significant changes to feeding practices. Its high digestibility and palatability make it a practical option for farmers looking to enhance livestock health and productivity. *Sesuvium portulacastrum* is valued for its salty taste and fleshy texture, making it a nutritious food option. In southern India, it's grown as a wild vegetable crop. In India and Southeast Asia, it's occasionally cultivated for cooking. To prepare it, it's best to wash the stems thoroughly and boil them in multiple changes of water to remove excess salt. In coastal areas, the plant is also used as feed for livestock such as goats, sheep, and camels, providing them with a tasty, salty forage. Crabs also eat this plant and it can be used as bait in traps. With its nutritious qualities, *Sesuvium portulacastrum* can be a good vegetable alternative in coastal regions and can serve as feed for cattle, as shown in the nutrient comparison table. Studies have shown that cattle consuming this plant exhibit improved weight gain and overall health, making it a promising addition to traditional feedstocks.

Conclusion

Sesuvium portulacastrum presents a versatile and sustainable option for both human and cattle nutrition. Its ability to thrive in saline environments and its rich nutritional profile make it a valuable resource in addressing food security and agricultural sustainability. Further research and development could unlock even more potential uses for this remarkable plant, benefiting both health and the environment.

References

Ayyappan, D., Sathiyaraj, G., & Ravindran, K. C. (2016). Phytoextraction of heavy metals by Sesuvium portulacastrum L. a salt marsh halophyte from tannery effluent. *International Journal of Phytoremediation*, *18*(5), 453-459.

Lokhande, V. H., Nikam, T. D., & Penna, S. (2010). Biochemical, physiological and growth changes in response to salinity in callus cultures of Sesuvium portulacastrum L. *Plant Cell, Tissue and Organ Culture (PCTOC)*, *102*, 17-25.

Shaygan, M., Reading, L. P., Arnold, S., & Baumgartl, T. (2018). Modeling the effect of soil physical amendments on reclamation and revegetation success of a saline-sodic soil in a semi-arid environment. *Arid Land Research and Management*, *32*(4), 379-406.

Nasreen, N., Niaz, S., Khan, A., Ayaz, S., Rashid, M., Khattak, I., Yu, Z., Wang, T., Al Sarraf, M., & Ali, A. (2020). Molecular characterization of ticks infesting livestock in Khyber Pakhtunkhwa Province, Pakistan. *International Journal of Acarology*, *46*(3), 165-170.

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MODERN INNOVATIVE APPROACHES OF PLANT BREEDING TO DEVELOP BIOTIC AND ABIOTIC STRESS TOLERANCE VARIETIES AND HYBRIDS

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Introduction

Now a days biotic as well abiotic stresses are important concern for reducing the production and productivity of crops. Most of the biotic stresses such as disease, pests and nematodes and abiotic stresses such as low temperature (frost), high temperature (heat stress), salinity, alkalinity, drought, frost and water logging are playing major constraints for yield and quality of crop. Biotic and abiotic stresses are responsible for stunted growth, reduce photosynthesis, impairing nutrient and water uptake, poor crop performance, reduce yield and productivity etc.

Under this circumstances it is necessary to use the new modern innovative approaches to develop biotic and abiotic stress tolerance crop varieties and hybrid for sustainable development. Here some modern innovative approaches are listed below:

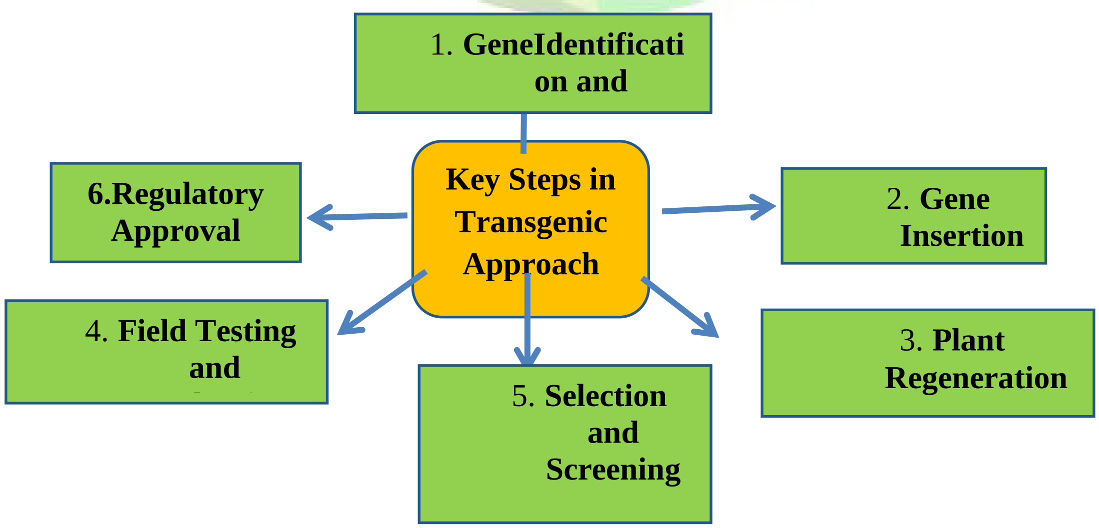
1. Genetic Engineering (Transgenic approaches)

2. Marker Assisted Selection (MABB, MAGP, MARS & Genomic Selection)
3. High throughput phenotyping
4. Omics Technology(**Genomics, Proteomics, Metabolomics & Transcriptomics)**
5. RNA-mediated gene transfer
6. Genome editing (CRISPR/Cas9)
7. Speed Breeding

These approaches are often used in combination to develop crop varieties that can thrive in challenging environments, ensuring food security and agricultural sustainability.

Genetic Engineering (Transgenic approaches): Genetic engineering is a DNA recombination technique that has made possible gene transfer between dissimilar genera or specie. It involves the direct manipulation of an organisms gene using r DNA technology. This method is very much useful for developing stress-tolerance crop varieties:

- **Gene Identification and Isolation**: Genes that confer stress tolerance in other organisms (e.g., bacteria, other plants, animals) has to be identify and isolation has to be done by using molecular cloning techniques.
- **Gene Insertion**:Isolated gene has to be insert into the plant genome either by using **Agrobacterium-mediated Transformation (**Utilizing the natural ability of Agrobacterium to transfer DNA to plant cells) **or by Gene Gun (Biolistics) (**Physically introducing DNA into plant cells by bombarding them with high-velocity microprojectiles coated with DNA)



- **Plant Regeneration**: Whole plant regenerate by tissue culture techniques from the genetically modified cells.
- **Selection and Screening**: Transformed plants are selected that have successfully integrated the new gene and allow for screening of these plants for the expression of the desired trait (e.g., stress tolerance).
- **Field Testing and Evaluation**: The transgenic plants under field conditions are evaluated to assess their performance and stress tolerance.

Crop	**Gene inserted**	**Method used**	**Resistance against**	**References**
Biotic stress resistance				
Tomato (*Solanum lycopersicum* L.)	Coatprotein, replicase	VIG	*Tomato yellow leaf curl virus* inactivation	1
	cry1Ab	*A. tumefaciens*	Resistance to larvae of *Helicoverpa armigera* and *Spodoptra litura*	2
Abiotic stress resistance				
Potato (*Solanum tuberosum*)	*SOD,APX*, *codA* under SWPA2 promoter	*A. tumefaciens*	Improved resistance to salt and drought stress	3
Eggplant (*Solanum melongena* L.)	*TaNHX2*	*A. tumefaciens*	Salinity tolerance	4

Regulatory Approval: Finally transgenic plants must undergo rigorous safety and environmental impact assessments before they can be commercially released.

Marker Assisted Selection (MAS): MAS is a modern technique in crop breeding that utilizes genetic markers to assist in the selection of desirable traits.It helps to avoid difficulties and challenges that that occurred by the conventional crop breeding. MAS enhances the efficiency, accuracy, and speed of crop breeding programs, making it a valuable tool in modern agriculture. Indeed, various molecular approaches fall under the umbrella of Marker-Assisted Selection

(MAS), each with its unique applications and benefits

Molecular approches	**Purpose**	**Application**:	**Process**:
Marker-Assisted Backcrossing (MABC)	Used to introgress specific genes or traits from a donor parent into the genetic background of a recurrent parent.	Commonly employed to introduce disease resistance or specific quality traits into an elite cultivar while retaining most of the recurrent parent's genome.	Involves several backcrossgenerations, where markers are used to select individuals carrying the desired gene(s) while recovering the recurrent parent genome.
Marker Assisted Gene Pyramiding(MAGP)	Combines multiple genes (often from different sources) that confer resistance to a particular disease or pest.	Useful in developing cultivars with durable resistance by stacking genes that provide resistance against different strains or types of pathogens.	Involves crossing parents with different resistance genes and using markers to identify offspring carrying all desired genes.
Marker-Assisted Recurrent Selection (MARS)	Enhances the frequency of favorable alleles in a breeding population.	Used in improving complex traits controlled by multiple genes, such as yield or drought tolerance.	Involves repeated cycles of selection and recombination, with markers used to identify and select individuals with desirable alleles in each cycle.
Genomic Selection (GS)	Predicts the breeding value of individuals using genome-wide markers, without	Suitable for traits with complex inheritance patterns, including those influenced by many small-effect	Involves genotyping a training population with known phenotypes to develop a prediction model, which is then used to predict

	necessarily identifying specific markers linked to traits. Genetic values of selected individuals depend on genome estimated breeding values (GEBVs)	genes	the performance of selection candidates based on their genotypic data

Achievements of MAS

Crop	Trait	Gene/QTLs	Marker	Particulars	Reference
Biotic stress					
Rice	Bacterial blight	Xa21	RFLP	Seedling and adult plant resistance against blight	5
	Bacterial blight, Rice Blast	Pi9, Xa23	PCR based primer	Rice blast and bacterial blight resistance.	6
	Brown plant hopper (BPH)	Bph3, bph4, Bph13(t), bph19(t), and Qbph-9	SSR	Phenotypic variations associated with BPH infestation varies from 17 to 20% concerning BPH biotypes	7
Maize	European corn borer and Mediterranean corn borer	LIR4, 17, and 22 MQTL	SNP	LIR MQTL present on chromosome number 1 and contain QTL for cell wall acidic constituents, fiber components and differentiates.	9
Barley	Fusarium head blight (FHB) along with agronomic traits	Additive and Epistatic QTLs	SSR and DArT markers	Multi-QTL analysis for the improvement of FHB resistance and agronomic traits using recombinant inbred population	11

Chickpea	Resistance to Fusarium wilt	QTLFoc02, QTLFoc5	SSR	Genetic distance is 10 cM	13
Mungbean	Powdery mildew resistance	QTLs	RAPD, CAP, AFLP	Genetic distance is 1.3	16
Abiotic stress					
Rice	Submergence tolerance beyond SUB1	5 QTLs	SSR	5 QTL were found on Chromosome 1, 4, 8, 9, and 10	8
Maize	Drought resistance	Major QTL	Major QTL	Major QTLs on chromosome number 1, 2, 8 and 10	10
Barley	Drought tolerance	Yield and biomass associated QTLs	SSR	QTL alleles introgression ensured yield potential and biomass stability under multiple environments.	12
Chickpea	salinity	48 QTLs (days to 50% flowering and maturity and days after sowing)	SSR and SNP	QTL present on CaLG05 and CaLG07 Chromosome loci	14
	Drought	93 QTLs (plant height, days to flowering and days to maturity	SSR	QTL present on LG3 and LG4 Chromosome loci	15
Soybean	Salinity	1 QTL (salt-tolerant)	SSR and SNP	QTL present on 3 Chromosome	17
	Drought	7 QTLs	SSR	QTL present on Gm12	18

		(canopy wilting trait)		Chromosome loci	

These molecular approaches offer a range of strategies for different breeding objectives, from retrogressing specific traits to improving complex traits through recurrent selection. They collectively enhance the efficiency, precision, and effectiveness of modern crop breeding programs.

2. **High throughput phenotyping:** High throughput phenotyping (HTP) is a technology-driven approach used to measure and analyze a large number of physical and biochemical traits (phenotypes) of organisms, especially plants, in a rapid and efficient manner. This method leverages advanced technologies such as robotics, imaging, and data analysis to gather extensive phenotypic data. HTP is particularly valuable in fields like agriculture, plant breeding, and genetics, where understanding the phenotypic traits of a large number of specimens can lead to significant advancements.
3. **Omics Technology(Genomics, Proteomics, Metabolomics&Transcriptomics):** Omics technologies refer to a suite of advanced methods used to comprehensively analyze the roles, relationships, and actions of various types of biomolecules in living organisms. The four main branches of omics technologies are genomics, proteomics, metabolomics, and transcriptomics.

Omics Technology	**Overview**	**Application**	**Key techniques**
Genomics	Genomics is the study of the complete set of DNA (the genome) in an organism. It includes the analysis of genes and their functions, interactions, and evolutionary histories.	·**Disease Research**: Identifying genetic mutations associated with diseases. ·**Personalized Medicine**: Tailoring treatments based on individual genetic profiles. ·**Agriculture**: Developing genetically modified organisms (GMOs) with desirable traits.	·**DNA Sequencing**: Methods like next-generation sequencing (NGS) and whole-genome sequencing (WGS) allow for the rapid sequencing of entire genomes. ·**Genome Mapping**: Identifying the physical locations of genes on chromosomes. ·**Bioinformatics**: Computational tools to analyze and interpret genomic data.

Proteomics	Proteomics is the large-scale study of proteins, particularly their structures and functions. Proteins are vital for virtually every cellular process.	·**Biomarker Discovery**: Identifying protein markers for diseases. ·**Drug Development**: Understanding protein targets for therapeutic interventions. ·**Functional Genomics**: Studying the functional output of gene expression	·**Mass Spectrometry (MS)**: Analyzing protein composition, structure, and abundance. ·**2D Gel Electrophoresis**: Separating proteins based on their isoelectric point and molecular weight. ·**Protein Microarrays**: Detecting and quantifying protein-protein interactions and other protein activities.
Metabolomics	Metabolomics is the study of metabolites, the small molecules involved in metabolism within cells, tissues, or organisms. It provides insights into the metabolic state of a biological system.	·**Disease Diagnosis**: Identifying metabolic signatures associated with diseases. ·**Nutritional Science**: Studying the effects of diet on metabolism. ·**Environmental Science**: Monitoring environmental changes through metabolic profiles.	·**Nuclear Magnetic Resonance (NMR) Spectroscopy**: Identifying and quantifying metabolites. ·**Liquid Chromatography-Mass Spectrometry (LC-MS)**: Analyzing complex mixtures of metabolites. ·**Gas Chromatography-Mass Spectrometry (GC-MS)**: Profiling volatile and non-volatile metabolites.
Transcriptomics	Transcriptomics is the study of the complete set of RNA transcripts produced by the genome under specific circumstances or in a specific cell. It helps in	·**RNA Sequencing (RNA-Seq)**: Sequencing and quantifying RNA in a sample. ·**Microarrays**: Measuring the expression levels of large numbers of genes	·**Gene Expression Analysis**: Studying how genes are regulated and expressed. ·**Developmental Biology**: Understanding the transcriptional changes during development. ·**Disease Mechanisms**: Identifying changes in gene expression associated with diseases.

	understanding gene expression patterns	simultaneously. ·**qPCR (Quantitative PCR)**: Quantifying specific RNA molecules	

The omics technologies offer powerful tools for dissecting the complexity of biological systems, leading to advancements in medicine, agriculture, environmental science, and many other fields.

4. **RNA-mediated gene transfer:** RNA interference has been widely used for increasing crop yield, resistance against biotic and Abiotic stresses and enriched nutrient fruits. It is a posttranscriptional level of sequence specificgene silencing. Two major player of RNA interference are (endogenous) microRNA and exogenous, such as transgene, small interfering RNA (SiRNA). They are produced by the breakdown of dsRNA by the ribonuclease enzyme DICER or DICER like enzymes (DCL).

RNA interference (RNAi) is a powerful tool used in plants to confer resistance to biotic (pests and pathogens) and abiotic (drought, salinity, temperature extremes) stresses.

Trait	**Targeted crop**	**Targeted gene/ pathogen/ casual organisms**	**RNAi Mechanisms**
Biotic Stresses			
Insect Pest Resistance	Cotton & Corn	cotton bollworm and the Western corn rootworm	RNAi has been used to develop crops resistant by targeting genes essential for survival of these pests
Virus Resistance	Papaya	Papaya ringspot	virus resistance was achieved through RNAi by targeting the viral coat protein gene
Fungal and Bacterial Pathogen Resistance:	Tomato	*Fusarium oxysporum*, a fungal pathogen.	RNAi targeting essential genes in *Fusarium oxysporum*, a fungal pathogen, has been used to develop resistant tomato plants.
Abiotic Stresses			
Drought		ethylene biosynthesis or	Silencing genes involved in ethylene

Tolerance		signaling pathways	biosynthesis or signaling pathways that negatively regulate drought responses can improve drought tolerance in crops
Salinity Tolerance	Rice	SOS1 gene	Silencing the gene, which negatively regulates salt stress responses
Temperature stress	Crops	Heat shock proteins (HSPs)	Silencing heat shock proteins (HSPs) that are not effective or modifying the expression of genes involved in cold acclimation can help plants better tolerate temperature variations.

RNAi offers a precise and effective method for improving plant resistance to a wide range of biotic and abiotic stresses, enhancing crop yields and stability in various environmental conditions.

5. **Genome editing (CRISPR/Cas9):**Genome editing is the method which allows for the removal, modification, or addition of genetic material at specified genomic locations.The most prominent genome editing technology is CRISPR-Cas9, but other methods like TALENs (Transcription Activator-Like Effector Nucleases) and ZFNs (Zinc Finger Nucleases)are also used.

Table : List of reported targeted gene(s) by genome editing technology in different plant species for development of biotic and abiotic stress (19)

Crop	Gene	Trait	Techniques
Biotic stresses			
Rice	*Os11N3*	Bacterial blight resistance	TALEN
Wheat	*TaMLO-A1*, *TaMLO-B1*, *TaMLO-D1*	Resistance to powdery mildew	TALEN
Abiotic Stresses			
Rice	*OsDERF1*, *SRL1*, *SRL2*, *OsAAA*	Drought	CRISPR-Cas9

	OsMYB30, OsAnn3, OsAnn5, OsPRP1	Cold torelance	CRISPR-Cas9
Maize	*ZmARGOS8*	Drought	CRISPR-Cas9
Tomato	*SIMAPK3* and *SlNPR1, SlARF4*	Drought	CRISPR-Cas9
Tomato	*SIAGL6*	Heat stress	CRISPR-Cas9
Soybean	*Drb2a, Drb2b*	Tolerance to drought and salinity stress	CRISPR-Cas9

6. Speed Breeding :

Speed breeding is an emerging strategy to develop new varieties in a shorter time. This strategy was initially developed for long-day and day-neutral crops by manipulating environmental conditions; for example, lengthening daily light exposure to shorten the time to flower and produce seeds, thereby bringing the succeeding generation as quickly as possible. Today, this technology is being developed in short-day crops as well.

Speed breeding is a technique designed to accelerate the breeding cycle of plants, enabling multiple generations to be grown and harvested in a single year. This approach utilizes controlled environmental conditions, such as extended photoperiods (light exposure), optimal temperatures, and sometimes increased CO2 levels, to promote rapid growth and early flowering. The Hickey Lab in Australia has optimized speed breeding protocols for several key crops: Spring wheat (*Triticum aestivum*), durum wheat (*Triticum durum*), barley (*Hordeum vulgare*), chickpea (*Cicer arietinum*) and pea (*Pisum sativum*). These protocols allow these crops to achieve up to six generations per year, significantly speeding up the breeding process compared to traditional methods.

Conclusion

Modern innovative approaches in plant breeding are revolutionizing the development of biotic and abiotic stress-tolerant varieties and hybrids. By integrating advanced genomic tools, precise genome editing technologies, speed breeding, and comprehensive omics analyses, breeders can rapidly develop crops that meet the challenges of a changing world. These advancements not only enhance agricultural productivity and sustainability but also ensure food security for future generations.

References

Abdel-Haleem, H., Carter, T. E., Purcell, L. C., King, C. A., Ries, L. L., Chen, P., ... & Boerma, H. R. (2012). Mapping of quantitative trait loci for canopy-wilting trait in soybean (Glycine max L. Merr). *Theoretical and Applied Genetics*, *125*, 837-846.

Ahmad, R., Kim, Y. H., Kim, M. D., Kwon, S. Y., Cho, K., Lee, H. S., & Kwak, S. S. (2010). Simultaneous expression of choline oxidase, superoxide dismutase and ascorbate peroxidase in potato plant chloroplasts provides synergistically enhanced protection against various abiotic stresses. *Physiologia Plantarum*, *138*(4), 520-533.

Badji, A., Otim, M., Machida, L., Odong, T., Kwemoi, D. B., Okii, D., ... & Rubaihayo, P. (2018). Maize combined insect resistance genomic regions and their co-localization with cell wall constituents revealed by tissue-specific QTL meta-analyses. *Frontiers in plant science*, *9*, 895.

Chen, H. M., Liu, C. A., George Kuo, C., Chien, C. M., Sun, H. C., Huang, C. C., ... & Ku, H. M. (2007). Development of a molecular marker for a bruchid (Callosobruchus chinensis L.) resistance gene in mungbean. *Euphytica*, *157*, 113-122.

Chen, H., Wang, S., & Zhang, Q. (2002). New gene for bacterial blight resistance in rice located on chromosome 12 identified from Minghui 63, an elite restorer line. *Phytopathology*, *92*(7), 750-754.

Cobos, M. J., Winter, P., Kharrat, M., Cubero, J. I., Gil, J., Millan, T., & Rubio, J. (2009). Genetic analysis of agronomic traits in a wide cross of chickpea. *Field Crops Research*, *111*(1-2), 130-136.

Gonzaga, Z. J. C., Carandang, J., Sanchez, D. L., Mackill, D. J., & Septiningsih, E. M. (2016). Mapping additional QTLs from FR13A to increase submergence tolerance in rice beyond SUB1. *Euphytica*, *209*, 627-636.

Ha, B. K., Vuong, T. D., Velusamy, V., Nguyen, H. T., Grover Shannon, J., & Lee, J. D. (2013). Genetic mapping of quantitative trait loci conditioning salt tolerance in wild soybean (Glycine soja) PI 483463. *Euphytica*, *193*, 79-88.

Hamwieh, A., Imtiaz, M., & Malhotra, R. S. (2013). Multi-environment QTL analyses for drought-related traits in a recombinant inbred population of chickpea (Cicer arientinum L.). *Theoretical and Applied Genetics*, *126*, 1025-1038.

Koul, B., Srivastava, S., Sanyal, I., Tripathi, B., Sharma, V., & Amla, D. V. (2014). Transgenic tomato line expressing modified Bacillus thuringiensis cry1Ab gene showing complete resistance to two lepidopteran pests. *SpringerPlus*, *3*, 1-13.

Lv, C., Song, Y., Gao, L., Yao, Q., Zhou, R., Xu, R., & Jia, J. (2014). Integration of QTL detection and marker assisted selection for improving resistance to Fusarium head blight and important agronomic traits in wheat. *The Crop Journal*, *2*(1), 70-78.

Merchuk-Ovnat, L., Barak, V., Fahima, T., Ordon, F., Lidzbarsky, G. A., Krugman, T., & Saranga, Y. (2016). Ancestral QTL alleles from wild emmer wheat improve drought resistance and productivity in modern wheat cultivars. *Frontiers in plant science*, *7*, 452.

Ni, D., Song, F., Ni, J., Zhang, A., Wang, C., Zhao, K., ... & Li, L. (2015). Marker-assisted selection of two-line hybrid rice for disease resistance to rice blast and bacterial blight. *Field Crops Research*, *184*, 1-8.

Prasanna, B. M. (2009). Molecular markers for maize improvement in Asia. In *Correct citation: Zaidi, PH; Azrai, M. and Pixley, KV, eds. 2010. Maize for Asia: Emerging Trends and Technologies. Proceeding of The 10th Asian Regional Maize Workshop, Makassar, Indonesia, 20-23 October 2008. Mexico DF: CIMMYT* (p. 202).

Pushpavalli, R., Krishnamurthy, L., Thudi, M., Gaur, P. M., Rao, M. V., Siddique, K. H., ... & Vadez, V. (2015). Two key genomic regions harbour QTLs for salinity tolerance in ICCV 2× JG 11 derived chickpea (Cicer arietinum L.) recombinant inbred lines. *BMC plant biology*, *15*, 1-15.

Shabanimofrad, M., Yusop, M. R., Ashkani, S., Musa, M. H., Adam, N. A., Haifa, I., ... & Latif, M. A. (2015). Marker-assisted selection for rice brown planthopper (Nilaparvata lugens) resistance using linked SSR markers. *Turkish Journal of Biology*, *39*(5), 666-673.

Tashkandi, M., Ali, Z., Aljedaani, F., Shami, A., & Mahfouz, M. M. (2018). Engineering resistance against Tomato yellow leaf curl virus via the CRISPR/Cas9 system in tomato. *Plant signaling & behavior*, *13*(10), e1525996.

Yarra, R., & Kirti, P. B. (2019). Expressing class I wheat NHX (TaNHX2) gene in eggplant (Solanum melongena L.) improves plant performance under saline condition. *Functional & integrative genomics*, *19*, 541-554.

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THE DOUBLE-EDGED SWORD OF FLY ASH: ENVIRONMENTAL HAZARD OR SUSTAINABLE SOLUTION

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Abstract

Fly ash is an industrial byproduct that is acknowledged as an environmental contaminant. It is produced when coal is burned to provide energy. Due to the environmental issues that fly ash poses, a great deal of research has been done on the topic globally. Currently, about 27% of the coal fly ash produced in India is recycled and used for a variety of purposes, including land reclamation, agriculture, contraction fields, wood substitute products, soil stabilization, road bases and embankments, and the cement industry. There are environmental issues because coal combustion leftovers, a percentage of the fly ash from coal that is not used, are taking up a large amount of land. The safe handling and eventual application of coal fly ash processing are essential for ecological management and long-term development.

Key words: Fly ash, air pollution, construction, soil reclamation

Introduction

Coal continues to be a primary energy source in the rapidly industrializing world, powering both homes and businesses. However, there is an important consequence associated with this reliance on coal: fly ash. The public seldom notices this fine, powdery substance, which is created when coal is burned in power plants, yet it has a significant negative influence on the environment. But what if this industrial waste might become a hero instead of a villain for the environment. Here we discuss about the effects of fly ash and its environmental applications.

The Dark Side of Fly Ash

Fly ash is often called the "silent pollutant" because its effects are not immediately visible. But make no mistake, the repercussions are far-reaching.

Air Pollution: The Invisible Threat

Fly ash is easily propelled into the air when handled or stored incorrectly. The tiny particles have the ability to travel great distances and contaminate the air we breathe. Respiratory illnesses, cardiac issues, and even early mortality have been connected to inhaling these microscopic particles, which poses a major risk to one's health. Furthermore, heavy metals that are harmful to both humans and wildlife, such as arsenic, lead, and mercury, are found in fly ash.

Soil and Water Contamination: The Hidden Menace

Fly ash can poison our soil and water in addition to air pollution. Its disposal in landfills and storage in ponds pose a risk to the environment because of the possibility of harmful materials seeping into them. This leaching has the potential to destroy aquatic habitats and contaminate groundwater, a vital supply of drinking water. In addition to lowering soil quality and decreasing fertility, heavy metals can also have an adverse effect on agricultural production.

Land Use: The Burden of Disposal

A big problem is the disposal of fly ash. Large tracts of land are needed for storage due to the enormous volume produced. In addition to consuming priceless land, this may result in the destruction of habitats and long-term environmental harm. As demonstrated by a number of previous environmental catastrophes, large fly ash ponds have the possibility of catastrophic spills if improperly managed.

Long-Term Environmental Impact

Local ecosystems may be disrupted by the long-term environmental deposition of fly ash. Fly ash contains harmful substances that can affect microbes, plants, and animals. This can change the equilibrium of natural environments and decrease biodiversity. Fly ash from coal is produced and disposed of, which adds to greenhouse gas emissions even if it has some uses. The process of burning coal releases a lot of carbon dioxide into the atmosphere, which is one of the main causes of climate change.

Human Health Hazards

People living near coal-fired power plants or fly ash disposal sites are at a higher risk of chronic exposure to harmful substances. This exposure can lead to a range of health problems, including respiratory diseases, cardiovascular issues, and cancer. The cumulative effects of long-term exposure to fly ash pollutants are often not immediately visible but can manifest over years or even decades. This delayed impact makes it difficult to trace health problems back to fly ash exposure, adding to its “silent” nature.

Turning a Problem into a Solution: The Green Side of Fly Ash

Despite these challenges, fly ash has a surprising potential for good. When properly managed and utilized, it can be a key player in promoting sustainability.

Building a Greener World: Fly Ash in Construction

Fly ash has a lot of potential applications in the construction industry, especially in the manufacturing of cement and concrete. Fly ash can be added to cement to increase the concrete's strength and longevity. This not only uses less cement, reducing carbon emissions, but it also recycles a waste product that would otherwise end up in a landfill. Fly ash is being used as a base material in road construction instead of conventional natural aggregates. This offers a strong and affordable alternative to mining for new materials while also lessening the negative environmental effects of road construction.

Stabilizing Soils and land reclamation: From Waste to Resource

Fly ash is being utilized more and more in the field of civil engineering to stabilize soils, particularly in regions with weak or expansive soils. Engineers can increase the soil's ability to support weight and prepare it for construction by incorporating fly ash into the soil. This application stops erosion and land degradation in addition to conserving natural resources. Fly ash can be utilized in the field of land reclamation, particularly in mining-affected areas, to stabilize the ground, stop erosion, and rebuild the landscape. This aids in restoring damaged, barren land to its ability to sustain plants and wildlife.

Cleaning Up Water: Fly Ash in Wastewater Treatment

Additionally, fly ash is being used in environmental remediation projects. Because of its special qualities, it is good in adsorbing heavy metals and other contaminants from wastewater. Because of this, treating industrial effluents and protecting our water resources may be done affordably. Many studies have been done on the adsorption of NO_x, SO_x, organic compounds, and mercury in air, as well as cations, anions, dyes, and other organic matter in waters, utilizing fly ash as an alternative to commercial activated carbon or zeolites. Fly ash can be chemically treated to make it a more effective adsorbent for cleaning water and gas. Studies also showed that fly ash's unburned carbon component is crucial to its adsorption capacity.

Conclusion

Fly ash has two drawbacks. On the one hand, there are serious health and environmental hazards if it is handled improperly. Conversely, it has the capacity to play a significant role in sustainable development. Making sure that the advantages of this industrial byproduct outweigh the risks is the difficult part of handling it responsibly. Fly ash was formerly a problematic waste, but as companies and governments collaborate to create better methods for using and disposing of it, we are getting closer to a time when it can be a vital component of sustainability. One brick, one road, and one reclaimed field at a time, we can create a cleaner, greener world by seizing an opportunity presented by an environmental crisis.

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ROLE OF SENSORS & IOT IN PLANT GROWTH & DEVELOPMENT

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Introduction

Traditional farming faces challenges from harsh environments and pest infestations, leading to crop loss and economic hardship. Integrating advanced sensors with the Internet of Things (IoT) offers a promising solution to enhance agricultural production and minimize these losses. Studies worldwide demonstrate the effectiveness of IoT-smart sensors in monitoring crucial environmental factors like moisture, humidity, temperature, and soil composition, along with greenhouse gases and soil nitrogen content. These insights help farmers optimize resource usage, including fertilizer application. Additionally, IoT-enabled equipment and drones facilitate accurate surveillance of pest attacks and diseases. While smart farming holds immense potential, its widespread adoption faces hurdles like high implementation costs, data security concerns, and limited digital literacy among farmers. Special economic policies, data encryption strategies, and digital literacy programs can pave the way for a future of sustainable and efficient agriculture empowered by IoT technology.

The Evolution of Agricultural Technology

Traditionally, farmers have relied on manual observation and historical data to make decisions about planting, watering, and harvesting. While these methods have been effective, they are often labor-intensive and can lead to suboptimal resource use. The advent of sensors and IoT has revolutionized this process by providing real-time data and insights, enabling more precise and efficient farming practices.

Sensors: The Plant Whisperers

They are tiny, intelligent devices whispering secrets about your plants. They collect real-time data on soil moisture, light levels, nutrient needs, and even stress levels and are embedded in the soil, leaves, or even the air surrounding your plants. They act as tireless observers, collecting crucial information that gives us an unprecedented glimpse into the world of flora.

IoT: Internet of Things

But sensors alone are just the first act. Now, picture these tiny data-gatherers talking to each other, sharing their insights, and even taking action based on their findings! This is where the magic of IoT comes in. It acts as the conductor, connecting the sensors, analyzing their collective data, and translating it into real-time adjustments. Irrigation systems whirr to life, lights dim or brighten, and nutrient delivery systems activate, all orchestrated by the symphony of data collected by the sensors. It's like creating a personalized spa experience for your plants, ensuring they thrive in their optimal environment.

Challenges faced by Farmers

- **Cost:** Initial investment in sensors, network infrastructure, and data analysis tools can be expensive, especially for small-scale farmers.
- **Technical knowledge:** Setting up and maintaining sensor networks and analyzing data requires technical expertise that many farmers may not possess.
- **Connectivity:** Reliable internet access, particularly in rural areas, is crucial for IoT systems to function. Lack of connectivity can hinder implementation and limit effectiveness.
- **Power supply:** Sensors often require constant power, which can be a challenge in areas with limited or unreliable electricity access.
- **Security and privacy:** Concerns exist about data security and privacy, especially with regards to sensitive agricultural information.
- **Interoperability:** Different sensor and system brands may not be compatible, creating challenges in scaling up or integrating diverse technologies.
- **Maintenance and repair:** Ensuring sensor functionality and addressing repairs can be complex and require specific skills or external support.
- **Data overload:** Farmers might struggle to effectively interpret and utilize the large amount of data generated by sensors, potentially leading to information overload.

- **Lack of training and support:** Access to training programs and technical support might be limited, hindering the adoption and effective use of the technology.
- **Ethical considerations:** Concerns exist about potential negative impacts on small-scale farmers, including data ownership, control over agricultural practices, and potential corporate dominance.

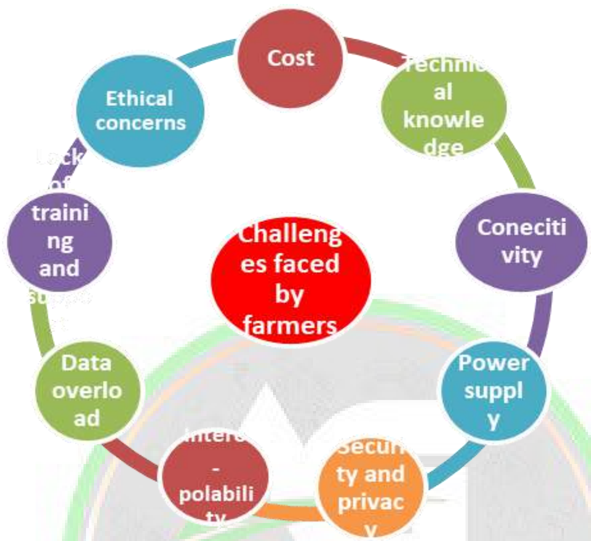

Fig: Depiction of challenges faced by farmers

Types of Sensors in Agriculture

- **Environmental Sensors:** Measure external conditions such as temperature, humidity, light, and soil moisture. These sensors help farmers understand the microclimate around their crops and make informed decisions about irrigation and crop protection.
- **Soil Sensors:** Provide data on soil health, including moisture levels, pH, nutrient content, and salinity. This information is crucial for optimizing fertilizer application and ensuring that crops receive the necessary nutrients.
- **Plant Sensors:** Monitor the physiological state of plants, including growth rates, leaf moisture, and overall health. Fiber Bragg Gratings (FBG) sensors, for instance, can detect minute changes in plant size and stress levels without causing harm.

The Role of IoT in Agriculture

The integration of IoT with sensor technology amplifies the benefits by enabling the collection, analysis, and transmission of data over the internet. This connectivity allows for:

- **Real-Time Monitoring:** Continuous data collection and immediate alerts about any deviations from optimal conditions.

- **Data Analytics**: Advanced algorithms and machine learning models process the data to provide actionable insights, such as predicting pest outbreaks or optimizing irrigation schedules.
- **Remote Control:** Farmers can control irrigation systems, greenhouse environments, and other agricultural equipment remotely, reducing labor costs and increasing efficiency.

Benefits of Sensor and IoT Integration

- **Precision Agriculture**: Enhanced accuracy in monitoring and managing crops leads to better yields and resource efficiency. Precision agriculture techniques ensure that inputs like water and fertilizers are applied precisely when and where needed.
- **Sustainable Farming:** Optimized resource use reduces waste and environmental impact. For example, targeted irrigation minimizes water usage, and precise fertilization prevents soil degradation.
- **Risk Management:** Early detection of plant stress, diseases, or pest infestations allows for timely interventions, reducing crop losses and improving overall farm productivity.
- **Cost Efficiency:** Automated systems reduce the need for manual labor and lower operational costs. Over time, the initial investment in sensors and IoT infrastructure can lead to significant savings.

Case Studies and Applications

1. **Plant Growth Monitoring by using Fiber Bragg Gratings Sensors**

   This research addresses the challenge of feeding a growing population in a changing climate by proposing new wearable sensors for plants. These sensors, made from Fiber Bragg Gratings embedded in silicone, can be attached to various plant parts without harming them. The sensors measure tiny changes in size and can even account for temperature and humidity variations. Initial tests in labs and fields show promise for using this technology to improve agriculture by monitoring plant health and optimizing crop yields.

2. **Growth and Microclimate Monitoring by using FGB Technology**

   This research highlights the importance of improving agricultural productivity for a sustainable future. It introduces a novel application of fiber Bragg gratings (FBGs) in plant wearables. Unlike existing wearables, these FBG sensors can continuously monitor both plant growth and surrounding conditions (temperature, humidity) in real-world settings. This paves the way for more precise monitoring of plant health, potentially leading to improved agricultural practices.

3. **Low Hysteresis and Fatigue-Resistant Polyvinyl Alcohol/Activated Charcoal Hydrogel Strain Sensor for Stable Plant Growth Monitoring**

   This study introduces a new type of strain sensor made from a conductive hydrogel for monitoring plant growth. This hydrogel, formed by combining activated charcoal (AC) with polyvinyl alcohol (PVA), offers several advantages over existing sensors. It has low hysteresis (minimal signal lag), high fatigue resistance (can withstand repeated bending), and good long-term stability. The authors tested the sensor by monitoring plant growth over 14 days, demonstrating its potential as a useful tool for agricultural development.

4. **Sensors for Evaluating Corn Stalk Lodging Resistance**

   Corn lodging, when stalks fall over due to wind, nutrient deficiencies, or disease, can significantly reduce crop yields. This study proposes a new method to assess corn lodging resistance in the field. The method is rapid, painless to the plant (non-destructive), and works regardless of the direction of pull (direction-insensitive). It uses a strain sensor and angle sensors to measure the force required to bend the stalk, and calculates an "equivalent force" that reflects the stalk's ability to resist bending. Tests on five corn varieties showed a strong correlation between the calculated equivalent force and the actual lodging rates observed in the field. This technique provides valuable data on a cornfield's susceptibility to lodging, allowing researchers to develop better corn varieties and agricultural practices.

5. **Biomimetic Wearable Sensor for Plant Pulse Monitoring**

   This research introduces a novel plant wearable system (IPWS) inspired by adaptive plant tendrils. The IPWS overcomes limitations of conventional sensors by using an adaptive winding strain (AWS) sensor that can securely attach to plants with waxy or hairy surfaces. This sensor, made with serpentine-patterned laser-induced graphene, is resistant to temperature changes, allowing for accurate monitoring of plant health. The IPWS system continuously tracks the plant's "pulse," reflecting water status and growth in real-time. This innovation holds promise for improved plant monitoring in agricultural applications.

6. **IoT for Growth Monitoring in Guava**

   This study describes an IoT-based system using a low-cost optoelectronic sensor to monitor the radial growth (circumference change) of fruits. The sensor utilizes a reflective tape with alternating black and white bars and an infrared sensor to detect tape movement caused by fruit growth. This design allows for continuous, long-term monitoring with minimal maintenance. Data is sent to a server for real-time analysis. Field tests showed a maximum measurement error of 2 mm and a data transfer success rate of 97.54%, indicating the system's effectiveness for plant growth monitoring.

7. IoT for Pest Management

This research presents an IoT-based system for crop protection using environmentally friendly methods. The system combines hardware (plant protection devices) and software (information management system) for real-time monitoring and control. Two types of devices are offered: ozone sterilization and light traps. Various sensors collect data on the crop environment. The software allows remote control of the devices through a mobile app, facilitating intelligent pest and disease management. This system has been successfully implemented in greenhouses and fields for crops like cucumber, tomato, and rice, demonstrating its effectiveness and practicality.

Challenges and Future Directions

While the benefits of sensors and IoT in agriculture are clear, there are challenges to widespread adoption:

High Initial Costs: The installation and maintenance of sensors and IoT systems can be expensive, particularly for small-scale farmers.

Data Management: Handling large volumes of data requires robust infrastructure and expertise in data analytics.

Interoperability: Ensuring that different sensors and systems can communicate effectively is crucial for seamless integration.

Despite these challenges, the future of agriculture lies in the continued development and adoption of sensor and IoT technologies. Advances in artificial intelligence and machine learning will further enhance the capabilities of these systems, providing even more precise and predictive insights into plant growth and development.

Conclusion

The integration of sensors and IoT in agriculture represents a significant leap forward in the quest for more efficient, sustainable, and productive farming practices. By harnessing real-time data and advanced analytics, farmers can optimize resource use, improve crop yields, and ensure food security for the growing global population. As technology continues to evolve, the potential for these innovations to transform agriculture is boundless, promising a smarter and more sustainable future for farming.

References

Lo Presti, D., Di Tocco, J., Cimini, S., Cinti, S., Massaroni, C., D'Amato, R., ... & Schena, E. (2022). Plant growth monitoring: design, fabrication, and feasibility assessment of wearable sensors based on fiber bragg gratings. Sensors, 23(1), 361.

Lo Presti, D., Cimini, S., Massaroni, C., D'Amato, R., Caponero, M. A., De Gara, L., & Schena, E. (2021). Plant wearable sensors based on FBG technology for growth and microclimate monitoring. Sensors, 21(19), 6327.

Wang, L., Zhang, Z., Cao, J., Zheng, W., Zhao, Q., Chen, W., ... & Lu, B. (2022). Low hysteresis and fatigue-resistant polyvinyl alcohol/activated charcoal hydrogel strain sensor for long-term stable plant growth monitoring. Polymers, 15(1), 90.

Guo, Q., Chen, R., Sun, X., Jiang, M., Sun, H., Wang, S., ... & Hu, J. (2018). A non-destructive and direction-insensitive method using a strain sensor and two single axis angle sensors for evaluating corn stalk lodging resistance. Sensors, 18(6), 1852.

Zhang, C., Zhang, C., Wu, X., Ping, J., & Ying, Y. (2022). An integrated and robust plant pulse monitoring system based on biomimetic wearable sensor. npj Flexible Electronics, 6(1), 43.

Slamet, W., Irham, N. M., & Sutan, M. S. A. (2018, May). IoT based growth monitoring system of guava (Psidium guajava L.) Fruits. In IOP Conference Series: Earth and Environmental Science (Vol. 147, No. 1, p. 012048). IOP Publishing.

Wang, Z., Qiao, X., Wang, Y., Yu, H., & Mu, C. (2024). IoT-based system of prevention and control for crop diseases and insect pests. Frontiers in Plant Science, 15, 1323074.

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SENNA – A PROPHETIC HERBAL MEDICINE

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Introduction

Senna, botanically Cassia angustifolia, is a member of the Leguminosae family. In Ayurveda treatment, it is extensively utilised. Because of their laxative qualities, senna leaves and pods are in high demand in Western nations. Senna was reportedly brought to south India in the early eleventh century by traders and physicians from Arabia, and farmers in Tamil Nadu began cultivating it. It is presently referred to as Tinnevelly senna since it was subsequently grown for commercial purposes in the Tamil Nadu districts of Tirunelveli and Ramanathapuram. Senna is in high demand internationally, thus Indian farmers have a fantastic chance to grow senna commercially. In 1 lakh hectares of arid and semi-arid parts of India, it is commercially grown in the districts of Tirunelveli, Madurai, Tiruchirappalli, Tamil Nadu, Andhra Pradesh, Karnataka (Mysore), Gujarat, Rajasthan, Maharashtra, West Bengal, and Tripura. An estimated 1285 tonnes of senna leaves and pods are consumed domestically each year by Indian herbal enterprises. Senna produces between 6000 and 7500 tonnes of leaves and pods a year, of which 80% are exported and bring in between 350 and 360 million. The majority of India's senna leaf exports go to countries including the US, Canada, Mexico, Australia, Japan, Germany, Italy, Thailand, and the Netherlands. On the global scenario, India is the leading manufacturer and exporter of senna. As such, it offers farmers a fantastic opportunity to cultivate senna with ease and at a reasonable cost of production. The senna is a hardy crop in general and hence it can be grown as a rainfed crop. It can withstand drought circumstances as well, and if 2-4 supplemental irrigations are given, the production and net profit will increase. Senna may be produced as a rainfed crop, needs little input, and can withstand a certain amount of saline in the soil. Senna cultivation is thus a feasible way to improve the standard of living for small and marginal farmers on waste, marginal, and difficult soils. Global markets have seen an increase in demand for organic products in recent years. Since pesticides are not used for senna production, organic senna goods represent a 30% premium above conventional senna products on the international market, making organic senna cultivation a great potential for Indian farmers.

Medicinal use

The laxative qualities of sennosides A, B, C, and D are found in senna leaves and pods. Because of its cathartic properties, it is used as a "cleansing" herb. Senna leaves are used to make herbal tea throughout Europe. Senna functions as a harmless purgative and encourages the colon's peristaltic activity when taken to treat chronic constipation. It is applied following anal-rectal surgery to guarantee smooth bowel movements and gentle instruments. Senna leaves are employed in a variety of medication compositions in the herbal industries due to their antibacterial, anti-cancer, and antioxidant qualities. In addition, it has antidysentric, expectorant, and carminative properties. It is used to treat wounds, ringworm, scabies, and eczema. Senna leaves have anti-diabetic qualities and slow down the consequences of long-term hyperglycemia. Senna leaves are used to cure anaemia, indigestion, malaria, splenomegaly, hepatomegaly, jaundice, and loss of appetite. The leaves and pods are added to medications that are prescribed for a range of common home cures. Senna leaves have benefits for the liver.

Senna is a rain-fed crop that requires little in the way of inputs to grow and can withstand periods of drought. This article goes into detail about the requirements for soil and climate, the varieties that farmers can choose from, how to prepare the land, propagate, sow, when to plant, cultural practices, control of pests and diseases, harvesting, post-harvest processing, yield, and the potential for marketing and exporting senna.

Cultivation

Soil and climatic requirement

Senna is a resilient crop that grows well in a variety of soil types. Alluvial, red, and sandy loam soils, however, are favourable for its growth. Additionally, it is grown on black cotton soils with sufficient drainage infrastructure. The optimal pH range for its cultivation is between 7 and 8.5 in soils. Furthermore, it can be grown in locations with troublesome soils, wastelands, and even areas prone to sand dunes, with little to no impact on the quantity and quality of senna leaves and pods. Red loam soils with sufficient drainage are ideal for growing it. Senna is often planted as a crop that is rainfed, while it is sometimes occasionally grown in locations that receive irrigation.

Senna is a sun-loving crop. Senna can be grown in regions with tropical and subtropical temperatures. For it to grow and thrive, the climate must be warm and humid. Regions with yearly precipitation lower than 300–400 mm are also conducive to its productive production. Although it is sensitive to water stagnation, it can withstand drought conditions. As a result, India's dry and semi-arid regions successfully farm it.

Varieties

Farmers have few options for commercial farming of senna with improved varieties. The goals of CIMAP, Lucknow, and ICAR-DMAPR, Anand, are to produce novel varieties to meet the demands of both industries and farmers. The description of the senna varieties is given in Table 1.

Variety	Description	Source of availability
ALFT-2	It is a late flowering type and produces high foliage yield. It is widely grown in Gujarat and Tamil Nadu	AAU, Anand
KKM-Sel 1	It is suitable to Killikulam and Tuticorin districts of Tamil Nadu.	TNAU, Coimbatore
Sona	It is suitable for north Indian conditions. It gives yield about 1.1 tonnes dry herbage and 0.4 tonnes seed and it contains 3.51%sennoside.	CIMAP, Lucknow

Land preparation, propagation and sowing

Senna cultivation doesn't require fine-tilth soil. Nonetheless, the ground needs to be ploughed twice; tillage tools should be used for levelling and harrowing. There should be no stubble or weeds in the field. To improve the soil's nutrient content, apply and incorporate 10–15 t of well-decomposed FYM into the soil at the time of the last ploughing. Subsequently, the field will be divided into manageable sections according to the soil's topography and land availability, making sure that adequate drainage is supplied. Seeds are used to spread senna. Senna is often planted as a rainfed crop according to the arrival of the monsoon. The best season to sow senna in western India is in the months of June through July.

Senna

Senna seeds

Senna plant

Senna field

Senna pods

Senna stem

Senna leaves

Senna leaf powder

In contrast, September through October planting is the best time to use the remaining moisture in southern India following paddy harvesting. Senna is cultivated either by line sowing or by dispersing seeds. However, line sowing outperforms broadcasting in that it makes intercultural operations easier and maximises crop stand production. In rainfed locations, 25 kg of seed is needed to grow 1 ha of land using the broadcasting method, while 12-15 kg of seed is enough to raise 1 ha under irrigated circumstances. For a 1 ha land area, about 6 kg of seed is needed using the seed dibbing method. In order to prevent infections in the seedlings during the early stages of the crop, the seed should be treated with Thiram (3g/kg of seed). To ensure optimal germination, it is important to sow the seed 1-2 cm deep into the soil. To get a high germination rate and a healthy crop stand, irrigation must be applied right away after sowing. To achieve larger yields, use the seed dibbling method and sow the seed in lines with a spacing of 45 × 30 cm.

Crop Management

Senna is grown as a rain-fed crop, although it produces larger yields when irrigation is added. During the crop period, irrigation is applied between two and four times, depending on the weather and soil moisture levels. During crop critical stages, irrigation is crucial twice a year: once right after sowing and again 30 days later if soil moisture levels are not sufficient. It is susceptible to persistently rainy days and situations where there is water logging, although it can withstand water scarcity. The output of senna is spoilt by prolonged wet days during its growth cycle. On the other hand, a little drizzle or rain throughout the crop time promotes crop development and growth. The field should be maintained in weed free condition.

After 25 to 30 days following seeding, the first weeding and thinning should be completed in order to preserve the ideal plant population. Initially, the crop grew slowly; weed competition should be considered at this time. Later, when the crop reaches a height of 20 to 25 cm, it grows luxuriantly and suppresses the weed. Applying the FYM @ 10-15 t is appropriate while preparing the land. For greater yields, application of N, P, and K in the ratio of 80:40:40 kg/ha is advised. At the time of sowing, the entire doses of P, K, and N must be administered, and the remaining half dose of N must be applied 90 days after sowing. The foliar application of micronutrients also boost growth and sennosides content. Compost enhanced with rock phosphate enhances sennosides and herbage output. Senna must be grown organically, as this is more practical and advantageous while using fewer chemicals and insecticides during production. Senna's organic products are selling for a premium on international markets.

Insect pest and disease management

Senna that is planted in soils with inadequate drainage is susceptible to the damping off disease in North and Western India. An appropriate slope should be included to drain out any extra water as a preventative measure. To stop the damping off disease, treat the seed with thiram (3g/kg of seed). Sometimes serious diseases in this crop include leaf spot caused by *Alternaria alternata* and leaf blight caused by *Phyllostica* spp. The weather, which is damp and overcast, facilitates the spread of illnesses. When there is a serious infestation, the leaves begin to dry out and fall, which severely reduces output. Pods are also impacted in the advanced stage. It is advised to apply two to three weekly applications of Ridomil at 0.15% as a preventative measure to monitor the illness. In order to prevent pesticide residues in the crop, care should be given when applying pesticides and to harvest the leaves 25–30 days after the last application. On rare occasions, severe crop loss was noted as a result of *Catopsilla pyranthe* feeding the leaves and continuing to be active from July through October. In their natural environment, *Trichogramma chilonis* has been found to significantly parasitise them. To manage this, release 1.5 lakh adult *T. chilonis*/ha/week at the same time as the pest lays its eggs.

Harvesting, post-harvest management and yield

Senna's young leaves and pods have a high sennoside content, therefore harvesting time is crucial, yet the grower must sell the produce based on weight. Therefore, when harvesting Senna, attention should be taken to maintain a balance between the weight of the output and the sennoside content in the leaves. Senna flowers at the first time two months after seeding. Pinch the initial blooming to promote additional vegetative growth and branching. The best way to harvest leaves is by manually picking them. When the leaves are completely developed, thick, and have a bluish green hue, harvesting is completed. It is best to pluck for the first time 50–70 days after seeding. The second picking is to be done between 90-100 days of sowing and the third picking should be done 130-150 days after sowing. The harvested output is made up of both leaves and pods when the complete plant is removed. To lessen the wetness, the harvested produce must be left in an open field for six to ten hours. To finish drying, the product should be left on a spotless floor or covered with a tarpaulin sheet and left in the shade for ten to twelve days. To prevent heat and maintain the light green to yellowish green colour of the dried leaves and high-quality produce, the collected produce should be turned often.

After gathering the pods, they are dried in the shade and beaten with sticks to separate the seeds. Stems and stalks are split, and the leaves are manually peeled by pounding them on the ground. To acquire quality produce, it is also beneficial to use rapid mechanical drying at 45 degrees. Subsequently, the produce is graded according to its size and colour. Larger leaves and bold, yellowish green pods are higher quality and command a premium price in the market; brownish leaves and pods are the next grade and small, broken leaves and pods are the lowest grade. Sennoside contents of 2.5% to 3.5% in leaves and 2.5 to 3.0% in pods are generally deemed acceptable by herbal industry. The seed doesn't contain sennosides and should be extracted by threshing the pods. Produce is wrapped in gunny bags, baled under hydraulic pressure in accordance with standards, and stored in dry, cold shelters with ventilation. Senna pods and 15 q/ha dry leaves were obtained under irrigated conditions; however, in rainfed conditions, 10 q/ha dry leaves and 5 q/ha dry pods could be obtained with proper management. Senna leaves are sold for 70/kg on the market, whereas pods are sold for 80/kg. The market pricing is erratic, disorganised, and subject to significant annual fluctuations.

Conclusion

Senna is a significant medicinal plant that is frequently used in traditional medicine to treat chronic constipation because of the laxative qualities of the sennosides A, B, C, and D found in its leaves and pods. It is a low-input-demand crop that is hardy. It is typically planted as a crop that receives rain and is drought-tolerant. The United States and other nations including Germany, Italy, the Netherlands, Canada, Mexico, Australia, and Japan, among others, get almost 80% of the country's exports. On the global scene, India is the leading manufacturer and exporter of senna. In Western nations, there is a growing need for natural sennosides due to the unavailability of synthetic sennosides in the market. Therefore, great opportunities exists for Indian growers to cultivate senna in the arid and semi-arid regions of India.

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FINGER MILLET: A SUSTAINABLE AND RESILIENT CROP FOR EFFECTIVE FARMING AND NUTRITIONAL ENHANCEMENT

Article ID: AG-V04-I08-60

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Introduction

Finger millet (*Eleusine coracana*) plays a significant role in promoting agricultural sustainability due to its resilience and adaptability to harsh growing conditions (Gowda & Nair, 2020). As a staple crop in the semi-arid tropics of Asia and Africa, it is valued for its nutritional benefits, drought tolerance, and low input requirements, making it a viable option for sustainable farming systems (Khedkar et al., 2020; Kumar & Singh, 2018). Its resilience under water-scarce conditions maintains agricultural productivity, reduces the risk of crop failure, and supports sustainable farming by conserving water and ensuring food security (Prasad & Sinha, 2018). Additionally, finger millet thrives in poor soils and benefits from organic fertilizers like farmyard manure and green manures, which enhance soil fertility and structure, thereby reducing reliance on chemical fertilizers and promoting long-term soil health and improved crop yields (Narasimhan, 2019).

Incorporating finger millet into crop rotation and intercropping systems helps to break pest and disease cycles, improves soil fertility, and optimizes resource use (Rao & Rao, 2019). These practices prevent soil nutrient depletion, reduce pest and disease buildup, and enhance biodiversity (Rao & Rao, 2019). Compared to major cereals such as rice and wheat, finger millet's low water requirement makes it an environmentally sustainable crop (Refer Table 1), conserving water resources in water-scarce regions and maintaining agricultural productivity (Prasad & Sinha, 2018). Furthermore, its low input needs and resilience result in a smaller carbon footprint, aligning with sustainable agricultural practices by reducing greenhouse gas emissions and minimizing the use of chemical fertilizers and pesticides (Mehta & Sharma, 2017). Growing finger millet thus supports environmental sustainability while securing livelihoods through a resource-efficient and resilient crop (Kumar & Singh, 2018).

Nutritional and Health Benefits

Finger millet is a highly nutritious crop, providing essential nutrients such as calcium (approximately 350 mg per 100 g), iron (about 3.9 mg per 100 g), and dietary fiber (around 7.6 g per 100 g) (Malleshi & Klopfenstein, 2016). These nutrients are vital for addressing nutritional deficiencies, particularly in farming communities where malnutrition is prevalent (Babu et al., 2020). The high calcium content supports bone health and may help prevent osteoporosis, while the iron content is crucial for combating anemia (Borges et al., 2018). Additionally, the dietary fiber in finger millet aids in digestive health and helps regulate blood sugar levels, contributing to overall well-being (Siddiq et al., 2021). Regular consumption of finger millet can significantly enhance health outcomes (**see Figure 1**) in regions suffering from nutrient deficiencies, thereby playing a critical role in promoting food and nutritional security for both farmers and consumers (Reddy et al., 2022). Efforts are underway to develop biofortified varieties of finger millet to further enhance its nutritional profile. Biofortification involves increasing the concentration of essential micronutrients, such as vitamins and minerals, within the crop through breeding or agronomic practices (Morris & Tanumihardjo, 2020). These enhanced varieties aim to address micronutrient deficiencies more effectively, thereby improving public health outcomes (Haas et al., 2021). The development of biofortified finger millet, with its already notable levels of calcium, iron, and fiber, increases its value as a staple crop, making it a more effective tool in the fight against malnutrition and micronutrient deficiencies (Gopalan et al., 2019).

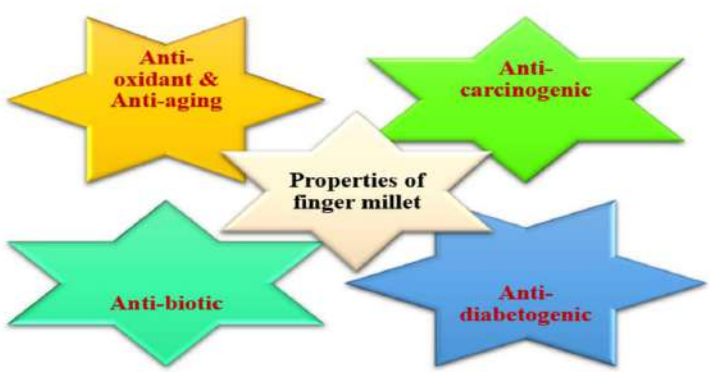

Figure 1. Properties of finger millet

Table 1. **Sustainable varieties of finger millet and their potent properties**

Variety	Potent Properties	Sustainability Features
Indaf-5	Drought-resistant, high-yielding, early-maturing	Suitable for rain-fed conditions, requiring less water compared to traditional varieties
GPU-28	High grain yield, good malting quality, resistant to blast disease	Improved disease resistance reduces the need for chemical pesticides, enhancing ecological sustainability
PR-202	High protein content, rich in calcium and iron	Nutrient-rich grain supports food security and nutritional needs, especially in resource-poor regions
KMR-204	High tillering capacity, good grain quality, tolerant to lodging	Enhanced plant structure leads to better resistance against environmental stressors, reducing crop loss
VL-149	Early-maturing, high-yielding, good resistance to drought	Reduced growth cycle allows for multiple cropping cycles per year, increasing land use efficiency
RAU-8	High grain yield, good resistance to common pests and diseases	Reduced dependency on chemical inputs due to inherent pest and disease resistance
GPU-67	High grain quality, good resistance to blast and rust diseases	Disease resistance reduces the need for fungicides, promoting a healthier environment
MR-1	High nutritional content, particularly in calcium and iron	Nutrient-dense grains support improved public health outcomes, reducing the need for external supplements
OEB-537	High yield potential, drought-resistant	Ideal for cultivation in arid and semi-arid, enhancing crop resilience to climate change
HR-911	Good grain size and quality, early-maturing	Early maturity allows for crop rotation and reduced water usage, supporting better land management practices

Benefits to The Farmers' Utility

Finger millet provides significant benefits to farmers by enhancing their livelihoods and supporting sustainable agricultural practices (Refer Table 1). It is particularly suited for low-input farming systems, thriving in conditions where other crops may falter (Nandi et al., 2021). The crop requires minimal application of fertilizers and pesticides, thereby alleviating the financial burden on farmers (Kumar et al., 2020). Its ability to grow effectively in nutrient-poor soils makes it an ideal choice for smallholder farmers with limited access to or means for expensive agricultural inputs (Reddy & Venkatesh, 2019). Additionally, finger millet's high nutritional value rich in calcium, iron, dietary fiber, and being gluten-free aligns with increasing consumer demand for health-conscious foods, opening up new market opportunities and potentially increasing farmer income (Singh & Kumar, 2021). Its versatility allows it to be marketed as food, used as animal feed, or sold as a cash crop, offering diverse revenue streams and reducing financial risks associated with reliance on a single crop (Ghosh et al., 2022). In regions such as Ethiopia, finger millet supports household food security and serves as a profitable commodity, providing farmers with better profit margins due to its low production costs and growing demand (Tadesse et al., 2021).

Biotechnological advancements in finger millet offer significant benefits to farmers by enhancing crop productivity and sustainability. Genetic modification and marker-assisted breeding have led to the development of high-yielding varieties with improved grain quality, which directly boosts economic returns (Patel et al., 2022). Enhanced drought tolerance through biotechnological interventions is particularly valuable for farmers in arid and semi-arid regions, ensuring stable yields under water-scarce conditions (Srinivas et al., 2023). Additionally, the development of disease and pest-resistant varieties reduces the reliance on chemical pesticides, thereby lowering production costs and minimizing environmental impact (Desai et al., 2021). Biofortification techniques have improved the nutritional profile of finger millet by increasing essential micronutrients like iron, zinc, and calcium, thereby providing farmers with a market advantage for nutritionally superior products (Ravi & Yadav, 2020). Furthermore, these advancements can reduce input requirements, such as fertilizers and water, promoting cost-effective and sustainable farming practices (Basu et al., 2022). Enhanced adaptability to diverse environmental conditions also broadens the crop's suitability across various agro-ecological zones, supporting more widespread adoption and contributing to improved livelihoods and resilient agricultural systems (Chowdhury et al., 2023).

References

Babu, A., Kumar, V., & Singh, R. (2020). Nutritional benefits and potential of finger millet: A review. Food Reviews International, 36(4), 303-315. https://doi.org/10.1080/87559129.2020.1813589

Chowdhury, S., Patel, R., & Kumar, R. (2023). Adaptation of finger millet to different agro-ecological zones. Field Crops Research, 281, 113-122. https://doi.org/10.1016/j.fcr.2022.108589

Desai, D., Rao, S., & Reddy, N. (2021). Disease and pest management in finger millet through genetic modification. Crop Protection, 139, 105323. https://doi.org/10.1016/j.cropro.2020.105323

Gowda, S. S., & Nair, K. S. (2020). Finger millet (*Eleusine coracana*) cultivation in semi-arid regions: A sustainable approach. Agricultural Systems, 179, 102762.

Khedkar, R., Shinde, K., & Deshmukh, S. (2020). Nutritional benefits of finger millet (*Eleusine coracana*): A review. Food Chemistry, 315, 126259.

Kumar, S., & Singh, S. P. (2018). Finger millet: An underutilized crop with immense potential. Journal of Sustainable Agriculture, 12(4), 45-60.

Mehta, R., & Sharma, A. (2017). Finger millet cultivation in Ethiopia: Impact on food security and economic stability. African Journal of Agricultural Research, 12(8), 547-556.

Morris, S. S., & Tanumihardjo, S. A. (2020). Biofortification: A new approach to improve the micronutrient status of populations. Food and Nutrition Bulletin, 41(2), 133-142. https://doi.org/10.1177/0379572120916089

Nandi, A., Tripathi, A., & Patel, R. (2021). Finger millet as a sustainable crop for semi-arid regions. Journal of Sustainable Agriculture, 45(4), 567-580. https://doi.org/10.1080/09709274.2021.2006523

Prasad, R., & Sinha, R. (2018). Water use efficiency and environmental benefits of finger millet compared to rice and wheat. Environmental Management, 62(3), 527-537.

Rao, S., & Rao, S. P. (2019). Economic viability and market potential of finger millet in India. Agricultural Economics Research Review, 32(2), 99-111.

Reddy, N., Kumar, S., & Rao, A. (2022). Enhancing the nutritional quality of finger millet: Current trends and future prospects. Plant Foods for Human Nutrition, 77(1), 42-53. https://doi.org/10.1007/s11130-022-01085-3

Singh, R., & Kumar, P. (2021). Nutritional and agronomic benefits of finger millet: A review. Journal of Cereal Science, 98(3), 112-120. https://doi.org/10.1016/j.jcs.2021.103456

Srinivas, B., Rao, N., & Suresh, K. (2023). Enhancing drought tolerance in finger millet through genetic engineering. Plant Science, 325, 111322. https://doi.org/10.1016/j.plantsci.2022.111322

Tadesse, T., Alemayehu, M., & Gebremariam, M. (2021). The impact of finger millet on food security in Ethiopia. African Journal of Agricultural Research, 16(4), 56-67. https://doi.org/10.5897/AJAR2021.1532

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CRIJAF SONA MICROBIAL CONSORTIUM- A BLESSING FOR JUTE FARMERS

Article ID: AG-VO4-I08-61

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Introduction

Retting of jute is a kind of fermentation process in which the cortical and phloem tissues of the bark of the plants containing free strands are decomposed to separate fibre from non-fibrous woody stem. Retting is best carried out in slow moving soft water, which is rarely available in various jute growing states. More than 90% of jute growers ret the jute plants in stagnant water following conventional method of retting using mud and banana plants as covering material. The repeated retting of jute and mesta in the stagnant water of same natural retting tank lead to the production of inferior quality fibre unless the is recharged with fresh water after each retting. To overcome this problem, use of talc based CRIJAF Sona in stagnant water was found suitable not only for the reduction of retting duration by 6 to 7 days but also for the improvement in fibre quality by at least two grades. CRIJAF Sona is a a talc-based microbial formulation consisting of three different strains of pectinolytic bacteria *Bacillus pumilus* which aids in easy retting and results in good quality retted fibre.

Merits:

- 4 Kg CRIJAF Sona required for retting of jute from 1 bigha area.For the second retting in the same stagnant water, the need of microbial formulation will be half of the amount required for first retting.
- Retting duration reduced by 6 to 7 days.
- Improved productivity by 8-10% because of reduction in retting period.
- Fibre quality is improved by at least 2 grades over conventional method.
- The shelf life of the formulation is 6 months.

❖ This microbial formulation is user friendly and does not have any adverse effect on plant, animal and human health.

Many Farmers fron the jute growing areas of West Bengal, Orissa,Bihar, Assam are using CRIJAF SONA for jute retting and have reported its success.

Success story-1

Name of the farmer: Goutam Bogi
Village :Basudebpur
Block: Barrackpore-I
District: North 24 Parganas

I have 15 bigha of land where I cultivate jute crop. I came to know about CRIJAF Sona from the demonstration conducted by ICAR-CRIJAF in our locality during 2021-22. I was impressed by the results. I adopted the technology in 2022. There was shortage of water required for retting during August 2022 . I could ret my jute in low amount of water using CRIJAF Sona. The fibre obtained was of high quality than my counterparts. I sold my jute fibre at the rate of Rs 7200 per Quintal which was around Rs 450 more than other farmers. I also have observed that the fibre recovery is more when CRIJAF Sona is used. I would recommend this technology to my fellow farmer friends as it is cost effective, natural based and obviously gives more returns to farmer.

Success Story-2

Name of the farmer: FatikBiswas

Village :Ratanpur

Block: Amdanga

District: North 24 Parganas

I have 8 bigha of jute crop field. In our village there is only stagnant water available for retting. Our jute fields are in low lying areas and water get stagnated in the field by the middle of july month provided there is enough rain. Most of the farmers in my village harvest jute and ret in the water stagnated in the field itself. We used to get dark coloured or black fibre and it fetched very low price. I came to know about CRIJAF Sona, its application and results from the hands on training conducted at our village by ICAR CRIJAF.

I have adopted the technology in the year 2022, and got very good results. I could reduce the retting time by the use of CRIJAF Sona and also received golden fibre which fetched a bumper price for me. I could earn an additional income of Rs 350 to 500/quintal of fibre sold. Jute cultivation can be made more profitable with application of CRIJAF Sona during retting.

Success Story-3

Name of the farmer: Shyamal Sarkar

Village :Beraberia

Block: Amdanga

District: North 24 Parganas

I have around 15 bigha of land where I cultivate jute crop. When I saw with my eyes the quality of fibre obtained as a result of application of CRIJAF Sona, I didn’t think twice to adopt the technology. After putting up maximum effort in cultivating jute, many farmers fail to reap the profit from jute because of poor retting and low quality fibre. The introduction of CRIJAF Sona is a boon to jute farmers who have only stagnant water available for retting. I have adopted this technology and in the very first year could see marvellous output. My golden fibre got a bumper price of Rs 8000 per quintal of jute fibre when the price received by other farmers were around 7400 to 7600 Rs per quintal of jute fibre. In addition to the increased price received for jute fibre, I also observed that the fibre recovery after using CRIJAF Sona was around 10 percent more.

Extraction became more easier after using CRIJAFSona and only 9 number of labour spent for extraction of jute fibre from one bigha area, which is one number less than the labour required for traditional retting of the jute fibre from same area. Altogether, I received an additional profit of Rs 3500 per bigha from jute cultivation only because of the adoption of CRIJAF Sona. I suggest all my fellow farmers to use CRIJAF Sona for retting so that the income from jute cultivation can be augmented.

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TAMILNADU: TRADITIONAL RICE VARIETIES AND HEALTH BENEFITS

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Introduction

Rice is the major food crop grown in India, predominantly with the richness of varietal diversity with respect to seasonality, geographical distribution, and water resource availability. Rice is the important crop cultivated in the region with respect to the favourable environment, consumers, market, rice-based food and value chain, and economic gain. In earlier days, people grew traditional varieties that were familiar to the farmers with different ecological, seasonal, and food qualities and uses. In the eastern part of India, from Kamrup to Kanyakumari, rice has been growing with genetic diversity and commonly many sub-centres of origin, as claimed The use of rice is a very common food with dietary needs to Ayurvedic medicine and fodder for cattle in the region. Old farmers were familiar with the unique varietal knowledge and their uses.

After famine, independent focus on breeding and adoption of the nutrient-responsive high-yielding, semi-dwarf, non-logging varieties was more to eradicate the hunger and feed the growing population, while gradually farmers shifted to the high-yielding and hybrid varieties looking to the yield and direct economic benefit and white rice preference by the consumers and demand in the market, which led to a reduction in the cultivation of traditional varieties due to low yield and lack of the chemistry of the old varieties. After the development of the chemistry of aromatic rice, black rice, brown rice, red rice, or high protein, zinc, iron, calcium, low glycaemic index, etc., or medicine, stand more behind and lose the important varieties. Now, after understanding the indigenous traditional knowledge system on rice and looking back and trying to collect, explore, and conserve the available traditional varieties following the traditional knowledge system with the regional and global sustainability goal.

The traditional rice varieties of Tamil Nadu

1. Karuppu Kavuni / Black Kavuni Rice

It is commonly known by the name Emperor's rice. It is also known as purple rice or Forbidden rice. The reason why this type of rice is called by royal terms is that, it enriches the health and ensures the longevity.It is used to prepare varieties of desserts during ancient times. Earlier in those days, one has to get consent from the royals to consume it, as it is believed that it cures almost all the body related problems.

It is said that China was the first to use this type of rice. The black color pigmentation is due to the presence of anthocyanin in it, which is normally present in blueberries and blackberries. It has a nutty flavor. Since they are very rich in phytonutrients, consuming it shields you from major risks of heart, intestinal problems, liver problems and much more.

Alternative Names: Forbidden rice| Karuppu Kavuni Arisi | Black Kavuni Rice

The duration required to yield: 175-190 days

Health Benefits:

- Black rice is highly rich in Fibre content
- This type of rice has highest level of antioxidants than any other type of rice variety. As we know antioxidants helps to fight the free radicals (Causes damages to the tissues and cells) which are released from the human body. It also reduces inflammation.
- Consuming black rice on regular basis, reduces the risk of Asthma
- It acts as a wonderful Detox for liver
- It also helps in prevention of diabetes.
- It absolutely reduces atherosclerosis – Consuming Black rice helps in removal of fatty materials which gets deposited in the inner walls of arteries. It also prevents the disease which arises due to this.
- It entirely controls the Hypertension
- It completely reduces cholesterol (LDL – Low-density Lipoprotein cholesterol, which is bad cholesterol)
- It helps in preventing Cancer
- It improves the digestive system

- It enhances the growth of hair and increases eye sight.

- It helps in preventing Cancer
- It improves the digestive system
- It enhances the growth of hair and increases eye sight.

Recipes:

- Idly,Dosa,Puttu,Plain rice for Meals,Black rice Risotto

2. Mappilai Samba Rice:

It is one of most popular varieties of rice, grown in Tamil Nadu, India. This type of rice is well suited for organic farming. The best part is that, it doesn't require any kinds of manure and fertilizers. It is rich in medicinal value. Typically the rice is red in color. The name Mappillai was given to this type of rice after a famous tradition, where a bridegroom (Mappillai in Tamil) is asked to lift a heavy rock just to express his valiance. In order to gain energy for doing this action, the bridegroom is given the cooked rice to strengthen his energy. Even today, this tradition is being followed in many parts of Tamil Nadu.

Alternative Names: Bridegroom rice | Mappillai Samba Rice

The duration required to yield:155-160 days

Health Benefits:

- Mappillai Samba is rich in Iron and Zinc. It induces the production of Hemoglobin and Myoglobin. These two are oxygen binding proteins that help to deliver oxygen to tissues and muscles; thereby your body stays energetic. Since it contains pro-anthocyanin, it controls high blood sugar level (Hyperglycaemia) and reduces cholesterol. Apart from Iron and Zinc, it contains manganese, phosphorus, molybdenum, magnesium. Yet, it doesn't possess sodium and calcium.

- It is high in fibre which helps in easy digestion. Hence it lowers the heart risks, obesity related problems and helps in a healthy digestive system.
- It helps the persons who are suffering from celiac disease to completely recover from it. Since rice is glutton/wheat free, it is highly recommended for these types of hereditary problems.
- It increases haemoglobin content in the blood
- It has numerous Micronutrients and hence consuming it gives enough vital nutrients required to strengthen the body. Vitamin B1 is abundantly present in this type of rice which helps in preventing stomach problems and ulcers.
- This rice when consumed, avoids mixing of glucose in the blood stream when compared to the consumption of other rice varieties. Thus, it is best suited for diabetic patients. Since it enhances energy level and induces growth, it is commonly given to kids.
- It improves the sexual activities. Consuming it helps men to last long in bed.
- It helps in nourishing vein, muscles, nerves and blood.
- Excessive cholesterol in the body may block the blood circulation which eventually leads to heart attack. Consuming it helps in lowering the Cholesterol level in your body.
- It contains 3 grams of dietary fibre, approximately 48 grams of Carbohydrates and 8% protein in every 50 grams served

Recipes:

- Dosa,Pancakes,Plain rice,Idly,Upma,Pongal

3. ORGANIC POONGAR BOILED HAND POUNDED RICE

This type of rice has more iron, magnesium and zinc compared to other colored grains. It has got a nutty flavor.

The color of the rice is slightly reddish and the reason for that is the presence of anthocyanin in it. As we know antioxidants helps to fight the free radicals (Causes damages to the tissues and cells) which are released from the human body.

As the name indicates these rice are hand pounded and doesn't involve any machines in it.

Since we have completely ceased consuming traditional foods, normal human body absorbs all hazards and we become ill easily.

Now it is time to come back to the traditional rice intake which helps our entire race to flourish.

Alternative Names: Poongar rice – Poongar Arisi | Organic Poongar Rice

The duration required to yield:110-120 days

Health Benefits:

- Apart from Iron and Zinc, it contains manganese, phosphorus, molybdenum, magnesium
- It is wonderful cure for Women's Hormonal problems. It Enhances stamina and boosts the immune system
- It is highly recommended for pregnant women and lactating mothers, as it provides strength to the body. It is normally given to them in the form of Kanji (Porridge)Vitamin B1 is abundantly present in this type of rice which helps in preventing stomach problems and ulcers.
- It increases hemoglobin content in the blood
- When consumed as Pazhaya Soru/Neeragaram (locally termed as Ice Briyani), we would get enough nutrients and vitamin B complex.
- It provides strength to the body and controls/prevents from paralysis
- It has numerous micronutrients and hence consuming it gives enough vital nutrients required to strengthen the body
- It helps the persons who are suffering from celiac disease to completely recover from it. Since rice is glutton/wheat free, it is highly recommended for these types of hereditary problems.
- It contains 3grams of dietary fiber, approximately 48 grams of Carbohydrates and 8% protein in every 50grams served.
- This rice when consumed, avoids mixing of glucose in the blood stream when compared to the consumption of other rice varieties. Thus, it is best suited for diabetic patients.It kicks out bad sweat developed in our body.

- Consuming this type of rice on a regular basis, baby will be hale and healthy when born.
- Excessive cholesterol in the body may block the blood circulation which eventually leads to heart attack. Consuming it helps in lowering the Cholesterol level in your body.It is high in fiber which helps in easy digestion.
- It also lowers the heart risks, obesity related problems and induces appetite.

Recipes:

- Soft Idlies,Dosa,Plain rice

4.KATTU YANAM RICE

Kattuyanam Rice is one of Popular Rice in Tamilnadu, India. Once Seeding process is done Farmers will go for harvest only. It doesn't need manure or Fertilizers. Even elephant can hide inside crop cultivated area. Hieght of plant is that much.

Alternative Names: Kattuyanam, par-boiled Rice | Kattu Yanam Rice

The duration required to yield:125-130 days

Health Benefits:

- It is rich in calcium , minerals , vitamins, potassium and magnesium.
- Kattu Yanam is one of the red rice varieties.
- This unpolised rice improves heart health and decreases cholesterol
- This rice has a high fibre content which enhances digestion.
- It is Par-Boiled rice. It is also called as "the enemy of diabetes".

RECIPES

- Dosai,Kanchi,Idly,Rice Varieties like Briyani

5. Bamboo Rice / Moongil Rice:

It is one of most popular varieties of rice, grown in India Forest. This type of rice is well suited for Forest farming. The best part is that, it doesn't require any kinds of manure and fertilizers. It is rich in medicinal value. Bamboo Rice taste like Wheat

Alternative Names: Mungil rice | Moongil Rice | Bamboo Rice

The duration required to yield:30 – 40 years

HEALTH BENEFITS

- It is considered to be a healthier option for diabetics, due to its Low Glycemic Index.
- It also strengthens and energises the body.
- Rich in Vitamin B6, Calcium, Potassium and Phosphorus content.
- It reduces and relieves joint pains and diseases such as rheumatoid arthritis.
- It lowers cholesterol levels
- Slightly sweet in taste and generally cooked like any other rice.
- Before Cooking, Please soak this rice for at least 12 hours before cooking. If it is cooked in a pressure cooker, then leave for 6 to 8 whistles.

RECIPES

- Dosa,Plain rice,Idly,Kichidi,Payasam

6. KICHILI SAMBA

The name Kichili was derived because of its natural fragrance like citrus fruit. It is always known by the name GEB 24 or Kichadi Samba. It is the mother DNA to all the popular IR varieties of rice.It is 135 – 140 days crop and shows a steady growth up to 3 feet. The rice is small in size and it is cultivated organically. This type of crop requires less fertilizer and mostly grown in Kancheepuram, Sirkazhi and Thiruvannamalai, Tamil Nadu.There are a few variants in this type of rice. But some of them are prominent, which are Ahttur Kichili Samba, Arcot Kichili Samba and Ottu kichili Samba.This type of rice has a unique flavor which improves the taste of curries and sambar when consumed together.This type of rice has been consumed by the royal family in ancient days.

Alternate Names: Kichili Samba Rice | Attur Kichili Samba| Rice

The duration required to yield:140 days

HEALTH BENEFITS

- It is easily digestible
- Consuming this type of rice is highly suitable for diabetes patients, since it has relatively low Glycaemic Index value of 50
- It helps in Strengthening of body and muscles
- Makes skin look glossy
- It boosts the immune system and keeps us away from various diseases

RECIPES

- Plain rice,Briyani,Sweet kozhukattai (Steam rice dumplings)
- Suitable for preparing tiffin

7.*THUYAMALLI *Rice

As the name indicates in Tamil, Thuyamalli is Thuya (Pure) + Malli (Jasmine), pure jasmine. The reason why pure Jasmine was given to this type of rice is just because of its resemblance of the bud of Jasmine flower. Further this rice type doesn't require much pesticide. It is one of the indigenous rice variety of TamilNadu.It is a pear colored and it is milled rice. Now is the trend is eating polished rice like Ponni. Having said that, there are people, who are still following our ancestor's footsteps and consuming our traditional rice varieties. But, only certain types of food create the fondness, when tasted it once. Thuyamalli rice is one among them. It is seen to be grown in Kalapaganur village of Salem district. There's a quote in Tamil "Unave Marunthu" which means "Food is Medicine" – Tamil ancestors were living a healthy life by in taking nutritious foods. Now is the golden time for us to return back to our healthy eating life style.

Alternative Names: Thooyamalli rice| Rice

The duration required to yield:130-140 days

HEALTH BENEFITS

- It not only strengthens the Nervous system, but keeps the entire nerves in the body to be active.
- It prevents diabetics completely
- It is pretty simple to cook and helps is easy digestion
- Helps the skin to be free from wrinkling and keeps it hale and healthy
- Eating this rice, helps us to be active both physically and mentally
- One of the best benefit is, it prevents the internal organs from quick ageing.

RECIPES

- Briyani
- Idly – Idlies made using this rice are really gorgeous. A proven fact. You could try confirming it
- Dosa,Plain rice,Lemon rice,Tomato rice,Tiffin items

8. Seeraga Samba Rice

Having TamilNadu as native, Seeraga Samba (Seera) is the most expensive rice grown. It has ovular grain and has a distinct taste with starch flavour.

The grain is much harder than the other types. On the contrary, it looks less fluffy and loose when cooked.

Alternative Names: Jeera Samba |Samba Rice

HEALTH BENEFITS

- It helps in fighting cancer – Since this type of rice has selenium in it, consuming it prevents the occurrence of colon and intestinal cancer.
- It has higher Calorific value
- It is highly rich in fiber and anti-oxidants. This helps to eradicate free radicals from the intestinal tract and colon.
- It reduces and controls the cholesterol level – It means that this type of rice reduces bad cholesterol called LDL (Low-density Lipoprotein cholesterol) and increases good cholesterol called as HDL (High-density Lipoprotein cholesterol) in your body
- It acts as a shield to the heart and strengthens it.
- Since this type of rice has ample amount of phytonutrients in it, consuming it helps women to be free from breast cancer.
- It is easy to digest and helps to get rid of constipation

RECIPES

Plain rice, Briyani. any moment. For that purpose, please f

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MUSHROOMS OF RUBBER PLANTATIONS: A PHOTOGRAPHIC JOURNEY

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Abstract

This report presents observations of five distinct mushroom species found in the rubber plantations of Kanyakumari District, Tamil Nadu, India. The identified mushrooms include Turkey Tail (*Trametes sp.*), Fringed Sawgill (*Lentinus sp.*), Dyeball or Horse Dung Mushroom (*Pisolithus sp.*), Oily Waxcap (*Hygrocybe sp.*), and Ear Wood Mushroom (*Auricularia sp.*). These fungi thrive in the plantations due to the high humidity and organic-rich conditions provided by the decaying rubber tree wood. The findings highlight the diversity of fungal species within these plantations and provide insight into how the local environment supports such biodiversity.

Introduction

Mushrooms play a crucial role in the decomposition of dead materials, which is essential for maintaining the health of the Earth. They are the fruiting bodies of fungi and contain spores, which are the reproductive cells of these microorganisms. This article explores the diversity of mushrooms in rubber plantations in Kanyakumari district, Tamil Nadu, India, and the conditions that favor their growth. Most basidiomycete fungi require high relative humidity to produce mushrooms. Kanyakumari, located at the southern tip of India and situated near the confluence of the Arabian Sea, the Bay of Bengal, and the Indian Ocean, experiences high relative humidity. Consequently, this region supports a rich diversity of mushrooms. In this article, we will examine five types of mushrooms found in this area: the Turkey Tail mushroom (*Trametes sp.*), the Fringed Sawgill mushroom (*Lentinus sp.*), the Dyeball or Horse Dung mushroom (*Pisolithus sp.*), the Oily Waxcap (*Hygrocybe sp.*), and the Ear Wood mushroom (*Auricularia sp.*).

Turkey Tail mushroom (*Trametes sp.*)

Appearance: The Turkey Tail mushroom is known for its distinctive, colourful, fan-shaped fruiting bodies that resemble the tail feathers of a turkey. The surface is often decorated with concentric zones of different colours, ranging from brown and beige to vibrant shades of blue and green. The underside features tiny pores rather than gills.

Figure 1 Turkey Tail mushroom (*Trametes sp.*)

Habitat and Distribution:

Habitat: *Trametes species* are commonly found on dead or decaying wood, particularly hardwoods, and are saprotrophic fungi that help in the decomposition process.

Distribution: They are widely distributed and can be found in temperate forests around the world, including North America, Europe, and Asia.

Favourable Conditions:

Climate: Turkey Tail mushrooms thrive in environments with high humidity and moderate temperatures. They can grow in a variety of climatic conditions, but they prefer areas that are not too dry.

Substrate: They grow on decaying wood, including logs, stumps, and fallen branches. The presence of decomposing organic matter is essential for their growth.

Season: They typically fruit in the cooler months, often in autumn and early winter, but can be found year-round in mild climates.

Ecological Role:

Decomposition: Turkey Tail mushrooms play a vital role in breaking down lignin and cellulose in wood, contributing to nutrient cycling in the ecosystem.

Biodiversity: By decomposing wood, they help create habitats for other organisms and contribute to the overall health of the forest ecosystem.

Fringed Sawgill mushroom (*Lentinus sp.*)

Appearance: The Fringed Sawgill is characterized by its distinctive gills that are fringed or serrated. The cap is typically convex to flat and can vary in color from pale brown to dark brown. The edges of the cap often have a fringed or "saw-like" appearance, which is a defining feature of the species.

Figure 2 Fringed Sawtail mushroom (Lentinus sp.)

Habitat and Distribution:

Habitat: This mushroom is usually found growing on dead or decaying wood, particularly on logs and stumps in forested areas. It is a saprotrophic fungus, playing a role in breaking down organic material.

Distribution: *Lentinus species* are distributed globally and are commonly found in tropical and temperate forests.

Favourable Conditions:

Climate: Fringed Sawgill mushrooms prefer high humidity and moderate temperatures. They thrive in environments where moisture is consistently available, as this supports their growth and fruiting.

Substrate: They require decaying wood for growth, making forests and plantations with abundant dead wood suitable habitats.

Season: They can fruit during the warmer months, but in regions with stable humidity, they may appear year-round.

Ecological Role:

Decomposition: As a decomposer, the Fringed Sawgill plays a crucial role in breaking down wood and recycling nutrients back into the soil, contributing to ecosystem health.

Biodiversity: By decomposing organic matter, they help create microhabitats for other organisms and support overall forest biodiversity.

Dyeball or Horse Dung mushroom (*Pisolithus sp.*)

Appearance: The fruiting body of *Pisolithus species* is typically rounded and irregular, with a rough, warty surface. The color can range from yellowish-brown to dark brown. It often resembles dung, which is why it's commonly referred to as the Horse Dung Mushroom. The term "Dyeball" comes from its historical use in dyeing.

Figure 3 & 4 Dyeball or Horse Dung mushroom (Pisolithus sp.)

Habitat and Distribution:

Habitat: This mushroom is found on decaying wood, dung, and in soil rich in organic matter. It is often associated with mycorrhizal relationships with plant roots, helping to decompose organic material and contribute to nutrient cycling.

Distribution: *Pisolithus species* are widespread and can be found globally in tropical, subtropical, and temperate regions. They thrive in various environments, including forests, plantations, and disturbed areas.

Favourable Conditions:

Climate: Prefers high humidity and moderate temperatures. It thrives in environments where moisture is consistently available.

Substrate: Grows on decaying wood, dung, and in soil with abundant organic matter. The presence of such substrates is crucial for its development.

Season: Can fruit during warmer months but may be present year-round in suitable conditions with consistent moisture.

Ecological Role:

Decomposition: Plays a significant role in breaking down organic matter, including dung and decaying wood, recycling nutrients back into the soil, and contributing to ecosystem health.

Mycorrhizal Association: Forms beneficial relationships with plant roots, aiding in nutrient uptake and improving soil health.

Oily Waxcap (*Hygrocybe sp.*)

Appearance: The Oily Waxcap is known for its distinctive, waxy appearance and vibrant colors. The cap is typically convex to flat, and can be smooth or slightly sticky to the touch, often appearing shiny or oily. The colors can range from bright yellow, orange, to red, depending on the species. The gills are usually well-spaced and may be of a similar or contrasting color to the cap.

Figure 5 & 6 Oily Waxcap mushroom (*Hygrocybe sp.*)

Habitat and Distribution:

Habitat: This mushroom is commonly found in grassy areas, including meadows, lawns, and forest clearings. It can also grow in disturbed soils and areas with a lot of organic matter. It prefers moist environments.

Distribution: *Hygrocybe species* are distributed across temperate and subtropical regions worldwide. They can be found in various habitats, including forest floors, grasslands, and sometimes in urban environments.

Favourable Conditions:

Climate: Prefers cool, moist conditions with high humidity. It is often found in areas with moderate to high rainfall.

Substrate: Grows on soil, particularly in grassy or mossy areas. It can also be found on decaying plant matter.

Season: Typically fruits in the cooler months, such as autumn and early winter, but in regions with stable humidity, it might appear year-round.

Ecological Role:

Decomposition: *Hygrocybe species* contribute to the decomposition of organic material in their environment. They play a role in breaking down plant matter and contributing to nutrient cycling in the soil.

Biodiversity: By thriving in a variety of habitats, they support ecosystem health and contribute to the biodiversity of fungal communities.

Ear Wood mushroom (*Auricularia sp.*)

Appearance: The Ear Wood Mushroom is characterized by its ear-shaped, gelatinous fruiting bodies. The cap is typically thin, translucent, and wavy or lobed, resembling an ear. It can vary in color from brown to black or dark gray. The surface is often smooth or slightly wrinkled, and the texture is gelatinous and flexible.

Figure 7 Ear Wood mushroom (*Auricularia sp.*)

Habitat and Distribution:

Habitat: Auricularia species are commonly found on decaying wood, particularly on dead or dying trees. They often grow in moi st, shaded environments like forests and woodlands.

Distribution: *Auricularia species* are distributed across temperate and tropical regions worldwide.

Favourable Conditions:

Climate: Prefers high humidity and moderate temperatures. It thrives in environments with consistent moisture and shade.

Substrate: Grows on decaying wood, including logs, stumps, and branches. The presence of decaying organic matter is essential for its growth.

Season: Often fruits in the cooler, wetter months but can be found year-round in suitable conditions with stable humidity.

Ecological Role:

Decomposition: Auricularia plays a crucial role in breaking down wood and recycling nutrients back into the ecosystem. It helps decompose dead plant material, contributing to soil health and nutrient cycling.

Biodiversity: By decomposing wood, it creates habitats for other organisms and supports overall forest biodiversity.

Conclusion

The presence of Turkey Tail (*Trametes sp.*), Fringed Sawgill (*Lentinus sp.*), Dyeball or Horse Dung Mushroom (*Pisolithus sp.*), Oily Waxcap (*Hygrocybe sp.*), and Ear Wood Mushroom (*Auricularia sp.*) in the rubber plantations of Kanyakumari District illustrates the rich fungal diversity in this region. The favourable conditions created by the humid climate and decaying organic matter from rubber trees support the growth of these species. These observations contribute to a better understanding of the ecological dynamics within rubber plantations and emphasize the importance of maintaining such environments to support fungal diversity and ecosystem health.

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CHRYSANTHEMUM- HARDY HERBACEOUS PERENNIALS

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Introduction

The specialist will spend endless time over his chrysanthemums to get large and perfectly- shaped blooms, probably for exhibition, but there is no good reason why you should not have more, though smaller, flowers to decorate the border in the autumn and early winter (September to November). There is a choice of four different groups.

Early Summer (May)

Continue to hoe weeds regularly to prevent them getting a hold and making the borders unsightly. Take care not to damage any shallow-rooting cultivated plants. Dig a spare corner in the garden, firm it by treading, and rake the soil to a fine tilth to make a seedbed for sowing biennials for flowering next year.

To help healthy growth of hardy herbaceous perennials, as well as spring-flowering bulbs, water them from time to time with liquid fertilizer. Start planting out chrysanthemums in positions prepared for them previously.

Climbers that have finished producing their spring flowers should have their flowering wood pruned out. If there are any weeds on the lawn, either treat it overall with a weedkiller or spot-treat individual weeds if there are only a few. Complete the sowing of hardy annuals where they are to flower.

Single

True singles have only one row of outer petals (called ray florets) which are long and thin-and an eye (which consists of daisy florets). The species that forms this group is *Chrysanthemum rubellum,* sometimes known as C. *erubescebs*. It covers itself with masses of pink daisies about 5 cm or more across. Each flower is on a long stem, so that the plant is also.

Useful for cutting. The whole plant may grow about 90cm high. There are a number of different coloured forms now available.

Korean

The Koreans are similar to singles in that they have a central eye, but in fact they are semi-doubles – that is, they usually have more than one row of outer petals.

The flowers are again about 5cm wide, and come in a number of colours, of which crimson and dark purple are the most common, though shades of apricot, salmon pink, yellow and bronze are also available. These are not always easy to obtain but if you can get them, they usually make a very brilliant display in mid autumn (September).

Pompon

As far as display in the border goes, you probably cannot do much better that the pompons. These produce large numbers of small, tight flowers, looking rather like powder puffs, that can be obtained in almost all colours from white to pink, red, purple and yellow. There are now some very attractive pastel shades in pale shell pink. It is a little difficult to suggest particular varieties as so-call 'improved' types are constantly being introduced and any list of names can soon become out of date. It is best to visit a chrysanthemum show, join a chrysanthemum society, or visit a specialist nursery. You can also study catalogues, so long as you bear in mind that nurserymen tend only to mention the most desirable features in their particulars. If you live in a town, a talk with someone in the Parks Department could well prove informative.

Decorative

Ordinary chrysanthemums that are grown for border ornament are becoming increasingly hard to obtain and you may well find that you have to get the outdoor decorative. These have actually been bred to make many-petalled, large show blooms, which must be specially grown and disbudded. On the other hand, if you do get a chance to get hold of varieties such as Garden White or Memento (White), Golden Orfe or Solley (Yellow) and Hilde or Pink Glory (pink), then do so without hesitation.

Routine care

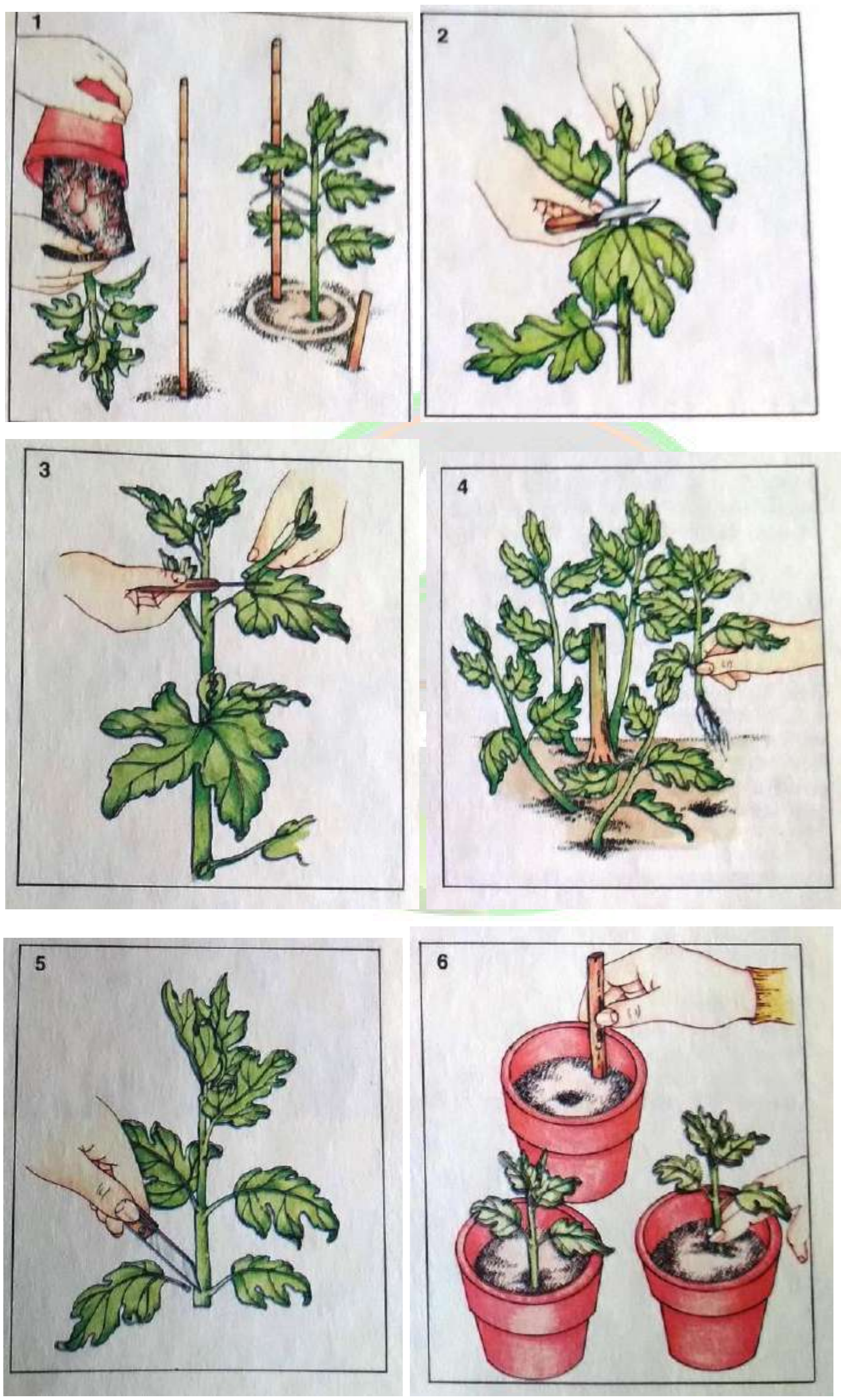
Whatever plants you select the treatment is the same. The nursery will supply rooted cuttings, preferably in late spring (April). These will have come out of a greenhouse and so will be very soft and particularly appetizing for snails and slugs. Pot them up separately and harden them off by standing the post outside where slugs cannot reach them. Be sure to sprinkle slugs cannot reach them. Be sure to sprinkle slug pellets around the pots as an added precaution. After about three weeks they should be ready to go into the border – and ideally should be there before mid-summer (by the end of May).

Although the cuttings are small the plants will get quite large, so plant them at least 75 cm apart. About a week after you have planted them out, remove the growing up only, so as to encourage the plant to throw out side growth. Do not remove any of the stem, however, as this will reduce the amount of sideshoots that a plant will produce. Removing the tips of the new sideshoots about a month later will encourage further bushing. After this all you have to do is sit back and wait for the plants to come into flower.

Chrysanthemums are fairly greedy plants, so top-dressing with a chrysanthemum fertilizer in late summer and early autumn (July and August) can do nothing but good, although it is by no means essential. Apply the fertilizer in the evening and give the plants a good soaking directly afterwards if the soil is at all dry. If you have a sprayer with a really fine spray. Use a foliar feed instead in any ease you should stop feeding the plants during early autumn (after the second week in August).

Plants from cuttings

Once flowering is over, cut the stems down to within about 5 cm of the ground and leave them over the winter. You now have two choices you can either leave the plants as they are, thinning the new growths out to about four per plant, or you can take cuttings and do exactly as you do the year before.



To root cuttings all you have to do is to pull up the shoots, which will appear in late winter or early spring (January to February), and cut them off just below a node (where you will see one or more leaves). The cuttings should be about 8cm long. Dip the ends into a rooting powder and put them in a potful of cutting compost, which can either be purchased or made up of equal portions of peat and sharp garden sand.

Very little heat is needed to root the cuttings, so if you have no greenhouse, you can do it perfectly well on a windowsill in a warm room. You can envelop the pot in a polythene bag, but in that case, you should turn the bag inside out every three days. The compost should be watered after you have inserted your cuttings, to ensure it is in contact with the base of the cuttings, but after that no further watering should be necessary unless the compost dries out.

The cuttings should root in two or three weeks and if you give a gentle tug and find that they do not feel loose, you can be fairly sure that they are rooted. Once they are, pot them up in 8cm pots in either or any growing compost and gradually harden off as before.

If you choose the easy way and leave your clumps in the border, you will need to lift them about every three years and split them up. This is best done in mid spring (March) when you should replant the new, outside growths in another part of the border.

1. Planting out from pots.
2. Cutting out top shoot and
3. Sideshoots
4. Thinning out new growth to four plants
5. Cuttings of new shoots below the node for propagation
6. Planting cutting with dibber-one centrally, or first of several cuttings around the pot.

If the leaves are discoloring in patches, then eventually yellowing and turning limp, the plants have probably got chrysanthemum eelworm pest. In this case you might just as well give up growing chrysanthemums altogether for at least three years. Dig out all the plants and burn them. However, eelworm attacks outdoor chrysanthemums comparatively rarely, although it likes the showier types.

Some other Chrysanthemums

There are a number of other chrysanthemums that you can grow in the garden.

Shasta daisy

Esther Read, such a stand-by of the flower arranger, is a double form of the Shasta daisy, which used to be called the Edward VII Chrysanthemum and is, botanically, Chrysanthemum maximum. This is so easy to grow that if anyone you know has it, they can probably let you have some of their divisions, all you have to do is plant them in the border and divide the clumps every three or four years. The Shasta daisy, but there are quite a few double forms besides Esther Read.

Pyrethrum

There is also an old friend, *Chrysanthemum coccineum*, but you may not recognize the name. This is the pyrethrum, that crimson daisy which is so much used for cut flowers in mid-summer (late May and June). This is not quite so easy to grow as C. *maximum,* as slugs are likely to do great damage when the new leaves appear in the spring; but if you use plentiful slug pellets or surround the plants with soot, you will find them quite trouble-free. They appear to exhaust the soil rather quickly, so many people split the clumps up and transplant every other Year. At one time there were many forms of pyrethrum, both single and double, in various colours from deep crimson to pale pink and white, but the choice is now much less and you will probably have to settle for either the deep crimson or the semi-double pale pink.

Annual chrysanthemums

Finally there are the annual chrysanthemums, which have been bred from three wild species, C.*carinatum*, C. *coronarium* and C. *Segetum*. These can be started from seed sown in warmth in mid spring (March), pricked out in boxes and eventually planted out, or sown outside in late spring (after the middle of April).

Two decorative-Anamone flowered Raymond Moundsey and spider-flowered Martha, excellent for town use and giving welcome autumn colour

Raymond Moundsey **Spider-flowered Martha**

A true single, Clara Curtis


Pyrethrum Even glow

Double and single types of Shasta daisy *C. maximum* Esther Read.


Single types **Double type**

There are both singles and doubles and they range in colour from white to sulphur, yellow, pink and red. They grow to about 60cm high and may be expected to flower from mid-summer to mid-autumn (late June until September). They are thus useful for filling up any gaps or for inserting between spring bulbs, so as to give a display after they have died down. They like sunny situations, and will thrive in all soils, although they prefer it to be fairly dry and well-drained.

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LEAF SPOT DISEASE ON POTENTIAL MEDICINAL PLANTS: ASHWAGANDHA

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Introduction

Withania somnifera L. Dunal, commonly known as Ashwagandha or Indian ginseng is one of the important medicinal crops and extensivelyused in the traditional medicine systems of India. It belongs to family Solanaceae. Ashwagandha is prone to several diseases and pests (Maiti *et al*, 2006), viruses, phytoplasmas, insects and nematodes (Sharma and Pandey, 2009). A number of leaf eating pests (mites, aphids, beetles) and diseases (seedling blight, leaf blight, die back etc.) are reported on Ashwagandha. Under field conditions, the plants are damaged by viruses, mycoplasmas, bacteria as well as fungal pathogens. The major fungal diseases are Alternaria leaf spot (Pandey and Nigam, 1985), Leaf spot disease of Ashwagandha caused by *Alternaria alternata* is the most prevalent disease. It was first reported by Pandey and Nigam, 1985. The disease has been causing considerable damage to the commercial fields of Ashwagandha during warm and humid climatic conditions. Infection often leads to serious defoliation. Leaf spot caused by *Alternaria alternata* is the most prevalent and responsible for substantial biodeterioration of its pharmaceutically important constituents (Pati *et al.*, 2008).

PATHOGEN

The genus Alternaria was first described in 1817, with *Alternaria tenuis* as the type isolate. Keissler (1912) found ambiguities in descriptionsof *A. tenuis* and synonymised both *A. tenuis* to *Alternaria alternata*. The telomorphs (sexual stage) are known in a very few species and placed inthe genus Pleospora of Loculoascomycetes (under Sub-division: Ascomycotina), in which sleeper-shaped, muriform ascospores are produced in bitunicate asci (Verma and Verma, 2010). *Alternaria* are best known for their role as plant pathogens and the USDA Fungal Host Index contains over 4,000 plant-host associations in this genus, ranking it 10thin terms of total number of host associations out of nearly 2000 fungal genera

.The *A. alternata* species group alone is recorded as causing disease on over 100 host plants (Thomma, 2003). This includes economically important crops including cereals, ornamentals, vegetables and fruits, with losses incurred through direct crop damage, postharvest spoilage or through contamination with mycotoxins. Since the genus' conception, over 1000 *Alternaria* species have been described. Many of these species names are invalid as they have since been classified into other genera, or because they lack type specimens (Simmons, 2007). The continued revision of the genus reflects its diverse nature, possessing considerable variation in spore structure and being identified in many different ecological niches.

MORPHOLOGY

Most classification of the *Alternaria* spp. has been based on morphology. This understanding was brought together through the life- work of E.G. Simmons who published 355 essays and papers on *Alternaria* morphology (Simmons, 2003). This work was subsequently summarised in an identification guide for the Alternaria genus, re-describing 275 morphological species (Simmons, 2007). TheAlternaria genus is characterised by large, multicellular, melanised conidia. which can possess both longitudinal and transverse septa. Spores are typically broadest at the base and taper towards the end. The tapering at theend of spores is commonly referred to as a "beak". Spores are produced on conidiophores often in chains, that may be branching or lead to secondary conidiophores that produce further spores. It is mainly the individual spore characters and the patterns of sporulation that are used to differentiate morphological species within the genus. *A. alternata* colonies are approximately 40 mm in diameter at seven days consisting of chains of 4-6 conidia on short conidiophores. The typical sporulation pattern comprises a single sub-erect conidiophore and an apical cluster of branching chains of small conidia separated by short secondary conidiophores. Single chains ofconidia may have up to 15-20 conidia. Spores at the base of the chain are more ellipsoid with dimensions 25-30 µm x 5-9 µm with transverse septae and a few, or no longisepta Subsequent spores are 7-25 µm x 5-12 µm with1-7 (commonly three) transeptae with few longisepta.

HOST RANGE

Alternaria is a large genus of worldwide distribution. Its species are mostly polyphagous fungi and responsible for causing leaf spot diseases in number of economically important crop plants. Alternaria diseases are among the most common diseases of many plants throughout the world and the total yield losses caused by the fungus on its wide range of host some time exceeds the total yield loss caused by any other pathogen(Agrios, 1997). The pathogen proved to be more devastating and causes one of the world's most catastrophic disease i.e. early blight of tomato, it also causes stem canker of tomato, leaf lesions on Asian pear, lesions on *Blumea aurita*, cumin blossom blight, leaf blight on carrot, infestation in cole crops, ringspot disease of pears, infestation in wheat, infection in tobacco. *Alternaria alternata* also causes leaf spots and blights of important medicinal plants as leaf spot of Mint (*Mentha arvensis* L.) leaf spot of *Ocimum sanctum*, leaf spot of Henbane (*Hyoscyamus niger*), leaf spot of Aloe, Leaf spot of stevia (Maiti *et al.*, 2006) and pomegranate (Madhukar and Reddy, 1976). *Alternaria* leaf spot of Ashwagandha was first reported by Gupta *et al* (1993) and later it was also reported by Pati *et al.*, (2008) from Amritsar India while the later also observed the disease is the most prevalent. The disease has been causing considerable damage to the commercial fields of Ashwagandha during warm and humid climatic condition. The older and mature leaves are more susceptible to infection. When *Alternaria* attacks the host leaf, morphologically it produces a series of concentric rings around the initial site of attack. This gives a "target spot" effect that is associated with early blights & leaf spots. Species of the genus are cosmopolitan and can survive as saprophytes as well as weak parasites.

DISEASE SYMPTOM

Alternaria leaf spot is one of the most devastating diseases of Ashwagandha. It causes 50-60% yield loss (Pati *et al.*, 2008). Multicellularpigmented spores are produced in chains or in branching fashions. The spores are broadest near the base and taper gradually to an elongate beak. When *Alternaria* attacks the host leaf, morphologically it produces a series of concentric rings around the initial site of attack. The older and mature leaves are more susceptible to infection caused by *A. alternata.*

DISEASE DEVELOPMENT

The mycelium of the fungus remains viable in dry infected leaves for a year or more. Conidia have been found to remain viable for 17 months at room temperature. The fungus can survive in susceptible weeds or perennial crops (Humpherson-Jones, 1980a,). Presence of infected crops on the ground after harvest also serves as a source of infection for majority of the *Alternaria* species. This type of spread is likely to occur in seedling beds as well infected seed beds can carry the inoculum to the field. Mycelium and conidia thus survive in the soil on diseased plant debris to cause primary infection to the next crop season. Infection of lower leaves first takes place through conidia formed on soil. Secondary spread of the disease occurs through conidia developed on primary spots. These conidia are disseminated by wind, water and insects. Infection occurs as a rule through the stomata but direct penetration may also take place. Incubation period varies from 48 to 72 hours. Generally the disease becomes serious when the season begins with abundant moisture or frequent rains followed by warm and dry weather. These conditions are unfavourable for the host and favour disease development.

MANAGEMENT

Considering the importance of *Alternaria* leaf spot disease, different strategies have been adopted for its management such as cultural, physical, biological and chemical control methods. Timely sowing should be done to avoid post-flowering drought and heat stresses, which aggravate the disease. However, most of the described control methods aim to reduce the inoculum level of the pathogen in soil or to minimize the contact of the inoculum and the host. Antagonists compete with the pathogen and reduce their population, while crop rotation mainly aims at reducing the density of inoculum in rhizosphere and phyllosphere. Breeding for resistance is another viable and effective strategy for the management of Alternaria leaf spot of Ashwagandha.

CHEMICAL CONTROL

Fungicides are the last line of defence in the armoury of an integrated disease management (IDM) approach. Chemicals are being used in the disease management programmes invariably throughout the world (Nene and Thapliyal, 1993).The chemical methods are considered as the most effective and efficient means of managing various pathogens, fungicides are chemicals formulated and successively used against their target organisms (Wright, 1981). They do not directly increase the yield, but protect an inherent yield potential that the grower may realize in the absence of disease, thus fungicide application can minimize the disease and thus increase the genetic potential and ultimately yield. In the field condition the efficacy of fungicides depend on factors like disease prevalence, virulence of the disease, environment and susceptibility of the host. Globally, the same fungicide active ingredients are used against a similar range of fungal pathogens. However, in the presence of the pathogen, the level of economic response to fungicide applications is primarily driven by the prevailing environmental conditions and their interactions with crop development and the pathogen. However the mechanism of fungicide action of SDHI group of fungicides efficient against Alternaria spp. is veryinteresting, the target enzyme are succinate dehydrogenase (SDH, so- called complex II in the mitochondrial respiration chain), which is a functional part of the tricarboxylic cycle and linked to the mitochondrial electron transport chain (Keon *et al.*, 1991). Meena *et al.*,(2013) reported that among five fungicides tested against the *Alternaria alternata* pathogen inciting leaf blight in Isabgol. Mancozeb was found most effective *in vitro* and *in vivo* conditions followed by Copper oxychloride and Zineb. Evaluation of seven amendments of biofertilizes for management of disease under field conditions revealed thatminimum PDI was observed in FYM and RDF + FYM. Maximum increaseof yield was recorded in FYM followed by RDF + FYM (Kathal *et al.*,2018).

BIOLOGICAL CONTROL

Biological control can be achieved either by introducing bioinoculants (biocontrol agents) directly into a field or by adopting cultural practices which stimulate survival, establishment and multiplication of the bioincoulants. Hence, more scientifically, biological control of pests and diseases can be defined as: reduction in disease severity, crop damage, population or virulence of the pest or pathogen inits active or dormant state by the activity of microorganisms that occur naturally through altering cultural practices which favours survival and multiplication of the microorganisms or by introducing bioinoculants. Evaluate blends of antagonists for wider applications (Baker and Cook, 1974). These indirect and direct mechanisms may act coordinately and their importance in the bio-control process depends on the strain the antagonized fungus, the crop plant and environmental conditions including nutrient availability pH, temperature and iron concentration (Bell *et al.*, 1982). Application of the fungicides is not economical in the long time because they pollute the environment leave harmful residues and can lead to the development of resistant strains of the pathogen with repeated use (Vinale *et al.*, 2008). Replacement of fungicides with bio-control agents is an alternative mean to manage the plant pathogens produce safetyfood and reduce the environment pollution (Barakat and Al Masri, 2005). One of the most important biocontrol agents is *Trichoderma* sp. that the most frequently isolated soil fungi and present in plant root ecosystems. Considering the importance of dry root-rotor charcoal rot disease, different strategies have been adopted for its management such as cultural, physical, biological and chemical control methods. Soil microorganisms themselves exert a natural biological control on root diseases. However, research on biological control gained impetus in the last quarter of tenth century, and several books (Baker and Cook, 1974; Cook and Baker, 1983) and review articles (Vivek *et al.*,2013) have come up highlighting the potential of microorganisms in disease management. Numerous microorganisms have been reported to cause antagonism against plant pathogenic fungi in laboratory and *in-vivo* condition. But, only a few have demonstrated antagonism to a level that could be exploited commercially. Maiti *et al.*, (2012) reported that *Pseudomonas aeruginosa* strain WS-1 isolated from the rhizosphere, showed both *in vitro* and *in vivo* antagonistic activity against the pathogen. The antifungal activity of the isolate has been found to linked with the production of a siderophore, volatile substances (hydrocyanic acid), proteases and chitinases. Foliar application of a talc talc-based formulation of *P. aeruginosa*strain WS-1 to field grown *W. somnifera* reduced disease severity by 80% compared to non-treated control. Rahman *et al.*, (2020) evaluated five *Trichoderma* strains viz.*Trichoderma virens* IMI-392430, *T. pseudokoningii* IMI-392431, *T. harzianum* IMI-392432, *T. harzianum* IMI-392433and *T. harzianum* IMI-392434 as bio-control efficacy against *A. alternata* and growth promoting effect in Ashwagandha. All the *Trichoderma* strains had varied antagonisticeffects against the pathogen.

References

Agrios,G.N.(1997).PlantPathology.AcademicPress.London.

Baker,K.F.andCook,R.J.(1974).BiologicalControlofPlantPathogens,W.H. Freeman and Co, San Francisco, California. American Phytopathological Society, St. Paul, Minnesota, pp 433.

Barakat, R.M. and Al-Masri, M.I. (2005). Biological control of gray mold diseases(*Botrytiscinerea*)ontomatoandbeanplantsbyusinglocal isolates of *Trichoderma harzianum*. *Dirasat Agril. Sci.*,32(2):145– 156.

Bell, D.K.,Wells, H.D. andMarkham, C.R. (1982). *InVitro* antagonismof *Trichoderma* species against six fungal plant pathogens. *Phytopathol.*,72(4): 379-382.

Cook, R.J and Baker, K.F. (1983). The nature and practices of Biological control of plant pathogen. *Amer. Phytopathol. Soc.*, St. Paul, MN 539.

Gupta, S., Kumar, A. and Thakur, R.N. (1993). Some problems in cultivation of *Withania somnifera* (L.) Dunal (Ashwagandha) in Jammu region of India. *J. Res. Edu. Indian Med.*,33: 234–235.

Humpherson-Jones, F.M. (1989). Survival of *Alternaria brassicae* and *Alternaria brassicicola* on crop debris of oilseed rape and cabbage. *Ann. Appl. Biol.*, 115(1): 45-50.

Kathal, D., Gupta, O. and Jagre, A. (2018). Control of Alternaria blight of Ashwagandha through fungicides, organic manures and biofertilizers. *Intl. J. Curr. Microbiol. App. Sci.*, SP7: 23-29.

Keissler, K.V. (1912). Zurkenntnis der pilzflorakrains. *Beiheftezum Botanischen Zentralblatt*, 29: 395–440.

Keon, J.P.R., White, G.A. and Hargreaves, J.A. (1991). Isolation, characterization and sequence of a gene conferring resistance to the systemic fungicide carboxin from the maize smut pathogen,*Ustilago maydis*. *Curr. Genetics*, 19: 475-481.

Madhukar, J. and Reddy, S.M. (1976). Some new leaf spot diseases of pomegranate. *Indian J. Mycol. Pl. Pathol.*, 18: 171-172.

Maiti C.K., Sen S., Paul A.K. and Acharya K. (2006). First report of *Alternaria dianthicola* causing leaf blight on *Withania somnifera* from India. *Journal ofPlant Disease*, 91: 467.

Maiti, C.K., Sen, S., Paul, A.K. and Acharya, K. (2012). *Pseudomonas aeruginosa* WS-1for biological control of leaf blight disease of *Withania somnifera. Arch. Phytopath. Pl. Protec.,* 45(7): 796-805.

Meena, R.K., Sharma, S.S. and Upaydhyay, B. (2013). Integrated managementofleafblightofIsabgolcausedby*Alternariaalternata*. *Indian Phytopath.*,67: 179-183.

Nene,Y.L. and Thapliyal,P.N.(1982). Fungicidesinplantdisease control.III. Edition: Oxford and IBH publishing Co. Pvt. Ltd. New Delhi, pp.325.

Pandey, G.N. and Nigam, K.B. (1985). Annual Work Shop: All India coordinate project on medicinal and aromatic plants, Bangalore, 22- 25.

Papavizas, G.C. (1985). Trichoderma and Gliocladium their biology, ecology and potential of biocontrol. *Ann. Rev. Phytopath.*, 23: 23- 54.

Pati, P.K., Sharma, M., Salar, R.K., Sharma, A., Gupta, A.P. and Singh, B. (2008). Studies on leaf spot disease of *Withania somnifera* and its impact on secondary metabolites. *Indian J. Microbiol.*, 48: 432-437.

Rahman, M.A., Rahman, M.A., Moni, Z.R. and Rahman, M.A. (2020). Biological Control of Leaf Blight of Ashwagandha [*Withania somnifera* (L.) Dunal]. *J. For. Environ. Sci.*,36(3): 207-218.

Sharma, P. and Pandey, R.(2009). Biological control of root- knotnematode; *Meloidogyne incognita* in the medicinal plant; *Withania somnifera*and the effect of biocontrol agents on plant growth Poorn.*African J. Agril. Res.*, 4(6): 564-567.

Simmons, E.G. (2003). Alternaria themes and variations (310-335) species on Malvaceae. *Mycotaxon*, 88: 163-217.

Simmons, E.G. (2007). *Alternaria caudata* (Cooke & Ellis), CBS Biodiversity Ser.(Utrecht) 6: 496.

Thomma, B.P.H.J.(2003). *Alternaria* spp.: from general saprophyte to specificparasite. *Mol. Plant Pathol.*, 4(4): 225-236.

Verma, N. and Verma, S. (2010).*Alternaria* diseases of vegetable cropsand newapproaches for its control. *Asian J. Exp. Biol. Sci.*, 1(3):681-692.

Vinale, F., Sivasithamparam, K., Ghisalberti, E.L., Marra, R., Barbetti, M.J., Li, H., Woo, S.L. and Lorito, M. (2008). A novel role for Trichoderma secondary metabolites in the interactions with plants. *Physiol. Mol. Pl. Pathol.*, 72: 80–86.

Vivek. M.N., Kambon, Y., Mamasam, Pallavi, S. and Kukulani, P.T.R. (2013). Bio-control potential of *Pimenta dioica* and *Anacardium accidentale* against *F. oxysporum, Z. gingiberi*. Boloadseiertile dominion 6

Wright, D.J. (1981). Nematicides: Mode of action and new approaches to chemical control, in Plant Parasitic Nematodes, Vol. Ill (eds B.M. Zuckerman and R.A. Rohde), Academic Press, New York, pp. 421– 49.

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MODIFIED BIOCHAR FOR WASTEWATER TREATMENT: A PATH TOWARDS GREENER FUTURE

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Abstract

Industrialisation and the increasing population continue to contribute to the immense amount of waste generation. Also, the nature of wastewater is changing and newer contaminants are added to the list of hazardous ones every day. On the other hand, conventional wastewater treatment systems are inadequate for the treatment of such pollutants. Adsorption is a process of surface sorption of contaminants which is highly effective. Different adsorbents are available, of which, biochar is fairly superior as well as multi-functional. However, to alter and enhance its functionality and make it suitable for a wide variety of contaminants, it can be modified by various methods such as steam activation, acid or alkali treatment, etc. Such engineered biochars have shown better sorption capacities and better contaminant removal potentials. Thus, using modified biochar as an eco-friendly alternative for better treatment of wastewater can help to achieve the goal of circular economy by reclamation of such treated wastewater.

Keywords: industrialisation; pollution; emerging contaminants; eco-friendly; circular economy

Introduction

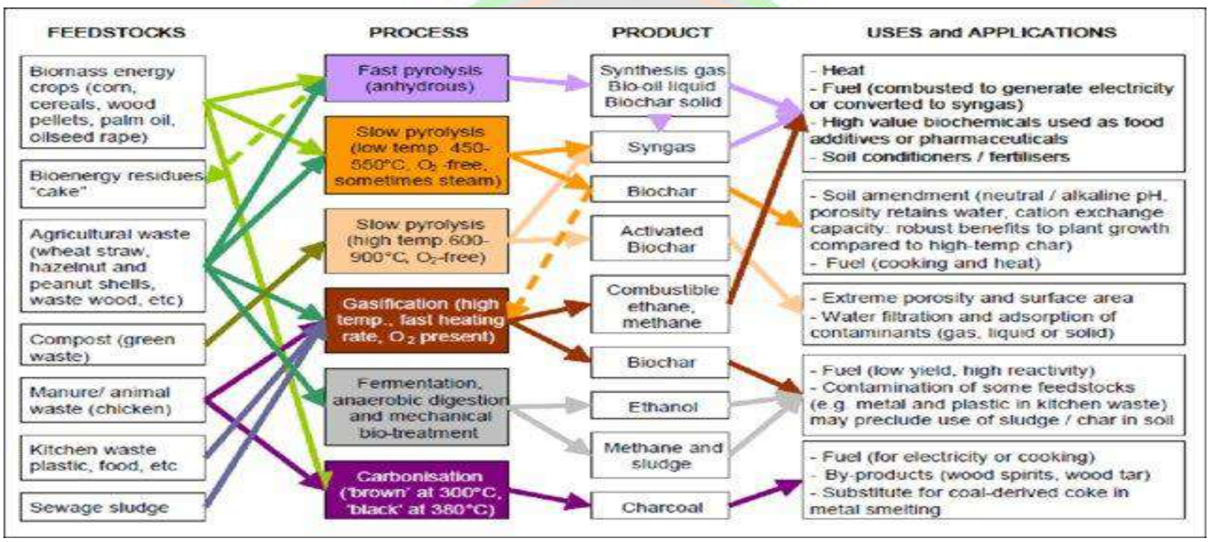
Industrialisation paved the way for a lot of changes in the socioeconomic affairs of people and the environment. Along with the positive changes, it triggered the problem of pollution, and the environment is damaged at an unprecedented level over the years. It raised the living standards of people but brought along with it a change in the consumption patterns, increased their purchasing capacity and thus contributed enormously to huge waste generation. Global population rise, which is set to be 9.7 billion by 2025, contributes significantly to this problem.

About 61754 MLD of wastewater is generated in India annually. However, not only has the volume of waste being generated increased, but the nature of wastewater has also changed. Heavy metals, agrochemicals and persistent organic pollutants are the contaminants usually observed in wastewater. Also, there is an increasing occurrence of Emerging Contaminants in the aquatic environment. Emerging Contaminants are chemical substances that are present in trace amounts but are potentially toxic to aquatic organisms. This class of compounds includes Pharmaceuticals and Personal Care Products, Pesticides, Endocrine Disrupting Chemicals, Persistent Organic Pollutants, etc. They are migratory and undergo various transformations along the way. Most of them have bioaccumulating, bioconcentrating and biomagnifying potential. Thus, they are dangerous to the aquatic biota and should be remediated.

However, the conventional wastewater treatment systems in practice are inadequate for the removal of such ECs due to varying reasons. The common methods being considered for ECs' treatment are electrochemical methods, adsorption, membrane processes, advanced oxidation processes, etc. Of these, adsorption is most suited because of its cost-effectivity, efficiency and wide operability. Adsorption is a process of surface sorption of chemical compounds by various interactions such as ion exchange, electrostatic attraction, surface complexation, etc. Activated carbon, polyacrylamide, silica gel, zeolite, aluminosilicate, etc. are most common adsorbents. These exhibit different physicochemical properties and hence, have different sorption potential. Activated carbon has a high specific surface area and good adsorptive capacity, but it is costly. Similarly, other listed adsorbents have less surface area available for adsorption. Hence, there is a need for a good adsorbent that is cost-effective as well as eco-friendly.

Biochar is fairly superior to the other adsorbents in this context. It is a porous pyrolytic product enriched with carbon produced under restricted or no oxygen conditions, from organic waste biomass. The properties of the produced biochar are characteristic of the raw agrowaste used and the pyrolysis parameters. Commonly used feedstocks are sugarcane bagasse, wood, press cakes from the oil and juice industry, rice husk, etc. However, it is also produced from animal waste, sewage sludge, organic manure, etc. Apart from water treatment, it is also used for soil amendment, increasing crop yield, carbon sequestration and combating global warming. Depending on the time-temperature regimes of the pyrolysis, different products are produced, which are further used for different purposes, as shown in Fig. 1.

Fig. 1. Commonly used raw materials, end-products, their uses and applications (Filiberto & Gaunt, 2013)



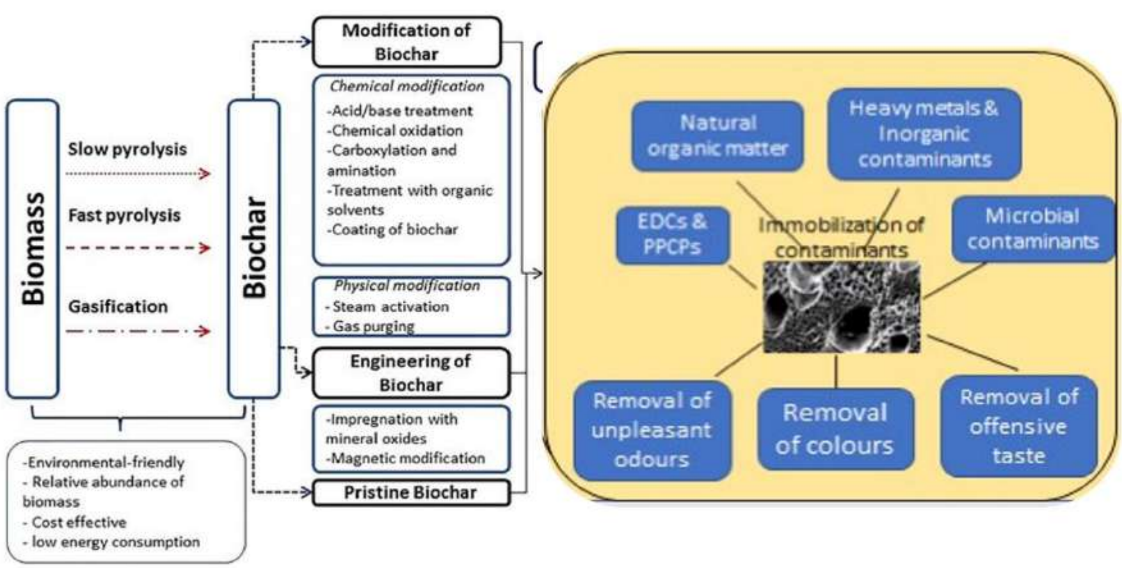
The functional properties of biochar, determined by its structure and elemental composition, are altered during the preparation process. The surface functionality of the biochar changes with the pyrolysis temperature and retention time. Biochar prepared at low temperatures has ample H- and O-comprising functional groups; however, as the temperature increases, their proportion reduces, and the CEC also decreases. On the other hand, the porosity, surface area and volatility of the biochar enhance with temperature. The resultant properties of biochar determine its adsorption capabilities.

Though biochar has gained increasing attention in terms of its adsorptive performance for wastewater treatment, its application is limited due to certain drawbacks. Several studies report that biochar has lower porosity, specific surface area, sorption sites and surface functionality compared to activated carbon. Pristine biochar has low affinity to heavy metals such as divalent lead, pentavalent arsenic and hexavalent chromium. It has a restricted potential to sequester contaminants from waters, especially from highly polluted waters. Hence, there is a need for the amendment of raw biochar to enhance its applicability. Thus, physicochemical modification of biochar is a potent way to uplift the functionality and application of biochar.

Methods of biochar modification

Different modification methods can be used for fabricating biochar with desired properties as shown in Fig. 2. The choice of modification method depends on the chemistry of the contaminant as well as the biochar and their possible interaction. Thus, the biochar can be engineered to facilitate effective remediation. It can be one-step activation, wherein carbonization and modification are done at a time, or two-step activation, where carbonization and preparation of biochar are followed by its modification.

Fig. 2. Biochar preparation, modification methods and water treatment using biochar (Produced from (Palansooriya et al., 2020))



Different modification methods are as follows:

1. Steam activation-

This is done to increase the porosity and O-comprising functional groups at the biochar surface, thereby increasing its hydrophilicity. Here, the prepared biochar is subjected to 800-900°C temperature for 0.5 to 3h with a steam flow rate of 2.2 to 5 mL min^{-1}. Steam removes the products of incomplete combustion trapped in the biochar pores and makes more room for the adsorption of other products. It also oxidizes the biochar surface by producing hydrogen, carbon monoxide and carbon dioxide.

2. Heat treatment-

Heat treatment is done by heating the biochar at 800-900°C temperature for 1-2h, followed by the introduction of air, H or Ar gas to form new basic functional moeities onto the biochar surface, thereby increasing its hydrophobicity. For e.g., heat treatment removes ether and carbonyl hydrophilic groups and produces basic pyrone groups, thus increasing the hydrophobic nature of the biochar surface. Hydrophobic surfaces are better for the sorption of hydrocarbons.

3. Acidic treatment-

Acid treatment is done by soaking the biochar (1 part) in acid (10 parts) at ambient temperature up to 120°C for hours or days. It is then washed, dried and pyrolysed to obtain the required modification. HNO_3 acid, H_3PO_4 acid and H_2SO_4 acid are commonly used. The H/C, O/C and N/C ratios increase. Also, there is the addition of acidic functional groups like hydroxyl, carboxyl, ketones, etc. Thus, the acidity and polarity of the biochar increase by eliminating the mineral species and thereby increasing the hydrophilicity of the biochar surface.

4. Alkaline treatment-

Soaking the biochar in basic solutions at room temperature to 100°C for usually 6-24h. The biochar is then washed, dried and pyrolyzed at 300-700°C for 1-2h to get the desired modified biochar. This method improves the basic functional groups such as naphthalene and pyrone and also nitrogenous functional groups such as primary, secondary or tertiary amines, quaternary ammonium, etc. Commonly used reductants are $NH_3 \cdot H_2O$, Na_2SO_3, $FeSO_4$, aniline and H_2.

5. Impregnation-

Impregnation is done by combining biochar with metal salts or oxides which is done in 2 ways:

a) treating the biochar with metal salts or metal oxides followed by pyrolysis

Biochar is dipped in varying concentrations of salts at ambient temperature to 120°C for 1-6h with constant mixing. This is followed by pyrolysis at 300-900°C with N_2 or partial O_2 supply.

b) preparing biochar and then impregnating it

Here, biochar is prepared prior to impregnation with metal salts or metal oxides.

Impregnation is usually done with ammonium chloride, carbonates, graphite, carbon nanotubes, etc. Magnetic biochar is produced using haematite or ferric chloride, ferric sulphate, etc. by techniques such as microwave heating, chemical co-precipitation, etc.

6. Biochar-based nano-composites-

Biochar-based nano-composites can be classified as follows depending on the materials used to modify the biochar: nano-metal oxide/hydroxide biochar nanocomposites, magnetic biochar nanocomposites and functional nanoparticles-coated biochar.

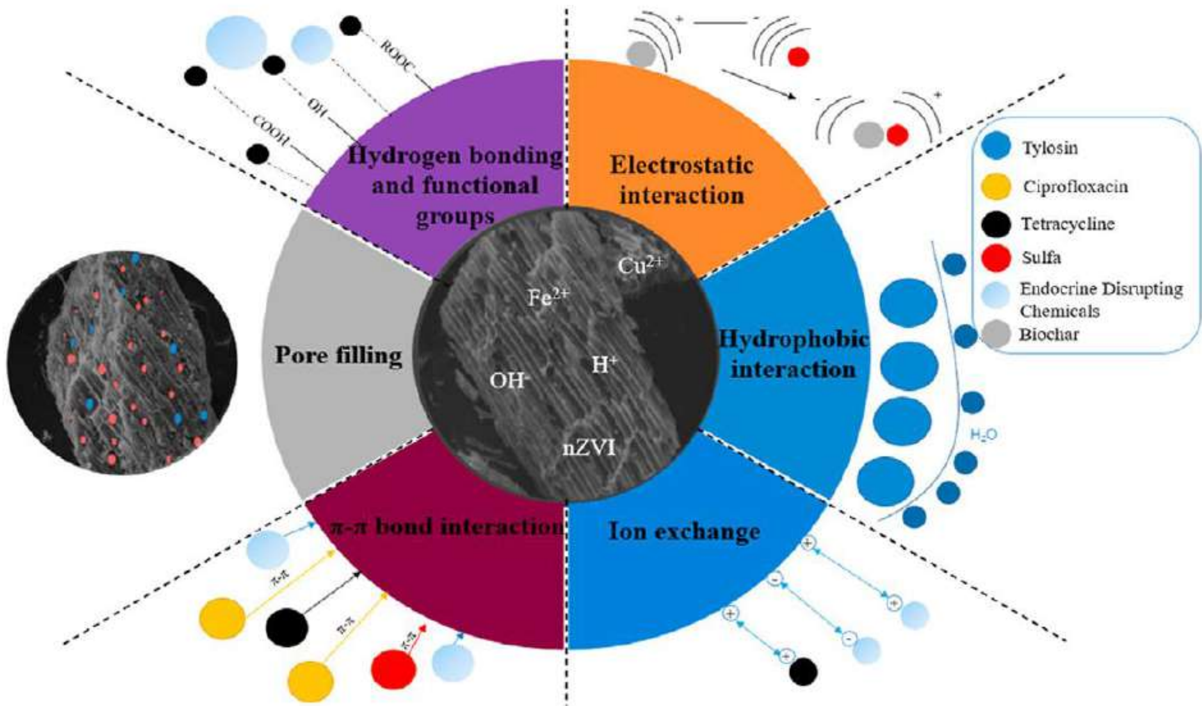
Properties of engineered biochar

Steam-activated biochar experiences an increased pore volume which might be responsible for the increased sorption. However, the aromaticity and polarity reduce due to the modification process compared to the other methods. Acid modification of biochar breaks its pore walls and converts the microspores into meso or macropores, thus lowering the specific surface area available for adsorption. However, modification by acid increases the oxygen content prominently and the resultant oxidation increases the O/C and H/C ratios, decreasing the hydrophobicity and increasing the polarity of the biochar. More acidic functional groups such as -COOH, -OH, etc. are formed on the biochar surface causing the chemisorption of wastewater pollutants. The alkaline modification increases the H/C and N/C ratio and decreases the O/C ratio in comparison with the acid-modified biochar. There is an increase in the aromaticity and the treatment increases the surface area available for adsorption of negatively charged organic pollutants. The surface area of alkali-modified biochar was enhanced 14 times, and a corresponding increase in its adsorption capacity has been observed. Impregnated biochar has increased surface functionalities due to the development of composites. Biochar-based nano-composites show enhanced functionality, structural properties, catalytic degradation capacity and easy separation.

Adsorption mechanisms of engineered biochar

The adsorption of pollutants on biochar surfaces depends on certain factors, such as the biochar's surface properties, i.e., the specific surface area, surface charge, functional moieties, pore characteristics, etc. The different adsorption mechanisms are: π- π interaction, H-bonding, hydrophobic interactions, electrostatic attraction and repulsion, pore filling, ion exchange, etc. Fig. 3 shows the different mechanisms for the adsorption of various water pollutants.

Fig. 3. Adsorption mechanisms of modified biochar (Cheng *et al*., 2021)



Wastewater treatment potential of engineered biochar (Ahmed *et al.*, 2016)

The contaminant adsorption and wastewater treatment potential of modified biochar is compiled in Table 1.

Table 1. Contaminant adsorption potential of modified biochar

Modified biochar	Contaminant removed	Adsorption capacity (mg g^{-1})
MnO_2 modified BC	Pb(II)	121.8
Citric acid treated BC	Pb(II)	159.5
Magnetic BC modified with ZnS nano-crystal	Pb(II)	367.6
Polyethylamine and alkali modified BC	Cr(VI)	435.7
Ammonium chloride treated BC	Elemental Hg	1.068
MgO treated sugar beet tailing BC	NO_3^-	95.5
MgO treated sugar beet tailing BC	PO_4^{3-}	835
Ca and Mg loaded sesame straw BC @ 600ºC	PO_4^{3-}	326.6
Acid or alkali treated BC	Furfural	93.5 - 109

Heat treated bamboo BC	Furfural	253.2
Citric acid treated eucalyptus sawdust BC	Methylene blue	185.6
Chemically treated bamboo BC	Methylene blue	605.5
Peanut shell BC treated by alkaline KOH	Phenol	93.5
Methanol modified rice husk BC	Tetracycline	95.6
Bur-cucumber plant derived BC @ 700 ºC	Sulfamethazine	32.2
Hickory wood BC nanocomposite prepared by dispersing sodium dodecylbenzenesulfonate onto carbon nanotubes	Sulfapyridine	27.9
Loblolly pine BC with 100% N supply	Diclofenac	231
Green waste BC	Atrazine	435
Green waste BC	Simazine	514
BC modified with Fe_3O_4	Carbamazepine	62.7
BC modified with Fe_3O_4	Tetracycline	94.2

Regeneration of biochar for reuse

Long-term use of sorbents causes its surface to saturate with the contaminants which necessitates it to be disposed off. However, treatment of the adsorbents with some process can recharge the biochar and it can be further reused. For the desorption of heavy metal contaminants from the biochar surface it can be treated with acid solutions like $NaNO_3$, HNO_3 or KNO_3 at different concentrations. Other techniques of contaminant desorption and biochar sites regeneration include temperature manipulation, inert fluid or gas treatment, pressure manipulation, pH modification, etc. Widely used solvents for biochar regeneration are hydrochloric acid, EDTA, acetic acid, sodium chloride and sodium hydroxide. Heavy metals are better removed by acids while sodium hydroxide is best suited for organic compounds desorption.

Conclusion

In order to tackle the issue of huge waste generation globally, biochar is being evaluated as a potential adsorbent, as it exploits the problem with a two-pronged approach. Biochar is, in itself, prepared from agro-waste. Hence it helps to convert waste for its productive utilization. Secondly, it is a proven eco-friendly adsorbent that helps to remove the contaminants from drinking water and wastewater and purify them for further use. However, engineered biochar has improved functional properties and surface area and hence, a higher sorption potential than the pristine biochar. It is effective in the sequestration of heavy metals, ionic and organic contaminants, including ECs. Recently, the Government of India has become a party to the Global Alliance for Circular Economy and Resource Efficiency (GACERE), which targets to collaborate with government and non-government organizations and endorse for a global and fair shift to circular economy and more sustainable management of natural resources. Working along these lines, the use of unconventional water resources like wastewater is indispensable. Hence, using modified biochar for the purpose of wastewater treatment, thereby making it fit for reuse can drive us better and faster toward achieving the goal of a circular economy in the near future.

References

Filiberto, D. M., & Gaunt, J. L. (2013). Practicality of biochar additions to enhance soil and crop productivity. *Agriculture*, *3*(4), 715–725.

Palansooriya, K. N., Yang, Y., Tsang, Y. F., Sarkar, B., Hou, D., Cao, X., Meers, E., Rinklebe, J., Kim, K.-H., & Ok, Y. S. (2020). Occurrence of contaminants in drinking water sources and the potential of biochar for water quality improvement: A review. *Critical Reviews in Environmental Science and Technology*, *50*(6), 549–611.

Ahmed, M.B., Zhou, J.L., Ngo, H.H., Guo, W., Chen, M. (2016). Progress in the preparation and application of modified biochar for improved contaminant removal from water and wastewater. *Bioresource Technology*, doi: http://dx.doi.org/10.1016/j.biortech.2016.05.057

Tan, X-f., Liu, Y-g., Gu, Y-l., Xu, Y., Zeng, G-m., Hu, X-j., Liu, S-b., Wang, X., Liu, S m., Li, J. (2016). Biochar-based nano-composites for the decontamination of wastewater: A review, *Bioresource Technology*, doi: http://dx.doi.org/10.1016/j.biortech.2016.04.093

Cheng, N., Wang, B., Wu, P., Lee, X., Xing, Y., Chen, M. and Gao, B. (2021). Adsorption of emerging contaminants from water and wastewater by modified biochar: A review. *Environmental Pollution*, *273*, 116448.

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A REVIEW OF CHALLENGES IN DEVELOPMENT OF PLANT-BASED MILK ALTERNATIVE

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Abstract

The surge in demand for plant-based milk alternatives in recent years reflects a growing preference among consumers for dairy-free options, driven by health, environmental, and ethical considerations. This expanding market encompasses a diverse range of alternatives, including almond, soy, oat, and coconut milk. However, alongside the opportunities presented by this growth, there are significant challenges that must be addressed to ensure the sustainability and viability of these products. This review explores key challenges faced in the development of plant-based milk alternatives, spanning agricultural practices, supply chain complexities, technological hurdles, and regulatory considerations. Despite these obstacles, the resilience and ingenuity of stakeholders within the industry have led to notable advancements, from innovative processing techniques to the cultivation of novel plant sources. Collaboration among farmers, manufacturers, researchers, policymakers, and consumers is essential to overcoming these challenges and driving further innovation. By embracing these challenges as opportunities for growth and cooperation, the plant-based milk industry can realize its full potential as a sustainable, nutritious, and accessible alternative to traditional dairy products. Ultimately, the prospects for plant-based milk alternatives are promising, offering a pathway to promote human health, environmental sustainability, and animal welfare in the future.

Introduction

In recent years, the demand for plant-based milk alternatives has surged, driven by a confluence of factors ranging from health and environmental concerns to ethical considerations. As consumers increasingly seek dairy-free options, the market for plant-based milks has expanded exponentially, encompassing a diverse array of alternatives such as almond, soy, oat, and coconut milk, among others. While this growth presents exciting opportunities for both producers and consumers, it also brings forth a host of challenges that must be navigated to ensure the sustainability and viability of these products. This introduction will explore some of the key challenges faced in the development of plant-based milk alternatives, ranging from agricultural and supply chain complexities to technological hurdles and regulatory considerations. By addressing these challenges head-on, stakeholders can foster innovation and drive the continued evolution of the plant-based milk industry, ultimately providing consumers with more diverse, accessible, and environmentally friendly options.

Challenges in the development of plant based milk alternatives

In the production and enhancement of Plant-Based Milk Alternatives (PBMAs), there are four main focus areas: enhancing stability, removal of unpleasant flavours, neutralizing or eliminating antinutrients, and extending shelf life.

Removal of unpleasant flavor

The presence of unsaturated fatty acids and lipooxogenases responsible for off flavours in plant based milk. Removal of off flavours by deodourization, inactivation of enzymes and masking of off flavour by addition of natural or artificial flavourings. Guo-Zhi *et al.,* (2022). Lipoxygenases catalyze the production of nonvolatile hydroperoxides from unsaturated fatty acids, which subsequently break down into medium-chain aldehydes and alcohols like n-hexanal and n-hexanol. These compounds are linked with attributes of beany or off-flavor. The deactivation of lipoxygenase through heat treatment represents the predominant technological approach for enhancing the flavor profile of plant based milk, a method that has been employed over numerous decades. Qiying *et al*., (2021).

During the process of grinding raw legumes, a research report revealed that the impact of pH on off flavors was investigated. The findings showed that there were no detectable off flavors at a pH below 3.85. However, it was observed that within this pH range, the extractability of proteins significantly decreased. This decline occurred because a majority of legume proteins have an isoelectric point between pH 4.0 and 4.5. Conversely, at pH 2.0, the highest level of extractability was achieved without any discernible off flavors. Leqi *et al*., (2020)

Production of bean-less flavored plant based milk through the utilization of carbon dioxide in a state of sublimation was meticulously executed. This method excluded any thermal or chemical interventions and consisted of a series of distinct phases. Initially, soybeans were immersed in deaerated water under a carbon dioxide atmosphere for a specific duration at an effective temperature, facilitating the absorption and expansion of the soybeans. Subsequently, the soaked and expanded soybeans were washed with water to eliminate oligosaccharides and ripening enzymes. Guo-Zhi *et al.,* (2022). These enzymes, being water-soluble, were dissolved in the soaking water. The washed soybeans were then ground in a carbon dioxide atmosphere by introducing carbon dioxide in a sublimed state (at -78°C under atmospheric pressure), resulting in the formation of a slurry. This slurry was subsequently filtered to yield soy milk. The final product exhibited elevated protein yields, as the process prevented denaturation caused by thermal treatment, consequently avoiding the presence of any beany or bitter taste. Bei *et al*., (2021).

Alteration of the conventional processing technique through the inclusion of procedures such as roasting, blanching, and soaking in alkaline conditions has been recognized for its ability to diminish the beany taste in legume-derived milk, consequently enhancing the product's level of acceptance. Moreover, the incorporation of flavorings and sugar has been demonstrated to elevate the overall acceptability of alternative milk derived from plants. Furthermore, the combination of legume milk with cereal milk and nut milk has proven beneficial in enhancing the quality and expanding the acceptance of plant-based milk. Shrishti *et al*., (2022).

Removal or inactivation of anti nutritional factors

Antinutrients are mainly found in raw seeds, particularly in cereals, legumes, and nuts. These plant-derived foods contain various primary antinutrients such as phytic acids, saponins, tannins, α-amylose inhibitors, trypsin inhibitors, protease inhibitors, lectins, oxalates, exorphins, and goitrogens.

Lectins, proteins or glycoproteins not originating from the immune system, are commonly found in cereals (0.5–7.3 mg/100 g) and nuts (37–144 μg/g). They have the ability to bind or modify carbohydrates like glycoproteins, glycolipids, and polysaccharides. Their actions include evading the immune system and causing disorders in the small intestine such as leaky gut syndrome. By providing incorrect signals to the immune system and encouraging the proliferation of certain white blood cells, they may potentially initiate autoimmune diseases.

Trypsin inhibitors are found in several food sources such as chickpeas, soybeans, and red beans, all of which are legumes, at a concentration level of 6.7 mg/100 g. Their presence leads to a reduction in protein absorption, negatively affecting human nutrition.

Denaturation and heat inactivation can impact the stability of these compounds. Excessive heat exposure aimed at fully deactivating trypsin inhibitors may result in the degradation of amino acids, a decrease in nutritional quality, and various adverse alterations. Manassero *et al*., (2016).

Limited research attention has been given to the antinutrients found in plant-based milk. This lack of focus can be attributed to the implementation of suitable preparation methods on plant-based milk, which typically results in decreased levels of antinutrients, except for tannins.

Through methods such as dehulling, soaking, fermenting, or thermal treatment (cooking), most antinutrient chemicals in seeds can be effectively eliminated. Combining these techniques often enhances the reduction or elimination of antinutrients, a common practice in the production of plant-based milk. Heat treatment can alter proteinaceous antinutrients, causing them to denature or aggregate, thereby losing their effectiveness. For instance, heating soymilk at 100°C for 10 minutes reduced trypsin inhibitor levels by approximately 80% and improved the protein efficiency ratio. Given that residual trypsin inhibitor activity can reach up to 71% of total soybean content and hinder protein absorption, it's vital to measure TIA levels in finished products, particularly in some commercial soymilks.Yuan *et al*., (2010).

A variety of techniques, such as fermentation, germination, debranning, autoclaving, soaking, and others, are utilized to reduce the presence of antinutrients in foods. By employing these methods individually or in combination, it is possible to decrease the concentration of antinutrients in food items. Samtiya *et al*., (2020).

Plant-based milk undergoes various processing methods to reduce trypsin inhibitor activity. Traditional steam injection at 100°C for 20 minutes reduces it by 13%, while blanching can decrease it by 25-50%. Ultra High Treatment, by elevating both temperature and duration, also diminishes trypsin inhibitor activity. However, phytates remain stable to heat and are unaffected by cooking processes, thereby reducing their bioavailability. Yet, the enzyme phytase can mitigate their presence. Additionally, non-chemical and non-thermal techniques like germination and sprouting enhance plant-based milk by increasing protein content, milk yield, and improving its organoleptic qualities. Furthermore, these processes effectively reduce trypsin inhibitors, fat, and phytic acid content. (Adapted from Sunday et al., 2023; Paul et al., 2020).

Improvement of shelf life

Plant-based milk, rich in nutrients, creates an ideal environment for microbial growth, leading to quality deterioration through rapid proliferation. Heat treatment is employed to extend its shelf life by either reducing or eradicating harmful microorganisms and spoilage agents. Thermal processing aims to prolong shelf life, enhance total solids yield, and improve flavor. However, prolonged heating adversely affects nutrients like vitamins and amino acids, and can induce browning and cooked flavors. Various time–temperature combinations are used to minimize these negative effects, aiming for optimal product quality. Methods such as pasteurization (maintaining temperatures below 100°C to eliminate pathogens), in-container sterilization (subjecting products to 121°C for 15–20 minutes for commercial sterility), and ultra-high-temperature treatment (exposing to temperatures of 135–150°C for a few seconds) are employed. Paul *et al.*, (2020).

UHT processing involves direct heating methods like steam injection and infusion, as well as indirect heating using plate or tubular heat exchangers. After any of these processes, packaging under aseptic conditions is essential to maintain sterility. Pasteurized products require refrigeration, whereas those subjected to in-container sterilization or UHT treatment can be stored at room temperature for a limited time. Thermal treatments are commonly used in processing soy milk and peanut milk. Therefore, alternative non-thermal methods are needed to extend the shelf life of these specific plant-based milk varieties. Various non-thermal techniques such as high-pressure throttling, ultra-high-pressure homogenization (UHPH), and high-pressure processing have been investigated for their effectiveness in prolonging shelf life. Further research is needed to explore the preservative effects of pulsed light, ultrasound, and other non-thermal technologies on plant-based milk. (Paul *et al.*, 2020).

Stability improvement

The stability of plant-based milk depends on several factors. These factors include the size of dispersed phase particles, such as fat globules, solid particles, and proteins, which can result in a sandy, gritty, or chalky texture and phase separation during storage, leading to sedimentation at the bottom of the package. Another factor is the formation of an emulsion.

Additionally, the presence of undissolved starch granules and the solubility of proteins also contribute to the stability of plant-based milk. (Paul *et al.*, 2019).

The type of mill and the extraction temperature used for plant-based milk extraction greatly influence the resulting particle size and the stability of proteins and fats. Higher extraction temperatures usually increase fat extractability and protein denaturation, resulting in reduced solubility and stability. (Shakerardekani *et al*., 2019)

In the realm of emulsion formation, notable factors include determining the minimum emulsifier concentration required to establish a stable emulsion and achieving the smallest possible mean droplet size under specified conditions such as homogenization pressure, number of passes, and emulsion composition. Moreover, the particle size distribution is crucial, as a narrow distribution offers advantages; larger droplets tend to cream faster than smaller ones, potentially leading to the formation of a cream layer on the surface. Regarding emulsion stability, a significant aspect lies in the emulsifier's ability to prevent droplet aggregation during storage or exposure to environmental stressors like pH fluctuations, ingredient composition, salt presence, and temperature changes. For instance, emulsions formed by plant-based proteins such as pea, lentil, or legume proteins display high instability under challenging conditions such as proximity to their isoelectric point (pH 5), high ionic strengths (>50 mM), and elevated temperatures (>70°C), whereas plant-based saponins and polysaccharides like Arabic gum exhibit stability under most of these circumstances. (McClements *et al*., 2019).

Several processes, including homogenization and thermal treatments, play vital roles in improving the suspension and microbiological stability of the final product, ensuring its safety for consumption. However, emerging non-thermal processing methods such as ultra-high-pressure homogenization (UHPH) and pulsed electric field processing are being investigated to address concerns regarding shelf life extension, emulsion stability, nutritional preservation, and sensory appeal without relying on high temperatures or additives. Among these methods, high-pressure homogenization, UHPH, and ultrasound have been extensively studied, demonstrating promising results. (Silva *et al*., 2020).

Fresh or pasteurized plant-based milk, when not packaged or packaged without aseptic conditions, have a brief shelf life, typically lasting only hours at room temperature or 2-3 days under refrigeration (4°C–5°C). Pasteurized plant-based milk, when aseptically packaged and stored refrigerated, demonstrate stability for 12-30 days. Ultra-pasteurized plant-based milk, when aseptically packaged, can extend shelf life to 90-170 days at room temperature. Thermal treatment is commonly utilized for preservation as it efficiently deactivates microorganisms and enzymes responsible for product deterioration.

The adoption of new processing technologies in plant-based milk has enhanced emulsion stability, reduced particle size, deactivated enzymes to prevent off-flavors, and decreased microbial load. Consequently, these technologies play a crucial role in stabilizing plant-based milk alternatives and, when combined with appropriate packaging techniques, help extend their shelf life. (Zhu *et al*., 2019).

Conclusion

As the demand for plant-based milk alternatives continues to rise, it is evident that the industry is at a critical juncture, poised for both growth and innovation. However, the journey towards widespread adoption and acceptance of these alternatives is not without its obstacles. The challenges discussed in this review article underscore the multifaceted nature of the plant-based milk industry, spanning agricultural practices, supply chain logistics, technological advancements, and regulatory frameworks.

Despite these challenges, there is ample reason for optimism. The resilience and ingenuity of stakeholders within the plant-based milk sector have already led to significant advancements, from the development of new processing techniques to the cultivation of novel plant sources. Moreover, the growing body of research surrounding plant-based nutrition and sustainability continues to provide valuable insights that can inform product development and marketing strategies.

Moving forward, collaboration and cooperation among stakeholders will be paramount in addressing the challenges outlined in this review. By fostering partnerships between farmers, manufacturers, researchers, policymakers, and consumers, the plant-based milk industry can overcome barriers, accelerate innovation, and realize its full potential as a sustainable, nutritious, and accessible alternative to traditional dairy products.

In conclusion, while the road ahead may be fraught with obstacles, the prospects for the development of plant-based milk alternatives are undeniably bright. By embracing the challenges as opportunities for growth and learning, stakeholders can collectively shape a future where plant-based milks play a central role in promoting human health, environmental sustainability, and animal welfare.

References

Manassero, C. A.; Vaudagna, S. R.; Sancho, A. M.; Anón, M. C.; Speroni, F. Combined High Hydrostatic Pressure and Thermal Treatments Fully inactivate Trypsin Inhibitors and Lipoxygenase and Improve Protein Solubility FOOD REVIEWS INTERNATIONAL 29and Physical Stability of Calcium-added Soymilk. Innov. Food Sci. Emerg. Technol. 2016, 35, 86–95. DOI: 10.1016/ j.ifset.2016.04.005.[88]

Yuan, S. H.; Chang, S. K. C. Trypsin Inhibitor Activity in Laboratory-produced and Commercial Soymilk. In ACS Symposium Series 1059 Chemistry, Texture, and Flavor of Soy; Cadwallader, K.R., Chang, S.K.C., Eds.; American Chemical Society: Washington, DC, 2010; pp 23–43.

Samtiya, M., Aluko, R. E., &Dhewa, T. (2020). Plant food anti-nutritional factors and their reduction strategies: an overview. Food Production, Processing and Nutrition, 2, 1-14.

Sunday, J., Olakanmi., Rahul, Islam, Barbhuiya., C., Wroblewski., Saipriya, Ramalingam., Gopu, Raveendran, Nair., Ashutosh, Kumar, Singh. (2023). Effect of microwave and conventional heat treatment on trypsin inhibitor activity and in vitro digestibility of edamame milk protein. Food Bioengineering, doi: 10.1002/fbe2.12050

Paul, A. A., Kumar, S., Kumar, V., & Sharma, R. (2020). Milk Analog: Plant based alternatives to conventional milk, production, potential and health concerns. Critical reviews in food science and nutrition, 60(18), 3005-3023.

Paul, A. A.; Kumar, S.; Kumar, V.; Sharma, R. Milk Analog: Plant Based Alternatives to Conventional Milk, Production, Potential and Health Concerns. Crit. Rev. Food Sci. Nutr. 2019, 1–19. DOI: 10.1080/ 10408398.2019.1674243

Shakerardekani, A.; Karim, R.; Vaseli, N. The Effect of Processing Variables on the Quality and Acceptability of Pistachio Milk. J. Food Process Preserv. 2019, 37(5), 541–545. DOI: 10.1111/j.1745-4549.2012.00676.x

McClements, D. J.; Newman, E.; McClements, I. F. Plant-Based Milks: A Review of the Science Underpinning Their Design, Fabrication, and Performance. Compr. Rev. Food Sci. Food Saf. 2019, 18(6), 2047–2067. DOI: 10.1111/1541-4337.12505.

Silva, A. R. A.; Silva, M. M. N.; Ribeiro, B. D. Review: Health Issues and Technological Aspects of Plant-based Alternative Milk. Food Res. Int. 2020, 131, 108972. DOI: 10.1016/j.foodres.2019.108972.

Zhu, Y.; Elbrhami, A. A.; Popović, V.; Koutchma, T.; Warriner, K. Comparative Effects of Thermal, High Hydrostatic Pressure, and UV-C Processing on the Quality, Nutritional Attributes, and Inactivation of Escherichia Coli, Salmonella, and Listeria Introduced into Tiger Nut Milk. J. Food Prot. 2019, 82(6), 971–979. DOI: 10.4315/0362-028X.JFP-18-4922.

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PROCESSING TECHNOLOGY OF FIGS

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Introduction

Figs are the edible fruits of the tree *Ficus carica L.*, one of the oldest cultivated trees which belongs to the Moraceae family. Being native to Mediterranean region, these trees yield one to two crops per year depending on the cultivator. Of the two crops, the first crop grows from the flowers that has been initiated in the past year and ripens at the onset of summer. The main crop is the latter one which is produced from the flower that has bloomed on the prevalent season and ripens by late summer. Both the crops can vary in shape and size since they are grown under different weather conditions.

Besides being a delightful and wholesome fruit, it also has anti- cancerous properties and may reduce the risk of heart disease. It is consumed in various forms such as fresh, dried, preserved, canned and even in candied form. Figs are utilised in the Mediterranean region for the production of wine and alcohol, and in fig- coffee preparation in Europe. Figs , both in their fresh and dry forms are a powerhouse of nutrients comprising of fibre, antioxidants, polyphenols, proteins, sugars, trace minerals, organic acids and also volatile compounds that contribute to the distinct pleasant aroma. Figs in their dried form can be stored upto 6 to 8 months.

The *Ficus carica* genus comprises of over 800 different varieties and are adapted to grow in warm and dry regions such as Mediterranean and the Middle east. Some of the sought after varities of fig are Kadota, Sarilop, Mission, Sarizeybek, Brown Turkey and Bursa siyahi. Of the one million tonnes of fig harvested globally in 2020, Mediterranean region contributed to 76% of the total harvest. Countries like Egypt, Morocco, Iran, Algeria and Greece has contributed between 20 and 30 % each to global production. Figs have been used for their medicinal purpose in many countries.

Figs are seasonal fruits that can be picked twice a year, depending on the cultivar, in the spring and summer or the early and late summer. It has a dark purple to green colour spectrum. Fresh, peeled or unpeeled, dried, jammed, or juiced, it is delicious. Iron, calcium, potassium, and vitamins are abundant in both fresh and dried products (especially thiamine).

Natural antioxidants such as phenolic compounds, organic acids, vitamin E, and carotenoids can be found in a wide range of fruits and vegetables, including figs. These compounds can limit free radical formation by decreasing or giving hydrogen to other molecules. Phenolic compounds are the most popular among them due to their well-known antioxidant capabilities. The study of phenolic acids and flavonoids in diverse species of fresh and dried figs, as well as their distribution between fig pulp and skin, has piqued scholarly interest in the literature over the last decade.

The effects of colour, fruit variety, harvest season, and drying processes on phenolic component concentration levels have been studied in a number of studies. Furthermore, the antioxidant potential of commercial figs has been widely assessed. The phenolic content of fig leaf and fig by-product extracts has been studied in fewer studies.

There are currently no comprehensive review studies available that provide comprehensive information on the occurrence and amounts of phytochemical components in fresh and dried figs, as well as the impact of different types, colour, ripening stages, and drying techniques on their antioxidant capacity. The primary goals of this review paper were to present the major antioxidant compounds found in figs, describe the analytical methods used to determine them as well as the various extraction procedures, and summarise the available data on the concentrations of phenolic compounds and carotenoids in fresh and dried figs produced in various cultivated regions based on the foregoing.

Categorisation of phytochemical compounds in figs

Phenolic acids, flavonoids, and carotenoids are phytochemical components present in both fresh and dried figs. The two subclasses of phenolic acids are benzoic acid derivatives or hydroxybenzoic acids and cinnamic acid derivatives. Hydroxybenzoic acids have the same basic structure as benzoic acid, with the exception that one or more hydroxyl groups are added to the benzene ring at various locations. The C6-C3 structure of hydroxycinnamic acids consists of a three-carbon chain attached to an aromatic ring. The most studied flavonoids representative classes include flavanols, flavonols, flavones, and anthocyanidins.

Flavonols are different from flavonoids in that they are chemicals. Positions 2 and 3 have a double bond, position 4 has oxygen, and position 3 has a hydroxyl group. These compounds are known as glycosides because a sugar can be linked in the 3-hydroxyl group. The most commonly related carbohydrates to flavonols are glucose and rhamnose. Flavones have a similar structure to glycosides, but they lack the hydroxyl group at position 3 and are hence uncommon.

Carotenoids are tetraterpene pigments that are found in nature. Each terpene unit has 10 carbon atoms, and they are formed up of four of them. They have double bonds and rings, with or without linked oxygen atoms, in their structure. Carotenoids are divided into two categories: xanthophylls and carotenes. Lutein, which contains one or more oxygen atoms, is the most well-known xanthophyll. Carotenes, on the other hand, are devoid of oxygen and are totally composed of carbon and hydrogen atoms; -carotene is the carotenes' major component.

Extraction Process

The most common phenolic acids found in whole fresh and dried figs are gallic acid and syringic acid, which are hydroxylated derivatives of benzoic acid and chlorogenic acid, respectively. The most common chemicals found in whole fresh and dried figs are ferulic acid, caffeic acid, and cinnamic acid, which are cinnamic acid derivatives. The most frequent phenolic acids in dried figs were gallic acid (up to 5.04 mg/100 g DM) and chlorogenic acid (up to 32.42 mg/100 g DM), while the same target compounds were found in whole fresh figs at up to 6.98 mg/100 g.

The highest concentration levels of flavonoids were found in dried figs at 14.62, 10.82, and 36.65 mg/100 g DM for rutin, quercetin-3-O-rutinoside, and epicatechin, respectively; however, these target compounds were found in fresh figs at 68.21 mg/100 g DM for rutin, 38.17 mg/100 g DM for quercetin-3-O-rutinoside, and Anthocyanins have also been discovered to be abundant in figs.

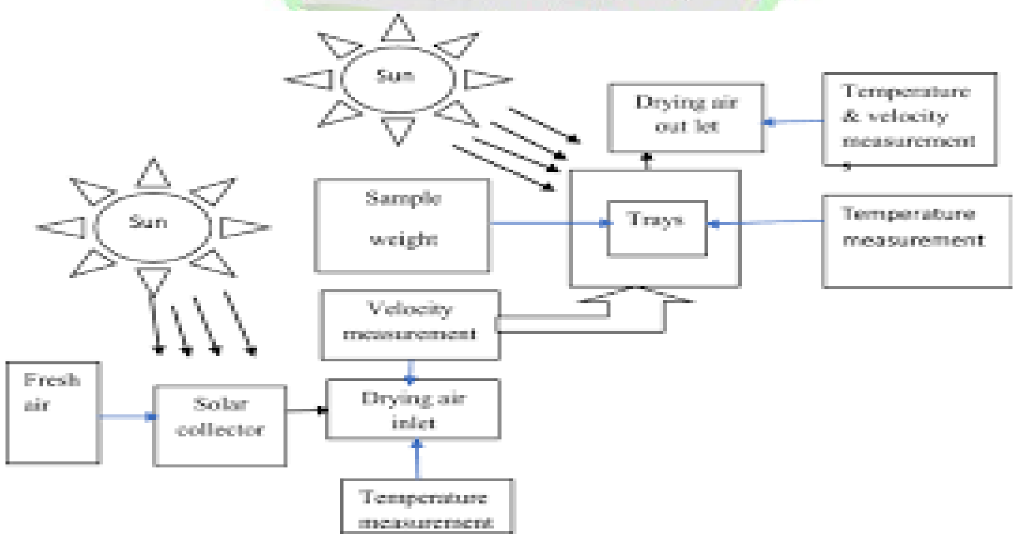
In most studies, the anthocyanin pigments cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside were the most common. The amounts of cyanidin-3-O-rutinoside in dried and fresh figs were 73.03 mg/100 g DM and 91.23 mg/100 g DM, respectively. It's worth mentioning that cyanidin-3 comprised for 95% of all anthocyanins, with this component accounting for 75% of the total. Gallic acid, ellagic acid, chlorogenic acid, psolaren, rutin, catechin, epicatechin, cyanidin-3-O-rurinoside, and cyanidin-3-O-glucoside were found in the highest concentrations in the skin and pulp of the fig varieties investigated.

Five carotenoids have been found in dried and fresh figs: lutein, zeaxanthin, -carotene, -carotene, and -cryptoxanthin. -carotene, zeaxanthin, and lutein were the most abundant components in fresh figs, while -cryptoxanthin and lutein were the most abundant molecules in dried figs.

Antioxidant capability and health benefits of figs

A number of antioxidant tests were used to assess the antioxidant capacity of various components of fresh figs (skin, pulp, entire fruit), as well as dried figs. The 1,1-diphenyl-2-picrylhydrazyl radical assay (DPPH), 2,2-azino-di-(3-ethylbenzothialozine-sulphonic acid) assay (ABTS), ferric ion reducing antioxidant power assay (FRAP), cupric ion reducing capability assay (CUPRAC), and oxygen radical absorbance capacity assay (ORAC) are among the methods that have been widely used in selected fig Because of the various experimental settings used in the aforementioned assays, no single assay can accurately identify each sample's profile.

Solar drying of fresh figs



(Yihun Tefera Sintie, 2020)

Fresh fig consumption is increasing as people become more interested in high-quality produce from less familiar fruits. Most fig cultivars have been selected for drying in some areas, such as California, and growers have little fresh fruit handling experience. However, in some northern Mediterranean conditions, where weather conditions are sometimes less favourable for drying, most figs are consumed fresh, and proper conditions for fruit drying must be established.

Figs can be sun-dried to guarantee good preservation. Traditional drying methods, on the other hand, do not allow for previous selection of food based on age, size, condition, or degree of ripeness. Furthermore, the produce is exposed to direct solar irradiation, and the product quality suffers as a result of the inability to adjust the drying parameters. As a result, sun-drying is not uniform, and the finished product is caramelised and crusted. The colour, vitamins, and oven-dried flavour of the figs are all destroyed by direct sunlight.**Process flowchart for drying of fresh Figs**

(TNAU Agri portal)

With a global production of roughly 1.14 million tonnes, dried figs are a significant crop. Dried figs are grown mostly in Mediterranean Europe, North Africa, and Central Asia, with Turkey being the world's largest producer. Each year, Spain exports about 4500 tonnes of dried figs. Fruit that will be dried is left on the tree until it is fully ripe, partially desiccates, and falls to the ground. In traditional sun drying, semidry figs are collected from the field and placed on wooden drying racks. The moisture content of each fig is measured by rotating it from one side to the other until it reaches 24 percent.

onsumers prefer the finished product because of its high nutritional value, which includes vitamins A, B1, B2, fibre, polyphenols, essential amino acids, and minerals such as iron, calcium, and potassium (Flores & Jiménez, 2007). The slowness of the drying process, depending on the environmental circumstances, can jeopardise fruit integrity by allowing pathogens to grow and multiply, as well as nutritional losses. As a result, the most significant problem with dried whole figs is the presence of moulds, which thrive in low-water situations (aw 0.87).

Indeed, fig fruits are regarded as a high-risk commodity in terms of toxigenic fungi and their mycotoxins, which pose the greatest danger in this type of product in terms of both economics and health and safety (Heperkan, 2006). The dominating mycoflora in dried whole figs varies significantly depending on ripening stage, geographical location, processing, and commercial variety. Aspergillus section Nigri, Fusarium spp., Aspergillus section Flavi, and Penicillium species are the most commonly reported toxigenic fungus (Heperkan, 2006). These secondary metabolites are produced while the fruit is still on the tree and the growing conditions are favourable. Mycotoxins can also be created during harvest, transportation, drying, and storage, especially when stored for long periods of time at high temperatures and aw. As a result of this health risk, European legislation has set rigorous restrictions for total aflatoxins in dried whole figs, with a maximum permitted level of 6–10 g/kg.

Other issues with dried figs linked to an inefficient drying process include enzymatic transformations of the fruit's primary components, such as sugars, organic acids, pectin, cellulose, hemicellulose, phenolic compounds, and minerals, resulting in physiological changes and, as a result, a loss of product quality. Brown colour is created by non-enzymatic browning reactions (the Maillard reaction, which is favoured at high temperatures) and sugar caramelization on the surface, both of which can have a considerable impact on the appearance and flavour of the figs.

All of these potential alterations caused by the traditional sun drying method could lead to considerable quality loss, health hazards, and, as a result, large financial losses. As a result, there is a growing demand for drying techniques or processes that allow for the control of final product quality and safety, as well as the avoidance of economic losses and health risks. Convective air oven drying has been studied in figs. Other osmotic solution-based treatments have been described as being beneficial not just in lowering drying time but also in retaining and stabilising specific qualitative features such as colour, fragrance, taste, and texture.

DRYING METHODS AND PACKAGING OF DRIED FIGS

Convective oven dehydration: In an oven HO450 Ibercelex with a dry bulb temperature thermometer and a humidity sensor, figs will be exposed in a single layer for dehydration by convective air. This treatment included a temperature ramp with an initial oven temperature of 50°C for 24 hours, followed by 60°C for 24 hours, and then 70°C for 12 hours. The drying procedure was carried out at a relative humidity of 15%. (RH).

Simple osmotic pre-treatment: Figs will be soaked in a solution containing 70% (w/v) sugar (glucose) for 24 hours at 30°C. The figs were then carefully wiped dry with tissue paper before being evenly spread in a single layer in a convection oven at 60°C and 15% RH for 48 hours.

Composite osmotic pre-treatment: Fresh figs will be steeped in an osmotic solution containing 50% (w/v) glucose and 10% (w/v) sodium chloride. The osmotic solution was immersed in for 24 hours at 30 degrees Celsius. The figs were then blotted dry and dried for 48 hours in a convection oven at 60°C and 15% relative humidity.

Chemical pretreatment: The fruits were immersed in an alkali emulsion of 10% (w/v) K_2CO_3 containing 1% (v/v) olive oil (AO), mixed with an osmotic solution of 60% (w/v) glucose, at 30ºC for 24 hours to improve the water permeability of fresh figs skin. Finally, the figs were blotted and exposed in a single layer, then dried for 24 hours in a convection oven at 60°C and 15% RH.

References

Yihun Tefera Sinti and Gebrie Teshome Aduye. (2020). Potential assessment and experimentalis of solar vegetable dryer: in case of northern Ethiopia . Sintie and Aduye Renewables 7:3.

Akpinar, E. K. (2010). Drying of mint leaves in a solar dryer and under open sun:
Modelling, performance analyses. Energy Conversion and Management,
51(12), 2407–2418.

Jeo Voinson, Ligia Zubik, Pramita bose and Najwa Samman and John Proch. 1999.
. Cereal Foods World. The functional food properties of figs.

Juan José Martínez-García, José Alberto Gallegos-Infante, Nuria Elizabeth Rocha-Guzmán, Patricia Ramírez-Baca, María Guadalupe Candelas-Cadillo, and Rubén Francisco González-Laredo. 2013. Drying Parameters of Half-Cut and Ground Figs (*Ficus carica* L.) var. Mission and the Effect on Their Functional Properties. Journal of Engineering .

M. E. Irget, U. Aksoy, B. Okur, A. R. Ongun, and M. Tepecik, "Effect of calcium based fertilization on dried fig (*Ficus carica* L. cv. Sarılop) yield and quality," *Scientia Horticulturae*, vol. 118, no. 4, pp. 308–313, 2008.

Effect of some Different Drying Methods on Quality Criteria of Dried Fig Fruits.

A Ronteltap, J C M van Trijp, R J Renes, L J Frewer. **2007.** Consumer acceptance of technology-based food innovations: lessons for the future of nutrigenomics. **Appetite.**

Heperkan, D., Meriç, B. E., Sismanoglu, G., Dalkiliç, G., & Güler, F. K. 2006. Mycobiota, mycotoxigenic fungi, and citrinin production in black olives. Advances in Food Mycology, 203–210

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KNOW MORE ABOUT SPECIAL CHROMOSOMES

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Introduction

While the majority of chromosomes follow conventional patterns of structure and function, there exist special chromosomes with unique features and roles. These chromosomes often deviate from the typical characteristics and perform specialized functions critical for specific biological processes. This chapter explores special chromosomes, highlighting their distinctive structures, functions, and significance in genetics and cell biology.

I.Ring Chromosomes

Ring chromosomes represent an intriguing class of chromosomal abnormalities characterized by their circular configuration, which arises from chromosomal rearrangements. These structural variants can have significant genetic consequences, impacting gene dosage, expression, and chromosomal stability. This chapter explores the characteristics, formation, clinical manifestations, and genetic implications of ring chromosomes, highlighting their role in chromosomal disorders and genomic instability.

Characteristics of Ring Chromosomes

Ring chromosomes result from breaks at both ends of a chromosome followed by fusion to form a circular structure. Unlike linear chromosomes with distinct telomeres at the ends, ring chromosomes lack telomeric sequences and exhibit a continuous circular configuration. The circularization process often leads to loss of genetic material from the chromosome ends, which can result in gene dosage imbalances and disrupted gene expression. Ring chromosomes vary in size and can involve any chromosome in the genome, although certain chromosomes are more commonly affected than others.

Formation of Ring Chromosomes

The formation of ring chromosomes typically occurs as a result of chromosomal breakage and fusion events during cell division. These events can be spontaneous or induced by exposure to genotoxic agents, radiation, or environmental toxins. Once formed, ring chromosomes may undergo further rearrangements or instability, leading to additional genetic alterations. The circular configuration of ring chromosomes can pose challenges for chromosome replication, segregation, and stability, contributing to genomic instability and chromosomal disorders.

Clinical Manifestations of Ring Chromosomes

Ring chromosomes are associated with a spectrum of clinical manifestations, ranging from mild to severe phenotypic effects. The phenotypic consequences of ring chromosomes depend on various factors, including the size of the ring, the genes involved, and the extent of genetic material loss. Common features associated with ring chromosome syndromes include developmental delays, intellectual disabilities, growth retardation, congenital anomalies, and dysmorphic features. The phenotypic variability observed in individuals with ring chromosomes underscores the complexity of their genetic effects and clinical outcomes.

Genetic Implications of Ring Chromosomes

Ring chromosomes can have profound genetic implications for affected individuals, impacting gene dosage, expression, and chromosomal stability. The loss of genetic material from the chromosome ends can disrupt normal gene function and regulatory mechanisms, leading to aberrant gene expression patterns. Ring chromosomes may also undergo further rearrangements or instability, resulting in additional genetic alterations and chromosomal abnormalities. Understanding the genetic implications of ring chromosomes is essential for diagnosing and managing chromosomal disorders and providing appropriate genetic counselling to affected individuals and families.

Ring chromosomes represent complex structural variants with significant genetic consequences for affected individuals. Their circular configuration, resulting from chromosomal rearrangements, can disrupt normal gene dosage, expression, and chromosomal stability, leading to a spectrum of clinical manifestations. Further research into the formation, clinical manifestations, and genetic implications of ring chromosomes is essential for advancing our understanding of chromosomal disorders, genomic instability, and the molecular basis of disease.

II. Isochromosomes

Abnormal Chromosomal Variants with Unique Genetic Consequences

Isochromosomes are structural abnormalities characterized by the duplication or deletion of one arm of a chromosome, resulting in two identical arms of either the long (q) or short (p) chromosome arm. These aberrations can lead to gene dosage imbalances, disrupted gene expression, and phenotypic abnormalities. This chapter explores the characteristics, formation, clinical manifestations, and genetic implications of isochromosomes, shedding light on their role in chromosomal disorders and genomic instability.

Characteristics of Isochromosmes:

Isochromosomes arise from errors in chromosome segregation during cell division, leading to the formation of chromosomes with two identical arms. The duplicated or deleted arm of the chromosome may lack genetic material or contain extra copies of specific genes, resulting in gene dosage imbalances and disrupted gene expression. Isochromosomes typically involve one chromosome arm and can affect any chromosome in the genome, although certain chromosomes are more commonly affected than others.

Formation of Isochromosomes

The formation of isochromosome occurs due to errors in chromosome segregation during cell division, particularly during mitosis or meiosis. These errors can lead to unequal distribution of genetic material between daughter cells, resulting in the formation of chromosomes with two identical arms. The duplicated or deleted arm of the chromosome may arise from misalignment of sister chromatids or aberrant recombination events during chromosome replication or recombination. Once formed, isochromosomes can be transmitted through generations and may contribute to genomic instability and chromosomal disorders.

Clinical Manifestations of Isochromosomes

Isochromosomes are associated with a spectrum of clinical manifestations, ranging from mild to severe phenotypic effects. The phenotypic consequences of isochromosomes depend on various factors, including the size of the duplicated or deleted segment, the genes involved, and the extent of gene dosage imbalances. Common features associated with isochromosome syndromes include developmental delays, intellectual disabilities, growth retardation, congenital anomalies, and dysmorphic features. The phenotypic variability observed in individuals with isochromosomes underscores the complexity of their genetic effects and clinical outcomes.

Genetic Implications of Isochromosomes

Isochromosomes can have significant genetic implications for affected individuals, impacting gene dosage, expression, and chromosomal stability. The duplication or deletion of one chromosome arm can disrupt normal gene function and regulatory mechanisms, leading to aberrant gene expression patterns. Isochromosomes may also contribute to genomic instability and chromosomal disorders through additional genetic alterations or rearrangements.

Understanding the genetic implications of isochromosomes is essential for diagnosing and managing chromosomal disorders and providing appropriate genetic counseling to affected individuals and families.

Isochromosomes represent abnormal chromosomal variants with unique genetic consequences for affected individuals. Their formation, resulting from errors in chromosome segregation, can lead to gene dosage imbalances, disrupted gene expression, and phenotypic abnormalities. Further research into the formation, clinical manifestations, and genetic implications of isochromosomes is essential for advancing our understanding of chromosomal disorders, genomic instability, and the molecular basis of disease.

References

Niss R, Passarge E. Derivative chromosomal structures from a ring chromsome. 1975;28:9–23

Watson A., Watson D., Taylor C. Life with r(20)-Ring chromosome 20 syndrome. Epilepsia. 2014;56:356–358. doi: 10.1111/epi.12729

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POST HARVEST MACHINERIES IN SPICES AND PLANTATION CROPS

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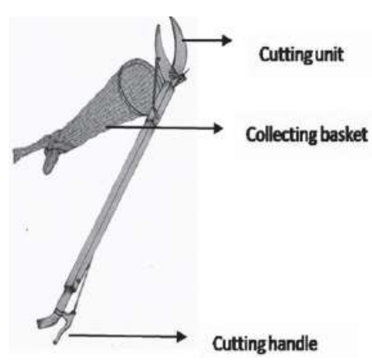
Introduction

Spices are high value export oriented crops and India is the major exporter of spices and spices products. In the quality aspect, the major consuming countries like Europe and USA are demanding more and more quality compliance by the producing countries. To meet this challenge it is necessary to equip in producing, processing and marketing high quality spices, with internationally accepted food safety standards. Hence, precautions has to be taken from harvesting, primary processing which includes washing, threshing, blanching, drying, cleaning, grading and packaging in order to meet the standards.

1. Black pepper

1 a. Pepper harvester

In general, the pepper spikes are nipped of by hand and collected in bags. Three models of Pepper harvester have been developed by the Department of Farm Machinery & Energy Department, Kelappai College of Agricultural Engineering and Technology, Kerala Agricultural University. Among the three, the model (Figure as shown) with a hollow rectangular aluminium pipe of suitable length with cutting unit, collection basket and cutting handle, is most efficient and user friendly due to its light weight, easiness in operation and minimum loss.

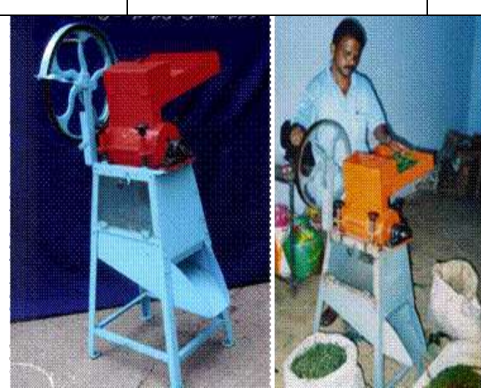


1 b. Mechanical pepper thresher

Harvested green spikes are heaped for a day before threshing to ease the separation of berries. In few plantations, mechanical threshers are used for separating and cleaning the berries, which would improve the quality of the product and increase the efficiency of operations. Threshers for pepper have been designed by different agencies and the details of some are given below.

Parameter	Model / Make of thresher			
	Gudalur thresher	**KAU thresher**	**TNAU thresher (Improved model)**	**Malaysian thresher**
Capacity (kgh^{-1})	600	50	200	600
Power source	2 hp motor	0.5 hp motor	1 hp motor	-
Threshing mechanism	Wooden cylinder with aluminium angles	Metal drum with rubber lining	Metal drum with rubber lined rasp bar	Metal drum with rubber lined rasp blades
Maximum efficiency (%)	99.50	98.00	99.60	99.80
No. of passes	2-3	2-3	2	2
Damage (%)	<0.3	<0.5	Negligible	-

Power operated pepper thresher



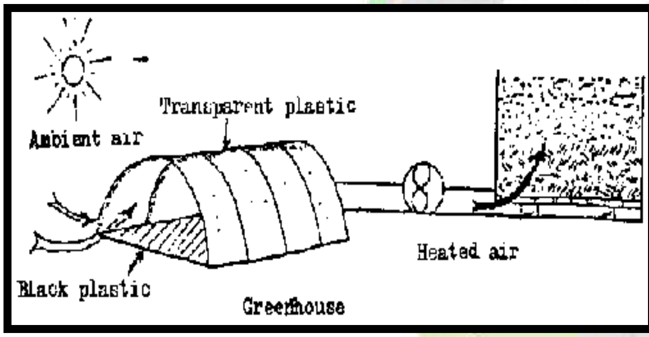
Hand operated pepper thresher developed by TNAU

1 c. Drying

Pepper has a moisture content of 60 - 70 % at harvest, which should be brought to safer levels of 10 -1 2 percent before drying. The green colour of the matured pepper is due to chlorophyll pigment. During drying, enzymatic browning sets in and the phenolic compounds are oxidized by atmospheric oxygen under the catalytic influence of the enzyme phenolase and eventually turn black. Sun drying is the conventional method followed to bring the moisture content below 10 %. The average dry recovery varies between 33-37 % depending upon the varieties.

1 d. Solar tunnel dryer for pepper (Coconut dryer and for drying all agricultural products)

Solar tunnel dryer is a cylindrical shaped drying chamber of size 2 m X 3 m to a height of 2 m for drying 100 kg of pepper. The floor is covered with black sheet of 200 micron thickness, which acts as absorber for better absorption of solar radiation. The metallic frame structures are covered by UV stabilized semi transparent polythene sheet of 200 microns.



1 e. Mechanical driers

Natural convection reverse air flow mechanical dryer developed National Institute of Interdisciplinary Science Technology, Thiruvananthapuram are used by the farmers and cottage scale industrial units for drying of black pepper. These dryers are also widely for drying coconut, spices, ayurvedic products, etc. This dryer has a capacity of 200-225 kg of berries per batch and takes 25-28 hours of drying time at 55-60° C temperature of drying chamber.

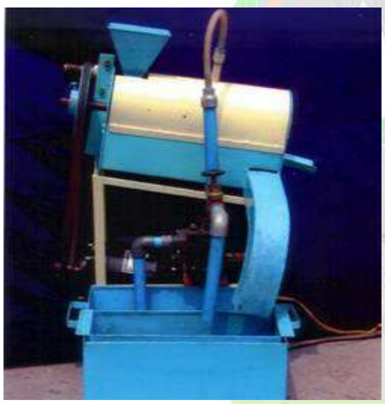
1 f. Cleaning and grading

A hand operated rotary type cleaner cum grader has been developed at Tamil Nadu

Agricultural University, Coimbatore to clean the pepper and grade according to the AGMARK specifications. the unit consists of a rotor for a length of 1.35 m and diameter 400 mm. Along the length of the rotor are three segments of 450 mm each with provision to place any sieves. Below each sieve there is an outlet.

A spiral is provided inside the rotor for easy conveying of the feed materials to the sieve perforations. At the centre of the rotor, a shaft is provided to mount the rotor on two bearings and rotate with a handle. A feed hopper to hold about 15 kg of pepper has been provided at the inlet end with appropriate side slopes for easy feeding of the materials into the sieves. The unit is provided with three sieves of sizes 3.5 mm, 3.8 mm and 4.8 mm diameters which are as per the AGMARK specifications for the grades, 2, 1 and bold respectively.

Peeler cum washer for the production of white pepper hygienically from ripe pepper berries.




2. Cardamom

Among the various spices cultivated in India, cardamom called the ' Queen of spices' is the true fruit of *Elettaria cardamom,* a tropical perennial shrub with pseudostem.

2 a. Drying

Cardamom capsules should be subjected to drying within 24-26 hours of harvest to avoid deterioration. Drying is one of the unit operations as it determines the colour of the end product, which is the attractive and most important quality character. There are mainly two types of drying *viz.*, natural (sun drying) and artificial drying using firewood or electricity as fuel.

i. Natural (sun) drying

Sun drying requires 5-6 days or more depending upon the availability of sunlight. Cardamom is prone to capsule splitting during sun drying as they are subjected to frequent turning during drying. Sun dried capsules are mainly converted into bleached cardamom.

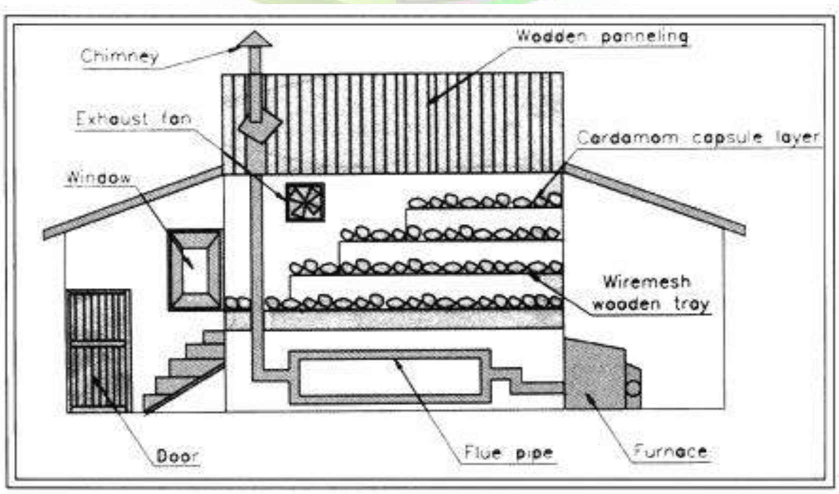
ii. Artificial drying

Using dryers artificial drying is achieved. Cardamom capsule looses about 70-85% moisture on drying. The normal conversion ratio of green to dry cardamom is 4 : 1 or 5 : 1, which varies according to size, moisture level and method of drying. The retention of natural colour is a positive index of quality.

iii. Kiln dryers

These type of dryers are widely used in cardamom plantations. Kiln dryer consists of a wood - burning furnace, heat exchanger pipe and drying racks in a chamber. The furnace is made up of fire bricks or ordinary bricks. The hot flue gas escape through the chimney after circulating air through 250 -300 mm diameter flue pipe made of mild steel sheets placed in the centre of the room. The heat is transferred to the chamber by radiation from hot surface to the flue pipe. Racks are kept at 1.2 m height from the flue pipe to avoid overheating.

The drying trays of 1 x 1m each containing about 3 to 4 kg fresh cardamom are arranged on the racks @ 3 to 5 trays / tier. The roof of the chamber is insulated from inside with wooden planks or asbestos sheets. The capsules kept for drying are separated thin and stirred frequently to ensure uniform drying. The fuel requirement is about 1 quintal per 100 kg of fresh cardamom. The drying air temperature is maintained at 45-55°C by controlling the supply of wood in the furnace. The drying time is about 24 - 36 hours. Exhaust fans are provided to flush out moisture - laden air.



Disadvantages

(i) The whole process takes about 24 - 36 hours and kilns have very low thermal efficiency

(ii) The average fire wood requirement is 1 quintal per 100 kg of fresh cardamom, which leads to deforestation

(iii)The construction costs of kiln is high

iv. Electrical dryer

cardamom dryer consists of combuster, blower, chimney, hot air duct , drying chamber, hot air recirculation duct, control panel, combustion blower, thermostat etc. The flue gas is produced by burning firewood in the combuster in excess of air with near complete combustion of the fuel. the air is supplied by means of blower which is operated by 0.25 hp motor. A suitable chimney is provided with appropriate height to induce draft for complete combustion of the fuel. A thermostat is fitted at the plenum chamber to control the temperature of the hot air. A perforated wire mesh is fitted at the bottom of the drying chamber to hold the cardamom capsules to a height of 30 cm. An exhaust duct is provided to vent out moisture laden air to prevent condensation. A recycling duct is provided for recirculation of the hot air if the relative humidity of the air drops below 60 %. The temperature of the hot air varies from 45 -80° C during the drying process. The stage of completion of drying is assessed by hearing the sound of the seeds inside the capsules.

2 b. Garbling

Garbling is the process of removal of flower stalks from the dried cardamom. Traditionally, this is achieved by rubbing against coir mat or wire mesh and winnowed to remove any foreign matter. Power operated garbling drum is being used in plantations which is powered by 0.5 hp and has a batch capacity of 5 kg. Garbling done using gunny bags or on a wire mesh, is popular in the cardamom plantations. Use of gunny bags to hold and garble the cardamom is cumbersome and also results in dust pollution.

An oscillatory type semi mechanical garbling unit developed by TNAU has a capacity of 2-3 kg per batch whereas the rotary garbler will take about 2-3 minutes to garble one batch of about 5 kg. Its capacity is 100 kg/h and the efficiency was 98%.

3. Ginger

India and China are the world's largest producers and exporters of ginger. In India, domestic market prefers fresh green ginger for culinary use while two other types of dried ginger i.e. bleached and unbleached are also produced for export purpose. The fresh ginger immediately after harvest is subjected to washing, which is performed to remove dirt, residues of farm chemicals and other foreign materials.

After washing the ginger rhizomes are subjected to peeling operation. Indigenously, peeling of ginger is done by scraping with sharpened bamboo stick. The scraped or peeled rhizomes are again washed well and dried in sun for a week or more and then rubbed again to give a polish.

3 a. Ginger Peeler

A **mechanical brush type ginger peeling machine** consists of two continuous brush belts being driven in opposite direction with a downward relative velocity by a variable speed motor. The parameters optimized are brush belt spacing (1 cm) and belt speed (65 rpm) of the driving brush belt resulting in the belt relative velocity of 199 cm/s. Number of passes required is 4 to 5. The peeling efficiency of the mechanical brush type ginger peeling machine developed by Rajasthan Agricultural University is 85 % and the capacity is 200 kg/hr.

The sun dried ginger is brown in colour, more or less irregular wrinkled surface and when broken, shows a dark brownish colour. However, it is reported that the quality of dry ginger in the bright sun is better than the quality of ginger cured in a closed oven with artificial heat.

3 b. Dried Ginger polisher

Polishing of dried ginger is done to remove the wrinkles developed during drying process. In the indigenous method, the dried ginger is rubbed against a hard surface. However, hand or power operated polishers similar to turmeric polishers are also employed for the purpose of polishing dried ginger. In the case of hand operated polishers an output of 5-6 quintals per day of 8 hours is obtained with the help of two persons. The dried ginger rhizomes are manually graded. The machines of various capacities to pulverize dried ginger from 25 kg per batch to continuous powdering of 2-3 t /day for large scale production are available.

4. Turmeric

Maturity of the crop is indicated by complete drying of the aerial parts of the plant including the base of the stem. The leaves and stem are cut close to the ground. Two days earlier to digging out the rhizomes, irrigation is given. In case of ridge method of planting, plough is used to lift the rhizomes or it is lifted manually. The harvested rhizomes have to be cured within 2-3 days after harvest for securing maximum out turn.

4 a. Turmeric Harvester

In order to save the time taken for digging out the rhizomes mechanical harvesting is practiced in the turmeric growing regions of Tamil Nadu.TNAU has developed a power tiller operated mechanical turmeric harvester with a capacity to harvest 0.6 ha per day. Tractor drawn turmeric harvester mounted on 35-45 hp tractor with a capacity to harvest 1.6 ha per day have also been developed by TNAU. The tractor mounted harvester may be adjudged as the best mechanical harvester for saving of time and reduce the percentage of damaged rhizome apart from the removal of drudgery in harvesting of quality rhizomes.

Power tiller operated turmeric harvester

Tractor drawn turmeric harvester

4 b. Turmeric Boiler

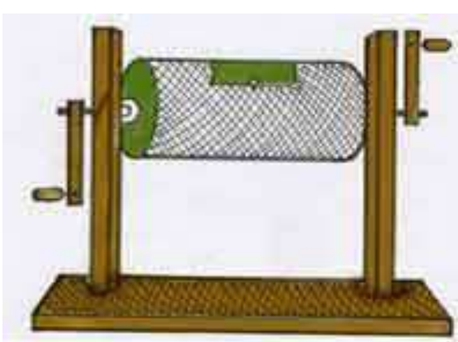
The harvested turmeric rhizomes are converted into a stable commodity before entering into the market through a number of post harvest operations like boiling, drying, polishing and colouring.

Boiling is a recommended practice that involves cooking of fresh rhizomes in clean water in mild steel or galvanized iron pans for about 60-90 minutes. The cooked fingers are then heaped on a cleaned drying floor and left undisturbed for 4-5 hours and later sun dried for 10-15 days by spreading in 5-7 cm thick layers on bamboo mat or on the drying floor.TNAU has developed an improved turmeric boiler using steam boiling technique. The capacity of the boiler is about 200-300 kg per batch and 40 quintals per day for 8 hours. Fuel used is 70-75 kg of agricultural waste materials.

In the commercial large scale steamers, a capacity of 1 tonne / batch, steam released from the boiler at a pressure of 2 kg/ cm^2 is used for boiling rhizomes by open steaming. The time taken for boiling / cooking is 10 - 15 minutes. The fuel required for steam production is about 18 -20 kg crop residues/ wastes per batch.

4 c. Turmeric polisher

Poor appearance of dried turmeric is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Manual polishing gives rough appearance and dull colour in the rhizome. A mechanical polisher for turmeric has been developed by the Agricultural University at Andhra Pradesh.



The unit consists of 88 cm diameter mild steel drum with meshes and is operated by a 2hp electrical motor. The drum speed is maintained at 30-32 rpm and the capacity of the polisher is about 600-700 kg/hr. A pedal operated hexagonal drum having six polishing plates of size 30 X 40 cm has been developed by OUAT. The capacity of this polisher is 100 kg/hr and 6 % polishing is achieved

5. Thresher for fennel and cumin

Tradionally, threshing of seed spices is performed by treading the crop under the tyre of tractor or by stick beating and then the threshed stocks are cleaned by winnowing in natural air steam or in the artificial air streamimg the processed products. The newly modified threshers for threshing cumin and fennel developed by CRSS, Jagudan was found to be economicall when compared to conventional method of drying.

6. Areacanut Dehusker

This machine is used to dehusk the dried arecanut. It consists of a mainframe on which a rotary shelling drum having 8 Nos. of solid rubbers on its periphery is mounted (like rasp bar threshing cylinder). Below this a concave is placed to aid shelling and to pass the dehusked material down. After dehusking, kernels and husk flow into the duct and reach the air stream, produced by a blower. The husk is thrown out and the kernels / nuts are collected at the bottom. Depending upon the size of fruits, the concave has to be changed for higher efficiency and minimum breakage. Grading the dried fruits before dehusking will also help to increase the dehusking efficiency and reduce the breakage.

7. Pulper cum Washer for Coffee beans

Pulping and washing are the two estate level important operations in the processing of coffee parchments. This unit consists of pulping unit and a washing unit. Compared to the traditional pulpers and washers, which are operated separately with two different power units, this unit is operated by a single power source. Besides the water requirement for pulping and washing is reduced considerably.

8. Tree climber for harvesting coconut

This manually operated coconut tree climber developed by TNAU is useful for climbing coconut trees for harvesting nuts, cleaning and other operations. Any unskilled person including ladies can climb the coconut trees using this unit. Requires 1.5 minutes to climb a tree of 30 to 40 ft height.

9. Solar tunnel for drying coconut (TNAU model)

The TNAU model of solar tunnel dryer is made up of semicylindrical shaped tunnel with a base area of 3.75 m x 18 m for capacity of 1 tonne per batch for drying of coconut. Metallic frame structure of tunnel dryer is covered by UV stabilized semi transparent polythene sheet of 200 micron thickness..

Length of the dryer depends upon type and quantity of the product to be dried per batch. A slope of 10-15° is provided along the length of the tunnel. An exhaust fan at the upper end of the tunnel, and a few chimneys on the top of the tunnel are provided to remove the moist air

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UNVEILING THE SECRETS OF ORCHID CARE: A GUIDE TO CULTIVATING EXOTIC BEAUTY AT HOME

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Introduction

Ever dreamed of adding a touch of the extraordinary to your living space? Orchids, with their captivating beauty and unique charm, offer just that. These fascinating plants, boasting a stunning array of varieties and distinct characteristics, are sure to spark curiosity and wonder in anyone who encounters them. Beyond their aesthetic appeal, cultivating orchids at home can be a rewarding experience, transforming your space into a serene oasis and offering a natural way to alleviate stress and enhance well-being. These plants exhibit extraordinary diversity, with over 28,000 species and numerous hybrids. Their adaptability to various environments, ranging from tropical rainforests to high-altitude mountains, highlights their remarkable resilience.

Orchids are renowned for their exquisite beauty and intricate adaptations. Their flowers, often possessing a unique lip-like structure, have evolved to entice specific pollinators through a dazzling array of shapes, colors, and fragrances. This specialized co-evolutionary relationship is a hallmark of orchid diversity. Unlike most plants rooted in soil, many orchids are epiphytes, anchoring themselves to trees or rocks. This aerial lifestyle allows them to access sunlight and nutrients from the air, rain, and decaying organic matter. This unique growth habit has contributed to their ability to thrive in diverse habitats, from tropical rainforests to temperate regions.

These extraordinary characteristics, coupled with their complex reproductive strategies, have made orchids a subject of fascination for botanists and horticulturalists alike.

Cultivating Orchids at Home: A labor of Love

Orchids, with their delicate blooms and air of exotic mystery, have captivated plant lovers for centuries. While they may seem demanding, many orchid species can thrive in home environments with proper care. Let's demystify orchid cultivation and unlock the secrets to enjoying their breathtaking beauty in your own home.

Embracing the Epiphytic Nature:

Unlike most houseplants that thrive in soil, orchids are epiphytes, meaning they naturally grow on other plants, drawing moisture and nutrients from the air and their surroundings. This unique adaptation requires a different approach to potting and watering. Instead of soil, orchids prefer well-draining mediums like bark chips, coconut husk, or sphagnum moss, which mimic their natural environment.

Creating the Perfect Oasis:

The key to happy orchids lies in replicating their native tropical conditions as closely as possible. This involves paying close attention to three crucial factors:

- **Light:** Orchids crave bright, indirect light. Think dappled sunlight filtering through a tree canopy. Avoid placing them in direct sunlight, which can scorch their delicate leaves. A good rule of thumb is to observe the leaves: dark green indicates insufficient light, while yellowish leaves suggest too much.
- **Humidity:** Native to humid environments, orchids thrive in humidity levels of 40-70%. Regular misting, using a humidifier, or grouping orchids together can help achieve this. Placing your orchid on a tray filled with pebbles and water can also increase humidity around the plant.
- **Temperature:** Most orchids prefer daytime temperatures between 18°C and 29°C (65°F and 85°F) with slightly cooler nights. However, specific temperature needs can vary depending on the species. Researching your specific orchid type is crucial.

Watering Wisely:

Overwatering is a common pitfall in orchid care. Remember, orchids are adapted to infrequent rainfall followed by periods of drying. Allow the potting medium to dry out slightly between waterings. Feel the medium with your finger – if it's dry to the touch, it's time to water. When watering, thoroughly soak the medium, allowing excess water to drain completely.

Watering methods:

- **Soaking:** Immerse the entire pot in lukewarm water for 10-15 minutes, allowing the potting medium to absorb moisture.
- **Hand watering:** Carefully pour water over the potting medium, ensuring even distribution.

Nurturing Growth:

Repotting an Orchid

Repotting orchids is essential for their continued health and successful growth. This process demands a gentle touch and careful attention to detail to ensure the orchid thrives in its new environment. Following the proper steps provides the orchid with optimal conditions for continued growth and overall well-being.

- **Choose the Right Pot:** Select a pot that is specifically designed for orchids, with drainage holes to prevent waterlogged soil. This is essential for orchids, as they are prone to root rot if the soil is too moist. A pot with good drainage will help to prevent this and ensure that the roots of the orchid receive the right amount of moisture.
- **Prepare the Potting Mix:** Use a well-draining orchid potting mix that is specifically designed for orchids. This type of mix is usually made from a combination of materials such as bark, sphagnum moss, and perlite, which provide good drainage and aeration for the roots. Avoid using regular potting soil, as it can retain too much water and cause root rot.
- **Remove the Orchid:** Gently remove the orchid from its old pot, taking care not to damage the roots. If the orchid is stuck in the pot, gently rock it back and forth to loosen it. If the roots are circling around the inside of the pot, use a sterile knife or pruning tool to carefully cut them away from the pot.
- **Prune Roots:** Remove any dead or decaying roots from the orchid. This is an important step, as dead roots can cause the orchid to become diseased or infested with pests. Use a sterile knife or pruning tool to carefully cut away any dead or damaged roots.
- **Repot:** Place the orchid in the new pot, ensuring that the roots are spread out evenly. Fill in with fresh potting mix, making sure to leave enough space between the roots and the potting mix for proper drainage. Water the orchid gently but thoroughly after repotting, and provide it with bright, indirect light and moderate temperatures.

Tips and Considerations:

- ✓ Repot an orchid in the spring or summer, when it is actively growing.
- ✓ Use a pot that is slightly larger than the previous one, to give the roots room to grow.
- ✓ Avoid repotting an orchid that is in bloom, as this can cause the flowers to drop off.
- ✓ Water the orchid carefully after repotting, as the roots may be sensitive to moisture.

Nutrition for Orchid Health

Maintaining healthy orchid growth and encouraging vibrant blooms relies heavily on proper fertilization techniques. While orchids are not heavy feeders, regular nourishment with a diluted fertilizer plays a crucial role in promoting robust growth and abundant flowering.

- **Selecting the Ideal Fertilizer:**
- ✓ A balanced fertilizer, containing equal parts nitrogen (N), phosphorus (P), and potassium (K), such as a 20-20-20 formulation, provides a solid nutritional foundation.
- ✓ Commercial fertilizers specifically formulated for orchids offer a convenient option, delivering essential nutrients in optimal ratios.
- ✓ Dilution, according to package instructions, is crucial to prevent root damage from over-fertilization.
- **When to Fertilize:**
- ✓ Orchids benefit most from fertilization during their active growth periods, typically spring and summer.
- ✓ Reducing or halting fertilization during fall and winter, when growth naturally slows, is recommended.
- ✓ Fertilizing should be avoided entirely when the orchid is in bloom or recovering from stress.
- **Effective Fertilization Techniques:**
- ✓ Watering with a diluted fertilizer solution allows for efficient nutrient absorption through the roots.
- ✓ Foliar feeding, misting the leaves with a diluted fertilizer solution, provides an alternative method, though flowers should be avoided.
- **Preventing Fertilizer Buildup:**
- ✓ Periodically flushing the potting medium with clean water helps remove excess salts that can accumulate over time.

- ✓ Regular repotting with fresh potting mix aids in preventing fertilizer buildup and maintains a healthy growing environment.

Observing an orchid's response to fertilization and adjusting techniques accordingly are essential for optimal plant health. Specific fertilization needs can vary depending on the orchid species and its growth stage.

Dive into the Diverse World of Orchids: Finding the Perfect Bloom for Your Home

Orchids, celebrated for their captivating beauty and remarkable diversity, provide a world of possibilities for plant enthusiasts of all levels of experience. While cultivating certain rare and exotic species demands a seasoned hand, a multitude of stunning orchids flourish in typical home environments when provided with appropriate care. From beginners embarking on their orchid journey to seasoned growers seeking new challenges, an orchid awaits to grace every home with its unique elegance. Here are some examples:

For the Budding Orchid Enthusiast:

- **Phalaenopsis (Moth Orchids):** These orchids are the gateway to the captivating world of orchid growing. Their elegant, long-lasting blooms resemble moths in flight and come in a stunning array of colors. Phalaenopsis orchids are incredibly forgiving, tolerating typical household conditions with ease. Bright, indirect light and moderate humidity are all they need to thrive.
- **Dendrobium Orchids:** Bursting with personality, Dendrobium orchids offer a delightful variety of flower shapes, sizes, and colors. These orchids are known for their abundant blooms, often producing multiple flowers on a single spike. They are relatively low-maintenance and adapt well to indoor environments.
- **Cymbidium Orchids:** If you're looking for a statement piece, look no further than Cymbidium orchids. These beauties produce large, long-lasting blooms on sturdy stalks, making them perfect for adding a touch of drama to your space. They prefer cooler temperatures and slightly lower light levels than other orchids, making them ideal for cooler rooms.

Leveling Up: Orchids for the Intermediate Grower:

- **Cattleya Orchids:** Considered by many to be the epitome of orchid beauty, Cattleyas are prized for their large, fragrant, and vibrantly colored blooms. These orchids require a bit more attention to detail, needing specific light, humidity, and temperature fluctuations to thrive. However, the reward of their breathtaking blooms is well worth the effort.

- **Paphiopedilum (Lady's Slipper Orchids):** These unique orchids are sure to spark conversation with their unusual, pouch-shaped flowers that resemble a lady's slipper. While they can be a bit more challenging to bring into bloom, their striking appearance and relatively easy-going nature make them a rewarding addition to any orchid collection.
- **Oncidium Orchids:** Known for their cheerful disposition and cascading sprays of small, vibrant flowers, Oncidium orchids, also called "Dancing Lady Orchids," bring a touch of whimsy to any room. They prefer bright, indirect light and slightly higher humidity levels than some other orchids.

Rare and Exotic Orchids: For the Experienced Grower

Experienced orchid growers seeking a true challenge can delve into the world of rare and exotic orchids. These exquisite and often delicate species require specialized knowledge and meticulous care to flourish. Some captivating examples include:

- ***Phalaenopsis amabilis*** **(Moon Orchid):** This species is known for its large, pure white flowers and is a great choice for those who want to add a touch of elegance to their orchid collection.
- ***Cattleya trianae:*** The national flower of Colombia, this stunning orchid is prized by collectors for its beauty and rarity.
- ***Paphiopedilum rothschildianum*** **(Gold of Kinabalu Orchid):** This highly prized and rare species is known for its large, exotic flowers and is a great choice for experienced growers who want to add a unique touch to their collection.

Selecting the right orchid involves careful consideration of an individual's experience level, available space, and the specific growing conditions a home environment provides. With a vast array of orchid varieties available, a perfect match exists for every enthusiast, from novice to expert. This guidance aims to empower individuals in discovering the ideal orchid to thrive in their care.

Safeguarding Orchid Health: Pest and Disease Prevention

While orchids bring joy with their beauty, they are not immune to the challenges of pests and diseases. Regular inspection for common culprits like snails, aphids, mealybugs, and scale insects is crucial. Wrap copper tape around the rims of pots or trays to prevent snail infestations. Prompt treatment with insecticidal soap or neem oil can effectively address infestations. Maintaining good air circulation and avoiding overwatering are essential practices for preventing fungal and bacterial infections.

Encouraging Blooms and Providing Post-Bloom Care

Achieving consistent orchid blooms relies on providing adequate light, appropriate temperature fluctuations, and proper fertilization. Once flowering concludes, trimming the spent flower spike encourages the plant to direct its energy towards new growth.

Expanding the Orchid Collection through Propagation

Orchid propagation offers a rewarding experience, allowing for the expansion of the orchid collection while enjoying the process of nurturing new plants.

Methods of Orchid Propagation

Several methods can be employed to propagate orchids, including:

- **Division**: Suitable for mature, multi-pseudobulb orchids, division involves separating the plant into two or more sections, each with its own roots and growth points.
- **Keikis**: These are plantlets that grow on the flower spike or occasionally on the plant's main stem. Once they develop roots, they can be removed and potted separately.
- **Backbulbs**: Older pseudobulbs can sometimes produce new growth. Once they develop roots, they can be separated and potted individually.

Providing Optimal Conditions for New Plants

Newly propagated orchids require special care to thrive. High humidity, bright, indirect light, and consistent warmth are essential. A well-draining potting mix should be used to prevent root rot, and fertilization should be avoided until new growth appears.

Tips for Successful Propagation:

- Sterilizing cutting tools before and after use helps prevent the spread of disease.
- Gentle handling during the propagation process is crucial to avoid damaging delicate roots or leaves.
- Patience is key, as orchid propagation can be a gradual process. Providing consistent care and allowing adequate time for development are essential for success.

With an understanding of these propagation methods and a commitment to providing optimal conditions, orchid enthusiasts can expand their collections and revel in the satisfaction of nurturing new plant life.

Conclusion

The journey of orchid cultivation is a rewarding endeavor, blending artistic appreciation with scientific understanding. Creating a thriving orchid collection relies on a deep understanding of their unique needs, providing optimal growing conditions, and mastering propagation techniques. Patience is essential when cultivating orchids. These plants may require some trial and error to determine their ideal care regimen. Close observation of the plants is crucial, and seeking advice from experienced orchid enthusiasts or experts can be beneficial when challenges arise. With dedication and care, an orchid collection can bring beauty and joy to any space. The process of nurturing these extraordinary plants can be a deeply enriching experience, providing a sense of accomplishment and connection to nature. Cultivating orchids is a lifelong journey that requires commitment, patience, and a willingness to learn. By embracing the challenges and rewards of orchid cultivation, one can develop a deeper appreciation for these unique and fascinating plants.

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A BIRD'S EYE VIEW ABOUT APPLICATION OF NANOTECHNOLOGY IN AGRICULTURE

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Abstract

In several domains pertaining to human endeavours, nanotechnology is a recently developed and rapidly growing technology. Several study discoveries have demonstrated the remarkable phenomenon that nanoparticles and nanostructures enhance numerous capabilities because of their tiny size, higher surface area and highly catalytic nature. A decrease in crop productivity and a rise in food demand are only two of the extraordinary issues that global agriculture is experiencing as a result of the world's population growing at an unprecedented rate, frequent extreme weather events and environmental degradation. Achieving food security particularly in the field of agriculture requires the use of nanotechnology. Through efficient microbial, pest and weed management with high economic value, security and safety, it can increase crop productivity. Moreover, nanotechnology reduces post-harvest losses by improving stability and security. Commonly employed nanoparticles such as Ag, Zn, TiO_2, ZnO, SiO_2, and MgO may potentially pose health problems because of their quick ability to enter cells and cause negative responses in human tissue, animal organs and plant components. Future study might reduce the dangers associated with nanoparticles by employing more environmentally friendly synthesis techniques and looking for simple, low-cost procedures for breaking down and removing existing nanomaterial from attack areas. This review discusses the relationship between agriculture and nanotechnology, emphasising some of the negative effects of this technology on agricultural plants.

KEYWORDS: Nanotechnology; Nanoparticle; Nanofungicides; Nanoherbicides; Nanosensors

Introduction

The population of the globe is predicted to increase and will exceed 9.8 billion people by the year 2050 (UN, 2022). The farming sector is and in the years to come will be central to the economic growth of India. Since its inception, agriculture has steadily and exponentially improved. Mechanisation has increased dramatically in the first half of the last century, while innovations like marker-assisted breeding and transgenic agricultural production have contributed to the second half. More study was conducted on soil health, microbiota, and biofertilizers in the decade prior to the last one. (Moulick et al. 2020). As global population is increasing at a very fast rate with finite resources, increasing crop productivity is crucial to agriculture. A few potential applications for nanotechnology in agriculture include genetic enhancement, increased yield, crop protection from pests and diseases and crop health monitoring using nanosensors. Therefore, in order to advance agriculture, we ought to have to make one audacious move. Naturally, the question of what this significant technology is plagues us. If we were to travel back in time to Feynman's 1959 lecture, "Plenty of room at the bottom," we would discover that the nanoprocess is in underway. Subsequently, the actual word nanotechnology was proposed by Professor Norio Tanaguchi in 1974 (Prasad et al. 2017). In this review article, a limelight on the potential applications of nanoparticles and nanobiosensors in agriculture as well as their recent developments is given.

DEFINITION OF NANOTECHNOLOGY

"Nanotechnology can be defined as the art and science of manoeuvring matter at the nanoscale" the characterization, form, production and application of structure, device and system by handling shape and size at nanoscale. It encompasses materials having size less than 100 nm and one nanometer is 10^{-9} meters (European Commission).

Some Unique Characteristics of Nanoparticles-

- Nanoparticles are more reactive and have a higher charge density because of their small size.
- Due to large surface to volume ratio, the nanoparticles possess greater strength, increased resistance to heat, decreased melting point and different magnetic properties of Nano-clusters.

- The occurrence of tetrahedral, cubic, and spherical nanoparticles is associated with increased catalytic activity; these structures are known to enhance chemical reactivity at the sharp corners and edges of the former (Abobatta, 2018).

APPLICATION OF NANOTECHNOLOGY IN AGRICULTURE

Application of Nanotechnology in agriculture can be fruitful if natural processes are simulated in a great scientific manner for successful implementation. For transforming agricultural sector, Nanotechnology is a prospective tool. It provides assistance for knowing the biochemical mechanisms of crops by improvement of conventional practices for determining environmental factors and in application of fertilizers and pesticides. In near future, this technology can be visualized as an economic driving force for a longer period (Sangeetha et al., 2017). Applications of Nanotechnology in Agriculture are depicted in figure 1 below:

- Analysis of gene expression and regulation
- Detection of plant disease
- Improvement of crop
- Increase efficient fertilizers and pesticides
- Soil and water management.

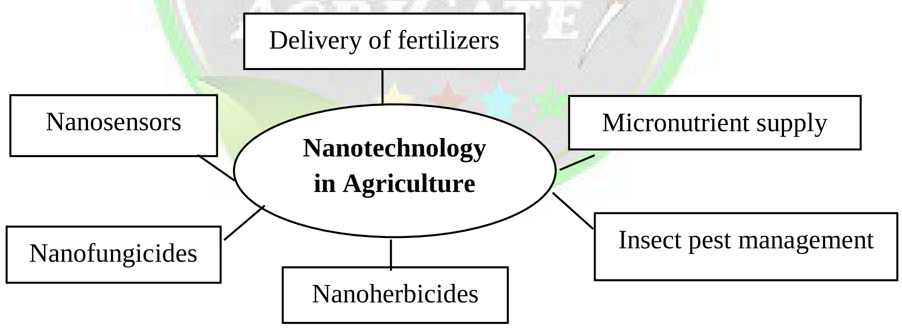

Figure1. Application of Nanotechnology in Agriculture

Biosynthesis of Nanomaterials and Their Use in Agriculture

Synthesis of nanoparticles can be done by physical, chemical and biological methods. As biological synthesis is economical and environment friendly so, plant leaf extract is used commonly for synthesis. Solvents like water, ethanol or methanol can be used to prepare plant leaf extract. By mixing plant extract and metal salt solution at desired pH, nanoparticles of interest are synthesized (Elumalai, 2015).

Silver nanoparticles- Experiments have shown that application of silver nanoparticles at the concentration of 10µg/ ml can be used to substantially increase potential of seed germination, mean germination time, seed vigour index, seed germination index, dry and fresh weight of seedling (Duhan et al., 2017).

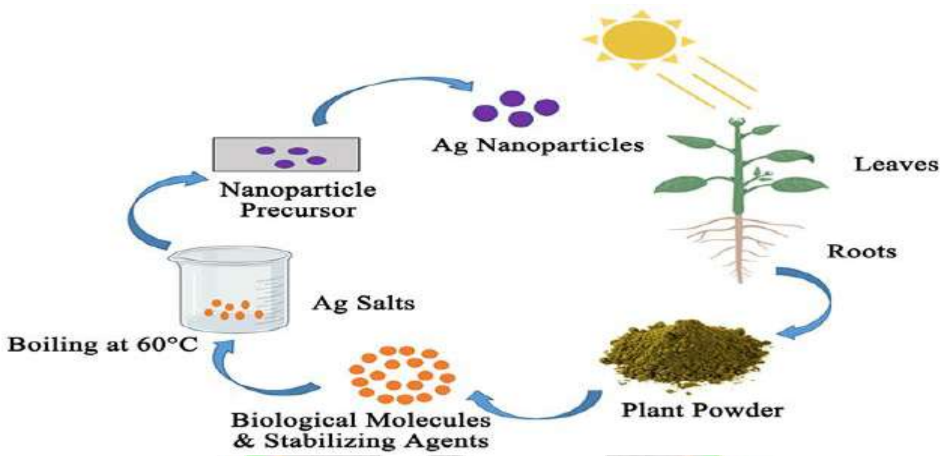

Figure 2. Biosynthesis of silver nanoparticles (Khan et al. 2022)

Zinc oxide nanoparticles- In farm production, alkaline soils with calcium carbonates are severely affected by Zinc deficiency and because of unavailability of zinc to plants, its application as fertilizer is limited. Application of zinc oxide nanoparticles can solve this problem as these nanoparticles provide more soluble and available form of zinc to plants because of higher reactivity than micron- or millimetre-sized zinc particles present in bulk. Also, zinc oxide nanoparticles can be used as antibacterial formulation against *Pseudomonas aeruginosa* (Bhumi and Savithramma, 2014).

Titanium dioxide (TiO_2) nanoparticles- Because of its non-toxic nature, it has great pathogen disinfection efficiency and because of its photo catalytic activity it is useful for degradation of pesticides (Pelaez et al., 2012).

Micronutrient Supply- Micronutrients such as boron, copper, iron, manganese, molybdenum, zinc etc. are essential for the maturation and improvement of health of plants. Micronutrient nano-formulations can be sprayed on plants or can be supplied to soil for uptake by roots to enhance soil health and vigor (Peteu et al., 2010). Schematic representation of few nanoparticles used in crop protection or fertilizer application is shown in figure 3.

Nanofertilizers- Nutrient absorption by plants from soil can be increased by using nanofertilizers. These nanofertilizers balance the release of fertilizers with their absorption by the plant and thus prevent the nutrient losses and also eliminate unwanted nutrients interaction with microorganisms, air and water. Nanofertilizers encapsulated nanosilica helps in preventing infections and enhance growth of plants under high temperature, humidity and also improve plant resistance to diseases. Growth of seedlings and root development can be enhanced by application of silicon-based fertilizers as silicon dioxide nanoparticles (Hutasoit et al., 2013; Emadian, 2017).

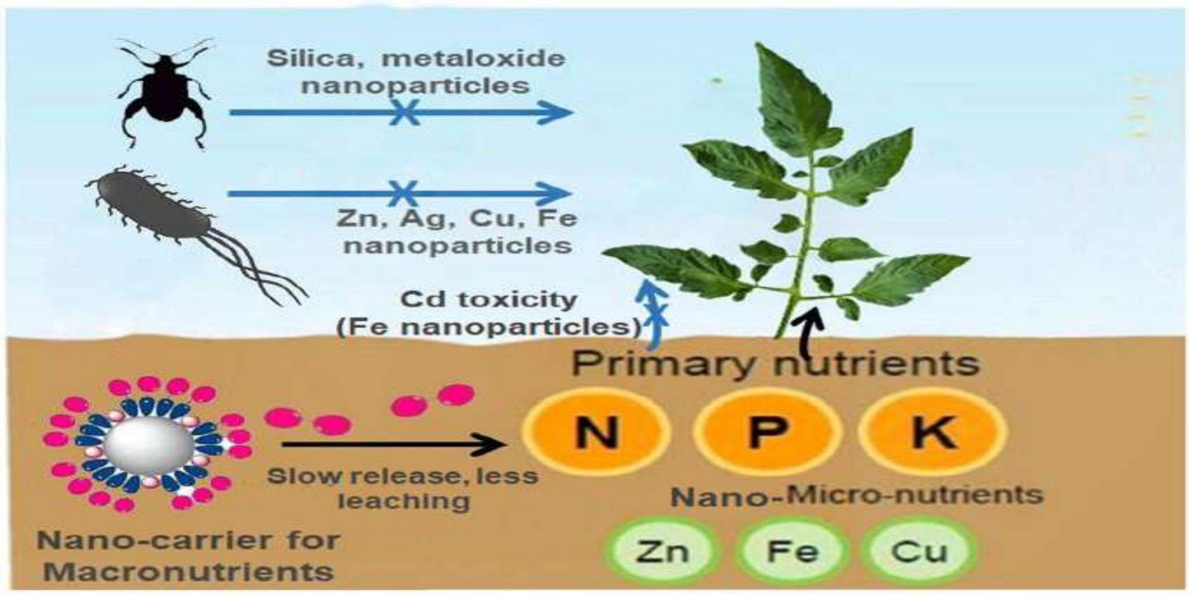

Figure 3. Schematic representation of few nanoparticles used in crop protection or fertilizer application (Moulick et al. 2020)

Biofertilizers- Biofertilizers include living, beneficial microorganisms like fungal mycorrhizae, *Azospirillum, Azotobacter, Rhizobium* and blue green algae, phosphate solubilising bacteria such as *Pseudomonas* and *Bacillus*. Application of gold and silver nanoparticles as a growth promoting materials has been found effective. These nanoparticles with natural biofertilizers such as *Pseudomonas fluorescens, Bacillus subtilis* and *Paenibacillus elgii* have resulted in very good growth enhancement under in-vitro conditions. Moreover, they are cost effective and are needed in very minute quantity than other fertilizers as one litre of nano-biofertilizers can be used in several hectares of crops (Dikshit et al. 2013; Shukla et al. 2015).

Nanofungicides- Experiments have shown that because of good adhesion on bacterial and fungal cell surface, well diffused and sustained nanoparticles solution can act as an excellent fungicide. For *Macrophomina phaseolina*, which is the main soil borne pathogen of pulse and oilseed crops, antifungal activity of nanoparticles of zinc oxide (35–45 nm), silver (20–80 nm) and titanium dioxide (85–100 nm) has been tested. And results showed higher antifungal effect of silver nanoparticles at lower concentrations in comparison to nanoparticles of zinc oxide and titanium dioxide (Shyla et al. 2014).

For checking the resistance against phytopathogens, *Fusarium oxysporum* and *Aspergillus niger*, maize was treated with nanosilica (20–40 nm) for comparing with that of bulk silica. The result showed that plant treated with nanosilica has a higher expression of phenolics compounds (2056 and 743 mg/mL respectively) in collected leaf extracts and a low expression of stress-responsive enzymes against these fungi. Also, higher resistance was seen in maize treated with nanosilica in comparison to bulk in respect of disease index and expression of total phenols, phenylalanine ammonia lyase, peroxidase and polyphenol oxidase, at 10 and 15 kg/ha. Therefore, silica nanoparticles can be used as an alternate antifungal agent against phytopathogens (Suriyaprabha et al. 2014).

Nanoherbicides- Weeds are the biggest problem in farming and a threat for declining the crop yield to a greater quantity because they take up the nutrients of main crop plants. Their removal by conventional methods is labour-intensive. With the application of Nanoherbicides, target specific nanoparticles loaded with herbicide has been developed for delivery in roots of weeds. These substances permeate the weeds' root systems, translocate the cells and block metabolic processes like glycolysis. This ultimately leads to death of plants (Ali et al. 2014).

Insect pest management- Nanoparticles possess an outstanding opportunity for management and control of insect-pests in modern agriculture. Polyethylene glycol-coated nanoparticles enhanced the insecticidal activity of garlic essential oil against *Tribolium castaneum* (red flour beetle) (Yang et al. 2009). Goswami et al. (2010) studied the application of different types of nanoparticles such as aluminium oxide, silver nanoparticles, titanium dioxide and zinc oxide for controlling rice weevil (caused by *Sitophilus oryzae*) and grasserie disease in silkworm (caused by *Bombyx mori* and baculovirus BmNPV (Bombyx mori nuclear polyhedrosis virus). Entomotoxicity of silica nanoparticles against rice weevil *Sitophilus oryzae* was compared with the potency of bulk-sized silica (individual particles larger than 1.0µm). The results showed higher potency of amorphous silica nanoparticles against this insect pest with 90% mortality and also indicated the effectiveness of silica nanoparticles to control insect pests (Debnath et al. 2011).

Nanobiosensors- Nanobiosensors have an effective usage in agriculture for sensing a vast array like fertilizers, herbicide, pesticide, insecticide, and moisture and soil pH. These nanosensors detect the occurrence of plant viruses, crop pathogens and level of soil nutrients. Bionanosensors also aid in rapid bacteria and viruses' detection with precise quantification, thus increasing the food safety for the customer (Otles and Yalcin, 2010; Duhan et al. 2017). Table 1 lists the nanotechnology-based products and their application in agriculture. Figure 4 depicts nanosensors recently developed for real-time monitoring of plant health (Moulick et al. 2020).

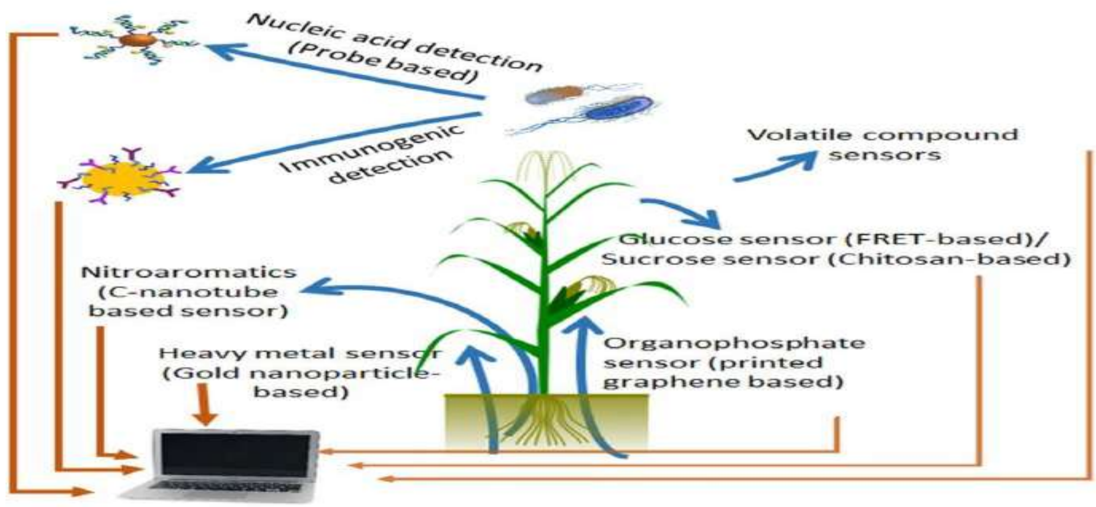

Figure 4. Few nanosensors recently developed for real-time monitoring of plant health

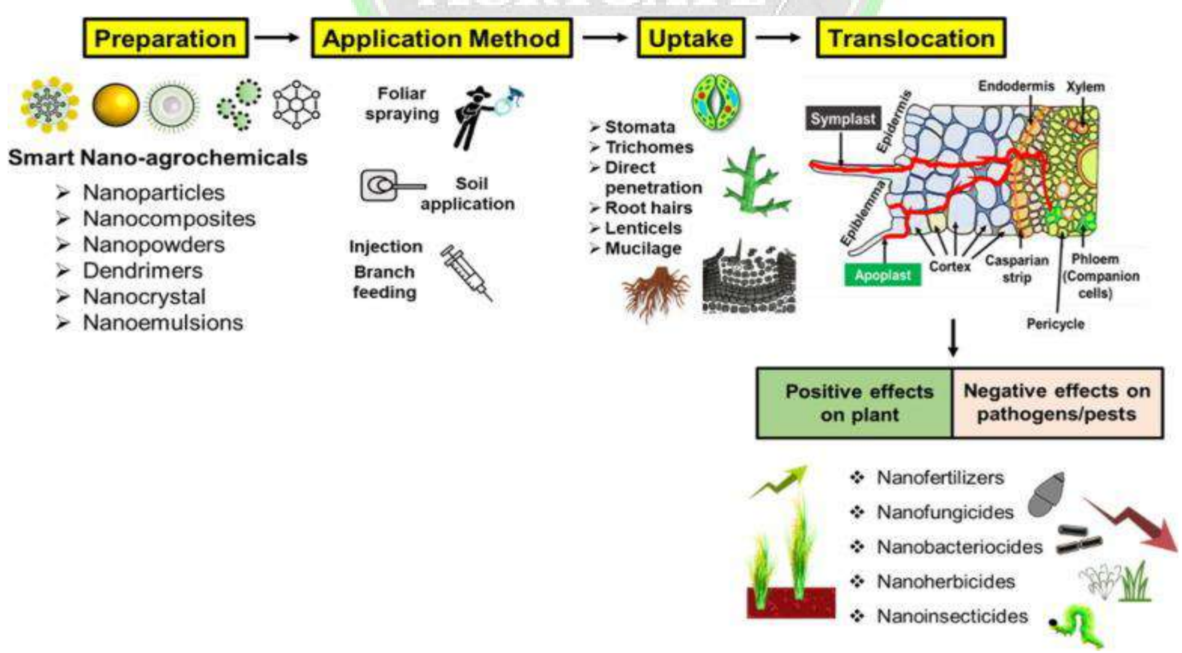

Figure 5. Schematic diagram of nano-agrochemicals with their positive and adverse effects on plants (Khan et al. 2022)

Conclusion

Agriculture is the only sector that is capable of producing food for humans using known technology from transitional and final inputs. Therefore, it is essential to acquire modern agricultural expertise. Nanotechnology is an emerging field that is rapidly gaining international benefits in many areas relating to human activity. Several study discoveries have demonstrated the fascinating phenomenon that nanoparticles and nanostructures exhibit. These qualities are enhanced by their tiny size, increased surface area and highly catalytic nature. Achieving food security requires the use of nanotechnology, particularly in the field of agriculture. It can increase crop productivity through efficient microbial, pest and weed management with high economic value, security and safety. Ag, Au, Zn, TiO_2, ZnO, SiO_2 and MgO are most commonly used nanoparticles. However, because they easily penetrate through cell membranes in human and animal organs as well as in various plant parts, they may potentially pose health problems. Future study might reduce the dangers associated with nanoparticles by employing more environmentally friendly synthesis techniques and looking for simple, low-cost procedures for breaking down and removing existing nanomaterial from attack areas. The use of nanotechnology in precision agriculture looks to have a promising future if these obstacles are cleared. A sustainable green revolution on Earth can result from the prudent and regulated application of nanotechnology.

References

Abobatta, W.F. 2018. Nanotechnology Application in Agriculture. *Acta Scientific Agriculture*, 2(6): 99-102.

Ali, M.A., Rehman, I., A. Iqbal, A., Din, S., Rao, A.Q., Latif, A., Samiullah, T.R., Azam, S. and Husnain, T. 2014. Nanotechnology: a new frontier in agriculture. *Advanced Life Sciences*, 1: 129–138.

Bhumi, G. and Savithramma, N. 2014. Biological synthesis of zinc oxide nanoparticles from *Catharanthus roseus* (l.) G. Don. Leaf extract and validation for antibacterial activity. *International Journal of Drug Development and Research*, 6: 208–214.

Debnath, N., Das, S., Seth, D., Chandra, R., Bhattacharya, S.C. and Goswami, A. 2011. Entomotoxic effect of silica nanoparticles against *Sitophilus oryzae* (L.). *Journal of Pest Science*, 84: 99–105.

Dikshit, A., Shukla, S.K. and Mishra, R.K. 2013. Exploring Nanomaterials with PGPR in Current Agricultural Scenario. Lap Lambert Academic Publishing, Germany.

Duhan, J.S., Kumar, R., Kumar, N., Kaur, P., Nehra, K. and Duhan, S. 2017. Nanotechnology: The new perspective in precision agriculture. *Biotechnology Reports*, 15: 11-23.

Elumalai, K., Velmurugan, S., Ravi, S., Kathiravan, V. and Ashokkumar, S. 2015. Green synthesis of zinc oxide nanoparticles using *Moringa oleifera* leaf extract and evaluation of its antimicrobial activity. *Spectrochimica Acta Molecular and Biomolecular Spectroscopy*, 143: 158–164.

Emadian, S.E. 2017. Physiological Responses of Loblolly Pine (*Finustaeda* L.) to Silicon and Water Stress, Texas A&M University college station, TX, 27–37 (Ph.D. Thesis, Diss. Abst.AAC8815865).

Goswami, A., Roy, I., Sengupta, S. and Debnath, N. 2010. Novel applications of solid and liquid formulations of nanoparticles against insect pests and pathogens. *Thin Solid Films*, 519 (3): 1252–1257.

Hutasoit, S., Suada, I.K. and Susrama, I.G.K. 2013. Antifungal activity test extract some type of marine life link to *Aspergillus flavus* and *Penicillium* sp. E J. Trop. *Agroecotechnology*, 2: 27–38.

Khan, N., Ali, S., Latif, S. and Mehmood, A. 2022. "Biological Synthesis of Nanoparticles and Their Applications in Sustainable Agriculture Production *Natural Science*, Vol.14 No.6.

Moulick, R., Das, S., Debnath, N. and Bandyopadhyay, K. 2020. Potential use of nanotechnology in sustainable and 'smart' agriculture: advancements made in the last decade. Plant Biotechnology Reports. https://doi.org/10.1007/s11816-020-00636-3.

Otles, S. and Yalcin, B. 2010. Nano-biosensors as new tool for detection of food quality and safety. *Log Forum*, 6: 67–70.

Pelaez, M., Nolan, N.T., Pillai, S.C., M.K. Seery, M.K., P. Falaras, P., A.G. Kontos, A.G., P.S. Dunlop, P.S., J.W. Hamilton, J.W., J.A. Byrne, J.A. and K. O'Shea, K. 2012. A review on the visible light active titanium dioxide photocatalysts for environmental applications. *Applied Catalysis B: Environmental*, 125: 331–349.

Peteu, S.F., Oancea, F., Sicuia, O.A., Constantinescu, F. and Dinu, S. 2010. Responsive polymers for crop protection. 2010. *Polymer*, 2: 229–251.

Prasad R, Bhattacharyya A and Nguyen QD (2017) Nanotechnology in Sustainable Agriculture: Recent Developments, Challenges, and Perspectives. Front. Microbiol. 8:1014. doi: 10.3389/fmicb.2017.01014

Sangeetha, J., Thangadurai, D., Hospet, R., Purushotham, P., Karekalammanavar, G., Mundaragi, A.C., David, M., Shinge, M.R., Thimmappa, S.C., Prasad, R. and Harish, E.R. 2017. Agricultural Nanotechnology: Concepts, Benefits, and Risks. In: *Nanotechnology* (eds. Prasad, R. et al.) Springer Nature Singapore Pte Ltd. 1-17.

Shukla, S.K., Kumar, R., Mishra, R.K., Pandey, A., Pathak, A., Zaidi, M. Srivastava, S.K. and Dikshit, A. 2015. Prediction and validation of gold nanoparticles (GNPs) on plant growth promoting rhizobacteria (PGPR): A step toward development of nano-biofertilizers. *Nanotechnology Reviews*, 4(5): 439–448.

Shyla, K.K., Natarajan, N. and Nakkeeran, S. 2014. Antifungal activity of zinc oxide, silver and titanium dioxide nanoparticles against *Macrophomina phaseolina*. *Journal of Mycology and Plant Pathology*, 44: 268–273.

Suriyaprabha, R., Karunakaran, G., Kavitha, K., Yuvakkumar, R., Rajendran, V. and Kannan, N. 2014. Application of silica nanoparticles in maize to enhance fungal resistance. *IET Nanobiotechnology*, 8(3): 133–137.

UN. 2022. World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100. Department of Economic and Social Affair, United Nations, https://www.un.org/en/desa/world-population-projected-reach-98- billion-2050-and-112-billion-2100 (Accessed 12 October, 2023)

Yang, F.L., Li, S.G., Zhu, F. and Lei, C.L. 2009. Structural characterization of nanoparticles loaded with garlic essential oil and their insecticidal activity against *Tribolium castaneum* (Herbst) (Coleoptera: tenebrionidae). *Journal of Agriculture and Food Chemistry*, 57(21): 10156–10162.

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VERTEBRATE/ NON INSECT POLLINATORS AND THEIR ROLE IN AGRICULTURE

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Introduction

Almost all terrestrial ecosystems depend on pollination, which is the movement of pollen from anthers to stigmas, which is primarily carried out by animals. The world's flora and fauna depend on this process for their conservation and sustainability. Specifically, honeybees are responsible for pollinating almost 90% of all tropical blooming plants, or angiosperms. Apart from the endless bees, plenty of non-bee pollinators, like wasps, moths, butterflies, flies, beetles, and other invertebrates, have been reported to visit flowers and act as effective pollinators. Approximately 1,500 species of vertebrates, which includes birds, bats, and non-flying mammals, such as different kinds of monkeys, marsupials, primates, rodents, lemurs, and tree squirrels, are known to visit flowers and function as pollinators. Around 15% of the world's crops are pollinated by solitary bees and other unmanaged fauna including birds, snails, and reptiles; the remaining 80% are managed by other bee species. It is only in recent years that the importance of vertebrate pollinators in the has been realized. This article made intensive efforts to widen the general understanding of the essential value of Non insect pollinator interactions for agricultural and natural resource conservation.

Vertebrate Pollinators

- Birds
- Bats
- Marsupials
- Monkeys
- Rodents
- Lizards
- Squirrels

Invertebrate Pollinator

- Snails

These vertebrate and non - vertebrate pollinators play a major role in pollination plantation crops and plains where bees and other insects were not abundant in nature. The process of co-evolution between these flowering plants and non-vertebrate pollinators has been proceeding for 225 million years and this co-evolution made this interaction a successful one.

Vertebrate Pollinators

The two vertebrate pollination systems—ornithophily, in which birds visit flowers and act as pollen vectors, and therophily, in which mammals that fly or do not fly transfer pollen—are significant.

Pollination by Bats

Powered flight is only possessed by bats, which belong to the order Chiroptera. They are thought to have originated around 50 million years ago and are classified into two groups: Megachiroptera, which includes the sole plant-dependent family Pteropodidae, and Microchiroptera, which comprises 17 families, of which the only family Phyllostomidae visits plants for floral resources. In comparison to their insect-eating counterparts, all bats that visit plants have larger eyes. They lack a nose leaf, just as phyllostomid bats, and their ear is simple without a tragus since they are unable to echolocate. *Pteropus poliocephalus* is the most common fruit observed to feed on the nectar-rich blossoms of the following eucalypt species: *Eucalyptus grandis*, *E. cloeziana*, *E. maculate*, *E. siderophloia*, *E. intermedia*, *E. crebra*, *E. moluccana*, E. pilularis, E. microcorys, *E. resinifera* and *E. siderophloia*.

Bat-pollinated plants must have the flowers accessible to the relatively large flower bats with poor sonar abilities. Plants with low densities and lineages that produce big flowers are more likely to be pollinated by bats. Nectar bats are extremely valuable for conservation because they contribute to maintaining the genetic continuity of plant populations in widely fragmented tropical ecosystems.

Species of bats which aided on Pollination in India

Common Name	Scientific Name
Salim Ali's fruit bat	*Latidens salimalii*
Greater long-tongued fruit bat	*Macroglossus sobrinus*
Indian flying fox bat	*Pteropus giganteus*
Island flying fox bat	*Pteropus melanotus*
Blanford's fruit bat	*Sphaerias blanfordi*
Long-tongued dawn fruit bat	*Eonycteris spelaea*
Nicobar flying fox	*Pteropus faunulus*

Fig. 1a Pollination by Indian flying fox bats

Fig. 1b Pollination by Honey Possum

Pollination by Marsupials

Metatherophily is the term for marsupial pollination. The fact that pollen is non-destructively transferred to animals' bodies during feeding—usually the head and snout—and that animals frequently carry larger than insignificant amounts of pollen are the most reliable signs that pollination occurs. It is logical to believe that since these animals come into contact with the stigmatic area of the style while feeding, they are returning pollen to the plant. Many countries, including Australia and South America, have evolved their inflorescences and flowers to be pollinated by small marsupials. These families include the Proteaceae and Myrtaceae. The most exceptionally well-adapted marsupial that consumes nectar is the honey possum, or

Tarsipes spencerae. Furthermore, pollen from the feces is present and typically has to be examined under a microscope.

Pollination by Birds

Bird pollination is known as ornithophily. Because temperate plants cannot bloom all year round, they are dependent on migratory bird species that migrate south for the winter. Due to their size and homeostasis, birds have higher energy requirements. Therefore, in order to produce large amounts of diluted nectar—the primary reward for pollinators—plants with blooms pollinated by birds devote more energy to this process.

Fig. 2a. Chestnut-tailed starling **Fig. 2b. Tawny-bellied babbler**

Sunbirds pollinate three species of orchids: Satyrium carneum, S. coriifolium, and S. princeps. Sunbirds that are foraging place their bills within the labellum chamber of the flowers and use their tongues to extract nectar from the labellum spurs. When birds scrape their bills on a branch, they often fail to remove pollinaria because of the huge, plate-like viscidia that cling to the pollinaria.

Birds which involved in Pollination

Purple sunbird	*Nectarinia asiatica*
Purple-rumped sunbird	*Nectarinia zeylonica*
Crimson sunbird	*Aethopyga siparaja*
Loten's Sunbird	*Nectarinia lotenia*
Small sunbird	*Nectarinia minima*
Common myna	*Acridotheres tristis*
Pied myna	*Sturnus contra*
Indian myna	*Acridotheres tristis*

Jungle myna	*Acridotheres fuscus*
Spot-winged starling	*Saroglossa spiloptera*
Chestnut-tailed starling	*Sturnus malabaricus*
Hill myna	*Gracula religiosa*
Tawny-bellied babbler	*Dumetia hyperythra*

Pollination by Monkeys

The monkeys drink nectar from the flowers of which bats are probably the primary pollinators. Monkeys are able to promote pollen transfer both among flowers of the same tree and between conspecific trees. The frequent use of *Daniellia pynaertii* flowers by monkeys was clearly shown both by the great contribution of nectar to the diets of monkeys and by the high number and duration of visits to trees. In this case monkeys were able to promote both cross-pollination and geitonogamy in this tree because of their frequent visits.

Fig 3a. Pollination by Lizard

Fig 3b. Pollination by Lemur

Pollination by lizards

Pollination by lizards is called Saurophily. In the tropical structures, 34 lizard species of seven different families consume reproductive structuresand rewards of plants. The families which contains pollinator lizards are Cordylidae , Lacertidae, Teiidae, Scincidae and Varanidae. In lizards pollen adheres to the bodies while they forage for nectar in flowers. Pollen is found in the ventral region of the body of lacertids (*Podarcis lilfordi*), as well as in the neck and nose. Plant fitness is increased by lizard species by producing more viable embryos.

Pollination by Rodents

Many species of shrews, mice, rats, and gerbils visit flowers. As they enter a flower to take in the nectar, pollen is collected on their heads, which they can subsequently spread to other flowers. Plants pollinated by rats can have inflorescences that are easily accessible to mice at ground level, such as geoflory, or that are buried deep inside the branches, as in the case of *Protea nana*, *P. cordata*, and *Leucospermum arenarium*. Inflorescences of plants pollinated by rodents may be hidden deep inside the branches (e.g., *Protea nana*, *P. cordata*, *Leucospermum arenarium*) and are often at or near ground level where they are readily accessible to rodents (aka geoflory). Pollination by rodents is called Sminthophily. Rodents are shy nocturnal animal that lives on native vegetation, and hides in burrows during the day . Rats are attracted to the fleshy bracts surrounding the flowers. Rodent regularly pollinate two Cape *Protea* spp., *Protea amplexicaulis* and *P. humiflora*, and that the flowers are specifically adapted for such pollinators.

Fig. 4. Pollination by Rodents

Rodents commonly involved in Pollination

Common Name	Scientific Name
chestnut spiny rat	*Niviventer fulvescens*
short-nosed rat	*Cynopterus sphinx*

Conclusion

Pollinators play an important role in enhancing biodiversity and maintaining ecosystem health by facilitating the reproduction of many flowering plants. Studies in India on are found to be scanty and incomplete Intensive studies on the Indian species of plants and their vertebrate pollinators are therefore needed for a better understanding of the pollination ecology. In conclusion, vertebrate pollinators whose services go unnoticed have a definite role to play in maintaining the diversity of world ecosystems, balance of Nature in the context of climatic change and sustaining biodiversity by producing fruits, nuts, berries in forests eaten by animals in wild and providing food security. In conclusion, undervalued vertebrate pollinators play an important role in maintaining biodiversity, the diversity of global ecosystems, the balance of nature in the face of climate change, and the production of fruits, nuts, and berries in forests that are consumed by wildlife and contribute to food security.

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PREPARATION OF PICKLES

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Introduction

The preservation of food in common salt (or) in vinegar is known as pickling. It is one of the oldest method of preserving fruits and vegetables for a long period without spoilage. Pickles are hot and tasty, good appetizers and add to the palatability of a meal. They stimulate the flow of gastric juice and thus help in digestion. Preservation by salt ($NaCl_2$) Sodium chloride is a necessary component of food. At lower concentrations it adds flavor to the product. At higher concentrations it acts as an important bacteriostatic agent. Salt is available easily and low cost. Pickling is prepared in two stages (1) By curing (or) fermentation with dry salting (or) fermentation in brine (or) salting without fermentation (2) By finishing and packing.

1. **Dry salting method:**

In this method vegetables and salt (20-30 gm of dry salt/kg vegetables) are kept in alternate layers in a vessel and cover with a cloth and a wooden board and allowed to stand for about 24 hrs. During this period sufficient juice comes out from the vegetables due to osmosis and form brine. The amount of brine required is usually equal to half the volume of vegetables. Brining is the most important step in pickling. Because it inhibits the growth of spoilage bacteria. For pickles, the advisable salt solution for vegetables is 10% for vigorous lactic acid fermentation. Under favourable conditions fermentation is completed in7-10 days. When sufficient lactic acid has been formed, lactic acid bacteria stop to grow and no further change takes place in the vegetables. However, precautions should be taken against spoilage by aerobic microorganisms.

2. **Fermentation in brine**:

Steeping of the vegetable in a salt solution of pre-determined concentration for a certain length of time is called brining. Generally this type of treatment is adopted in the case of cucumbers and similar vegetables which do not contain sufficient juice to form brine with dry salt. Brine can be prepared by dissolving in common salt in water and filtering it through the cloth to remove insoluble impurities. The remaining process is similar to that of dry salting method.

3. Raw materials used in pickling

a. Salt:

Using of salt in pickles should free from impurities, lime (CaO), iron (blackening), magnesium (results bitter taste).

b. Vinegar:

Four percent acidic acid content vinegar is suitable to use in pickles. Synthetic vinegar (or) low quality vinegar are not suitable for pickle preparations. Usually malt (or) cider vinegar is used.

c. Sugar:

Used in the preparation of sweet pickles should be of high quality.

d. Spices:

Spices are added practically to all pickles, the quantity added depending upon the kind of fruit (or) vegetable taken and the kind of flavour desired. The spices generally used are bay leaves, cardamom, chillies, cinnamon, clove, coriander, dill herb, ginger, mace, mustard,black pepper, cumin, turmeric, garlic, mint, fenugreek, asafoetida etc.

e. Water:

Only clean water should be used for the preparation of brine. Iron should not be present in the water in any appreciable quantity as it causes the blackening of the pickle.

f. Cooking utensils:

Vessels made of iron (or) copper are not suggestable. Glass -lined vessels, and stainless steel vessels are suitable. The laddles, spoons and measuring vessels should also be made on non-corrodible materials.

At present, pickles are prepared with salt, vinegar, oil (or) with a mixture of salt, oil, spices and vinegar. These pickles recipes discussed below

1. **Lime pickle:**

Required items:

Lime – 1 kg

Salt – 200 g

Red chilli powder –15 g

Cinnamon, cumin, cardamom and black pepper (powdered) each –10 g

Cloves – 5 Nos.

Process:

Limes → Washing →Cutting into 4 pieces → Squeezing out juice from ¼ amount of fruit → Mixing spices and salt with juice → Mixing with lime pieces → Filling in jars → Covering with lid → Keeping in sun for 4-6 days (shaking jar at least twice a day) → Storage at ambient temperature.

2. Cucumber pickle:

Cucumber – 1.0 kg

Salt – 200 g

Red chilli powder – 15 g

Cardamom (large), cumin, black pepper (powdered) each – 10 g

Cloves – 6 Nos

Vinegar – 750 ml.

Process:

Cucumbers → Washing → Peeling → Cutting into 5 cm round pieces → Mixing with salt → Filling in jar → Standing for 6-8 hrs → Draining off H2O → Adding spices and vinegar → Keeping in sun for a week → Storage.

Green chilli pickle:

Green chillies – 1 kg

Salt – 150 gm

Mustard (ground) – 100 gm

Lime juice – 200 ml (or) amchur – 200 gm

Fenugreek cardamom (large)

Turmeric, cumin (powdered) each – 15 gm

Mustard oil – 400 ml

Process:

Green chillies → Washing →Drying → Making incision → Mixing all spices in a little lime juice → Mixing with chillies → Filling into jar → Adding lime juice and oil → Keeping in sun for a week – Storage.

Tomato pickle:

Tomatoes – 1 kg

Salt 75 g

Garlic (chopped) – 10 g

Ginger (chopped)- 50 g

Red chilli powder, cumin, cardamom (large), cinnamom, turmeric, fenugreek – each – 10 g

Cloves – 50 nos

Asafoetida (powdered) – 2g

Vinegar – 250 ml, oil – 300 ml.

Process:

Tomatoes (ripe, firm and pulpy) → Washing → Blanching for 5 min → Cooling immediately in water → Peeling → Cutting into 4-6 pieces (or) mashing → Frying all ingredients in a little oil except vinegar → Mixing with pieces → Heating for 2 min → Cooling → Addition of vinegar and remaining oil → Filling in jar → Storage.

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SAFFRON: "THE RED GOLD"

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Abstract

Saffron is rightly known as the 'red gold', due to its increasing demand around the world. It is rich in aroma, flavour, colour and also has a wide range of nutritional and medicinal benefits. About 90% of India's saffron production is from Kashmir. In recent years, farmers face a loss in the production because of the erratic nature of weather and other such factors. However, this problem can be rectified by hydroponic technology. It is very much advantageous than the traditional farming of saffron. It is an opportunity for entrepreneurship and with the support of the government, it can result in great profits.

Keywords: *red gold, saffron threads, hydroponics, culinary spice, medicinal properties, GI tag*

Plant description

Saffron (*Crocus sativus*) is a perennial herb that belongs to the Iridaceae family. It is an expensive spice, that is popular for its aroma and flavour. The plant is 10 – 30 cm high. It is propagated through corms. Corms first give rise to cataphylls, non-photosynthetic leaves that protect the true leaves. Later, green, blade-like leaves emerge. Its floral axes bear bracteoles, that emerge from the pedicels. The flowers are purple in colour, with six petals, that bloom during the autumn season. The flowers have honey-like fragrance and contain three stamens and one style with three stigmas, which are orange to red in colour. The flowers are sexually sterile due to the presence of 24 chromosomes (2n = 3x = 24). One corm can lead to the formation of ten cormlets through vegetative division. The origin of saffron is Iran. It is being cultivated in countries like

Iran, Afghanistan, India, Morocco, Italy, etc. Iran is the leading country in saffron production. India stands second and Kashmir produces about 90% of the total production in India. *Crocus cartwrightianus* is the ancestral wild species which was said to be domesticated through selective breeding. Other species include – *C. vernus*, *C. baytopiorum*, *C. scardicus*, *C. sieberi*, etc. However, only *Crocus sativus* is edible.

Requisites for saffron cultivation

Saffron grows best in loose, well drained, well irrigated calcareous soil with high organic content. The suitable soil pH ranges from 6.8 – 7.8; the plant thrives on acidic pH. The appropriate planting time is from July to October. The temperature ranges that the plant can tolerate is; maximum temperature: 35 to 40 ^{o}C and the minimum temperature: -15 to -20 ^{o}C. The required temperature for flower initiation is 17 ^{o}C. The suitable elevation is 1500 – 2000 metres above mean sea level. The highest amount of water requirement ranges between 400 – 530 mm and the lowest ranges between 100 – 280 mm. The recommended fertilizer dose is 45:60:60 kg NPK per hectare. Nitrogen is required by the plant to develop green leaves and is also necessary for flower production. Phosphorus and potassium will increase the disease resistance of the plant and enhance its health. One third of nitrogen fertilizer, and complete potassium and phosphorus fertilizers are supplied at the time of plantation. The rest of the nitrogen is supplied later in two split doses. Nitrogen rich fertilizers such as well – composed manure, bone meal or fish emulsion can be used. Micronutrients like copper, iron, zinc, etc. can be supplied through foliar sprays. Organic fertilizers like manure and vermicompost are very much suitable, as they provide a balanced mix of nutrients and organic matter and also improve soil health and microbial activity. Fertilizers should be supplied during the active growth periods of the crop. Over – fertilization can lead to nutrient imbalances and make the plant susceptible to diseases.

Traditional saffron farming

The soil is ploughed well 3 – 4 times to make it fine and porous. Farm yard manure is added to the soil before plantation of the corms. To prevent water logging conditions, calcium carbonate at high doses is also added. Beds that are 15 – 20 cm high are raised with 30 cm wide drainage channels. The spacing between the corms/bulbs is 20 x 10 cm. The corms are graded. Those that weigh 6 grams or lesser are kept for multiplication and those that weigh 7 grams and above are used for flower production. About 15 cm pit is dug and corms are placed in it; soil is then loosely applied on it. The planting density is about 50 bulbs per square metre.

Irrigation is done at 15 days interval. Saffron starts flowering in 3 – 4 months of planting. Since saffron is a slow growing crop, weeds infestation is an important problem. Some of the important weeds belong to family Asteraceae, Brassicaceae, Fabaceae and Laminaceae. First weeding should be done in the month of October. Regular hand weeding will keep the weed infestation in check. Pre-emergence herbicides like pendimethalin (1.5 kg/ha) and fluchloralin (1.0 kg/ha) is recommended. There are a few major problems in saffron farming like pests, diseases and rodent damage. Saffron corms are susceptible to root rots and corm rots caused by *Rhizopus* sp., *Aspergillus* sp., *Fusarium* sp., and *Penicillin* sp. other diseases include corm neck rot and saffron smut. Therefore, use of healthy and disease-free corms is very important. Major pests of saffron are nematodes, mites, thrips and blister beetles.

Corm treatment with nematicides like phorate or carbofuran @ 1 kg a.i./ha reduces nematode infestation. Use of *Trichoderma viride* is recommended for soil inoculation before planting. Conservation of predators and maintenance of clean fields is important. In case of rodent management, smoking of rat burrows in fields can be done. Use of bromodiolon concentrates in baits @ 0.005% a.i. at regular intervals is also effective. Regular monitoring of the fields, short crop cycles followed by fallow, soil solarization, growing marigold in the borders of the field and such IPM practices will help protect the crop.

The stigmas or saffron threads are harvested when the flowers are fully opened and are still fresh. They are plucked by hand or by using tweezers. The harvest should be completed by midday. Before drying, the stigmas are pre-dried to prevent microbial activity. Pre-drying is the process where the saffron threads are placed on absorbent materials like towels for a few hours. Natural drying and artificial drying are both suitable for saffron. In natural drying, the threads are left to dry naturally whereas in artificial drying, dehydrators are used. The stigmas are dried upto 8 – 10% moisture is remaining. The weight loss is about 78 – 80%.

Recent trends in saffron production

The unpredictable changes in the weather conditions and lack of proper irrigation channels have led to a drastic decline in the saffron production. In the last two decades, many farmers have converted their saffron fields to fruit orchards or mustard fields. To overcome these difficulties, hydroponic systems prove to be a promising solution. Hydroponics technology can

be used in a wide range of crops, and in case of sensitive and expensive crops like saffron, strawberry, lettuce, spinach, and others, productivity is an upturn. Use of hydroponics in saffron cultivation will not only give farmers a controlled environment, but also help in doubling profits and reducing labour. Indoor saffron farming protects the crop from weeds, pests, diseases and rodent infestation. It also reduces cost of cultivation. Moreover, this is suitable for farmers with small land holdings. The initial investment in hydroponic saffron farming may be higher, but with faster crop cycles, higher yields and high-priced organic produce one can ensure return in investment in comparatively lesser time. Other advantages of indoor saffron cultivation include reduced chemical usage and reduced water consumption.

Saffron specific nutrient solutions containing all macro and micronutrients can be used. Regular check of the nutrient levels is important to prevent deficiencies. Temperature and humidity levels should be monitored. Acidic pH should be maintained at 6 – 6.5. Sunlight for six hours a day is required and in case of artificial lights, grow lights are used. With the right set up, greater quantities can be harvested from compact spaces. NABARD has promoted techniques that will help the farmers grow saffron using hydroponics. Beginning from 2018, the organization has been teaching farmers and encouraging them to undertake indoor cultivation. NABARD had funded a 3–year project covering cost of planting material and equipment for demonstration trials. There are many schemes initiated by the government like ASPIRE: Promoting Innovation in Rural Industries, Pradhan Mantri Mudra Yojana, Stand Up India Scheme, etc. to promote entrepreneurship. With proper government support and the right technical knowledge, hydroponic saffron farming is a great opportunity for a successful line of work.

Status of the "Red Gold"

Saffron is an expensive culinary spice. It is used in desserts, curries and in baking. Due to its rich aroma and colour, saffron is used in countless food preparation around the globe. It is dried, powdered and mixed with other spices and used for food preparations. It contains crocin, picocrocin and safranal which makes it an important ingredient for culinary purposes. It is rich in vitamins and minerals and has many medicinal properties.

It has anti-inflammatory, anti-cancer and decongestant properties. Saffron can be used to treat diabetic patients, tumor and arthritis patients. It helps lower cholesterol levels, helps relieve kidney stones, acts as an antidote for poisoning, helps with menstrual pains, treats respiratory

disorders, uterine diseases, small pox, blood disorders and so many more. It helps treat chronic diseases and prevents from Alzheimer's disease. When mixed with the right herbs, saffron can be used as a remedy for insomnia, coughing, indigestion, infertility, baldness and eye diseases. It contains quite a number of antioxidants that helps boost immunity and reduce stress level. Saffron is used in cosmetics, because of the anti-aging properties and also used in perfumes. In ancient India, saffron was used as a dyeing agent for the robes of Hindu and Buddhist monks. A traditional beverage prepared in Kashmir called 'Kahwa' is prepared using saffron. Saffron contains 12% – 15% carbohydrates; pigments such as lycopene, carotene, flavonoids, etc.; vitamins and minerals such as potassium, calcium, zinc, selenium, copper and iron. It can be justified that the uses of saffron are endless.

Geographical Indication (GI) signifies that the product has a specific geographic origin and possesses desirable qualities due to that origin. In the year 2020, Kashmiri saffron was given GI tag. It is known for its thicker stigmas, strong aroma, chemical free processing and richness in crocin, picocrocin and safranal. Due to these factors, Kashmiri saffron is liked better than Iranian saffron.

The Economic Times says that the price of saffron is five times more than that of silver. After receiving the GI tag, the price increased from 2 lakh per kg to 3.25 lakh per kg in the global market. The demand for Kashmiri saffron is said to be rising at a healthy rate of 7%. Anti-cancer properties of saffron, increased consumer preference in organic produce, investments in hydroponic systems and other such factors are also responsible for the popularity of Kashmiri saffron.

References

Deepak Kothari et. al. (15 March, 2021) "Agro climatic Suitability Evaluation for Saffron Production in Areas of Western Himalayas", Frontiers in Plant Science. Vol. 12

Dr. Rakesh Kumar, Dr. Amita Bhattacharya (2018) "Production Technology of Saffron in Non-traditional areas", CSIR – IHBT.

"IPM Packages for Saffron" (2003), Directorate of Plant Protection, Quarantine and Storage, Faridabad.

Ramesh Kumar N, Ahmed and Shiv Lal (10 Oct, 2012) "Saffron – A Golden Spice – Nutritional and medicinal Wonder" Science India, Vol. 15, Pg. No. 32 – 36

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PLANT PRODUCTS IN ECOLOGICALLY SAFE AND ENVIRONMENTALLY ACCEPTABLE DISEASE MANAGEMENT

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Introduction

The plant products play an important role in evolving an ecologically sound and environmentally acceptable disease management system. Plant products have been found to have fungicidal, bactericidal and antiviral properties. Plants have ability to synthesize aromatic secondary metabolites, like phenols, phenolic acids, quinones, flavones, flavonoids, flavonols, tannins and coumarins. The components with phenolic structures, like carvacrol, eugenol and thymol are highly active against plant pathogens. These groups of compounds are toxic to pathogens and serves as plant defense mechanisms against pathogenic microorganisms. The presence of potent inhibitors of plant viruses, also termed as antiviral principles (AVPs) which are identified in the extracts of a variety of plant species. When extracted from the plant and applied on infected crop plants, these components are called botanical pesticides or botanicals. Commonly used botanicals are neem (*Azadirachta indica*), garlic (*Allium sativum)*, eucalyptus (*Eucalyptus globulus)*, turmeric (*Curcuma longa*), tobacco (*Nicotiana tabacum)*, ginger (*Zingiber officinale*) etc. Essential oils such as nettle oil (*Urtica* spp.), thyme oil (*Thymus vulgaris*), eucalyptus oil (*Eucalyptus globulus*), rue oil (*Rutagra veolens*), lemon grass oil (*Cymbopogon flexuosus*) and tea tree oil (*Melaleuca alternifolia*). The gel and latex of *Aloe vera* is also used. Among the plant products, the neem products are highly explored due the presence of active principles such as azadirachtin, nimbin, nimbidin, nimbinene, nimbridic acid and azadirone. The primary advantages of using botanicals in plant disease management are eco-friendly and non-hazardous; easily bio-degradable and cheaper.

NEEM PRODUCTS

The tree (*Azadirachta indica*) contains several active principles in various parts. The important active principles present in neem products are azadirachtin, Nimbidin, Nimbinene, Nimbidic acid and Azadirone. Among the various neem products, neem seed kernel extract, neem oil, neem cake and neem cake extract are widely used as they are safe to ecofriendly populations.

1. Neem seed kernel extract 5% (NSKE)

Neem seed kernel is powdered. Twenty five kg of powdered neem seed kernel is taken in a gunny bag and tied. It is soaked in 100 litres of water for 8 hours. The gunny bag is shaked thoroughly to get the extract and the filtrate was taken. The volume of the filtrate was made 500 litres using water. To this extract 500 ml of sticker like Teepol or Triton AE or 500 g of Khadi soap is mixed. The neem seed kernel extract thus obtained is ready for spraying. It is used to control the green leaf hopper (GLH), the insect vector of Rice Tungro Virus (RTV). Foliar sprays of 5% NSKE at 15 days interval effectively control the vector and reduce the spread of RTV. Foliar spray of NSKE at the time of panicle emergence reduces the sheath rot disease (*Acrocylindrium oryzae)* in rice. In blackgram and greengram two sprays NSKE 5% at 15 days interval controls powdery mildew (*Eryspihe polygoni).*

2. Neem oil 3%

In plant disease management, neem oil 3% foliar spray is used. Here Teepol (1ml / litre of water) is mixed first with water to have emulsion and then the neem oil is added. The final solution will be milky white in colour. To get 3% solution 30 ml of neem oil is added to 1 litre of water. For one hectare, 15 litres of neem oil is required to mix in 500 litres of water.

Neem oil 3% is used to control green leaf hopper, the vector of RTV, for which three sprays are given at 15 days interval. For the control of whitefly vector of yellow mosaic in blackgram and greengram neem oil 3% spray is done. Sheath rot of rice is controlled with neem oil 3% when it is sprayed at the time of panicle initiation. Rice blast is also controlled by neem oil 3%. Rust of groundnut (*Puccinia arachidis*) and powdery mildew of blackgram (*E.polygoni*) are controlled by two sprays with neem oil 3% at 15 days intervals.

3. Neem cake

Neem cake obtained after extraction of oil is used in the control of soil-borne diseases. Neem cake is powdered and directly applied to the field before last ploughing for sowing. Soil application of 150 kg of neem cake per hectare as basal dressing reduces sheath blight (*Rhizoctonia solani*) and blast. In cotton, pre-emergence, post-emergence and damping off disease (*Rhizoctonia solani*) reduced by soil application of neem cake at 2.5 and 5.0 tonnes / ha respectively. Soil application of neem cake controlled root rot of blackgram and sesame (150 kg/ha), chickpea wilt (*Fusarium solani*), basal stem rot of coconut (*Ganoderma lucidum* 5 kg/ha), betelvine foot rot and leaf rot (*Phytophthora capsici*) and crossandra wilt (*Fusarium solani*).

4. Neem cake extract 10%

Neem cake is powdered. Fifty kilogram of neem cake is taken in a gunny bag and is soaked in 500 litres of water for a period of 8 hrs. The gunny bag is removed after a thorough shaking. To the extract, 500 ml of sticker (Teepol or Trition AE) is added and mixed well. This extract is used to control citrus canker (*Xanthomonas axonopodis* pv. c*itri*). Besides the above said preparation, some of the commercially available neem formulations are Bioneem, Biosol, Econeem, Field Marshall, Kemissal, Margocide, Neem Mark, Neemax, Neemazal, Nimbicidine, Neemgold, Neemguard, Neemicide, Neem plus, Nimba, Nimbin, Sunneem, Wellgro, etc.

OTHER PLANT PRODUCTS

In addition to neem products, products from several other plant species are also found to be effective in disease management.

	Plant	Disease / Pathogen controlled
1.	Tulsi (*Ocimum sanctum*) – leaf extract	Rice brown spot (*Helminthosporium oryzae)*

2.	Bael (*Aegle marmelos*) – leaf and pollen extract	Early blight of tomato (*Alternaria solani*) Purple blotch of onion (*Alternaria porri*)
3.	Periwinkle (*Catharanthus roseus*) – flower extract	Early blight of tomato (*A.solani*)
4.	Garlic (*Allium sativum*) – Bulb extract	Early blight of tomato (*Alternaria solani*) Blight of Ragi (*Heliminthosporium nodulosum*) Blast of rice (*Pyricularia oryzae*)
5.	Pepper mint (*Mentha piperita*) – leaf extract	Rice grain discolouration (*Drechslera oryzae*)
6.	Auhuhu (Kolinji) – root exudates	Basal stem rot of coconut (*Ganoderma lucidum*)
7.	Banana –rhizome extract	Basal stem rot of coconut
8.	Ballnut (Pinnai) (*Calophyllum inophyllum*) – seed oil	Groundnut rust (*Puccinia arachidis*)
9.	Chaste tree (Nochi) (*Vitex negundo*)-leaf extract – AVP	Rice tungro virus

Chemical nature of plant extracts and oils

Antimicrobial substances in plant cells include unsaturated lactones, cyanogenic glycosides, sulphur containing compounds, phenols, phenolic glycosides, saponins, *etc*.

Oils

Emulsified rapeseed oil controls apple powdery mildew and grapevine powdery mildew (as effective as Dinocap). Oils of sunflower, maize, olive and rapeseed control apple powdery mildew. Mustard oil, the esters of isothiocyanic acid occur in plants as glycosides which releases isothiocyanate which is having antifungal, antibacterial and antinemic properties.

Plant	**Chemicals present**
Onion and garlic	Allyl sulphoxide
Cabbage	Glucosinolates
Sorghum	Cyanogenic glucosides

Pear and walnut	Para hydroquinone glucosides
Maize, wheat and rye	Benzoxaines

Plant extracts

- Soaking of loose smut infected wheat seeds in garlic extract – controls the seed borne disease
- Bulb extracts of onion, garlic and ginger, leaf extracts of *Parthenium*, *Calotropis* and neem effective against *Macrophomina* and *Erysiphe*
- Rhizome powder of ginger controls pea powdery mildew
- Neem product controls bacterial blight of cotton.
- *Ipomoea* leaf extract 5% and *Prosopis* leaf extract. 5% control sheath rot of rice.

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ADVANCING TOMATO PRODUCTION WITH HYDROPONICS: TECHNIQUES AND BENEFITS

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Abstract

Hydroponics cultivation is gaining popularity all over the world because of efficient resources management and quality food production. It does not require soil therefore it is also known as soilless agriculture. Soil based agriculture is now facing various challenges such as natural disaster, climate change, indiscriminate use of chemicals and pesticides which is depletion the land fertility. Hydroponics is good alternative for producing healthy vegetable, free from soil borne pathogens. This approach is particularly beneficial for countries with poor soil conditions that are unsuitable for agriculture.

Introduction

The word hydroponics was coined by Professor William Gericke in the early 1930. Dr. William Frederick Gericke is known as father of hydroponic, he was able to grow tomato vines more than 7- meters long just using mineral- nutrients solution. The word 'hydroponics' to describe crops growing in non-soil media and nutrient–enriched water indoors and outdoors. Before the hydroponics was referred as 'nutriculture', 'chemiculture' or 'aquaculture'. The term Hydroponics was derived from the Greek words hydro means water and ponos means labour and literally means water work. Hydroponics is a technique of growing plants in nutrient solutions with or without the use of an inert medium such as gravel, vermiculite, rockwool, peat moss, saw dust, coir dust, coconut fibre etc. to provide mechanical support.

Hydroponics vs Field production

S. No.	HYDROPONICS	FIELD PRODUCTION
1	No soil is required	Good top soil is required
2	Plants are irrigated automatically	Plants need to be irrigated to minimize water stress
3	Nutrients are available at all times. Only soluble fertilizers are used.	Nutrients must be added to soil
4	Soil borne diseases can be eliminated	Soil borne diseases can build up in the soil
5	Hydroponics production is not organic because artificial nutrients are usually not grown in soil	It is possible to produce organic vegetables in soil because one can use organic fertilizers such as compost and manures.

Cultivars suited for hydroponic tomato farming

- ✓ Hybrid varieties: Trust and Bounty.
- ✓ Cherry varieties: Sun Gold, Sweet Million, and other Cherry tomato varietals are examples.
- ✓ Beefsteak varieties: Beef Master, Big Beef etc.
- ✓ Roma varieties: - Roma VF, Viva Italia etc.
- ✓ Heirloom varieties: Green Zebra, Black Krim etc.

Establishment of seedling

Seed are initially sown in small propagation cubes (germination cubes/ trays, rockwool cubes, cocopeat). Maintain the temperature of 22–24°C (72 to 75° F) for the proper germination. Transplanting shortly after the first "true leaves" appear gives a push to initial plant growth and early setting of the first truss.

Types of hydroponics system for growing tomato

Ebb and Flow method

Nutrient solution is pumped from a reservoir into the grow tray, where the liquid is kept at a specific level (by means of an overflow drain) for a set amount of time before the pump shuts off, allowing the nutrient solution to drain back down the input pipe. Using this system, plants are typically grown either in pots filled with soilless media larger or plugs housed in trays.

Compared to top sprinkle irrigation, ebb and flow systems improved tomato root parameters and stem diameter by 9–45%.

Drip irrigation

Nutrient solution is stored in a separate tank and pumped over the roots of the plants several times a day via drip lines at an interval that keeps the substrate moist. These drip lines are typically composed of a thin, black, polyethylene tube attached to a drip spike that is inserted into the growing media. Drip irrigation has been shown to improve tomato nutritional value and antioxidant levels compared to furrow irrigation.

Deep water culture

In deep water culture, roots of plants are suspended in nutrient rich water and air is provided directly to the roots by an air stone. Plants are placed in net pots and roots are suspended in nutrient solution where they grow quickly in a large mass. It is mandatory to monitor the oxygen and nutrient concentrations, salinity and pH as algae and moulds can grow rapidly in the reservoir.

Nutrient film techniques

NFT was developed in the mid 1960 in England by Cooper to overcome the shortcomings of ebb and flow system. In this system, water or a nutrient solution circulates throughout the entire system and enters the growth tray via a water pump without a time control. The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir. Plants are placed in channel or tube with roots dangling in a hydroponic solution.

The Media suitable for growing tomato in hydroponics system

- ✓ NFT (Nutrient Film Technique) – Clay pebbles, perlite and vermiculite or coco coir (often paired as a mix with other media)
- ✓ DWC (Deep Water Culture) – Clay pebbles, mixed media
- ✓ Drip – Rockwool, clay pebbles, coco coir, perlite or vermiculite

Nutrient content

In hydroponics, the nutrient solution is given based on the crop and growth stage. Nutrient needs vary during vegetative growth, plants need foliage-promoting solutions, while root development requires phosphorus-rich solutions and fruit ripening needs low nitrogen and high potassium solutions. Commercial solutions use an NPK 8-15-36 for tomatoes

Electrical Conductivity Management

The electrical conductivity (EC) of the nutrient solution must be 2-4 dS $m^{-1.}$ Yield of tomato increased as EC of nutrient solution increased from 0 to 3 dSm-^{1} and decreased as the EC increased from 3 to 5 dS m-^{1} due to increase of water stress.

p^{H} required to grow tomatoes hydroponically

The optimum pH is between 6 and 6.5. To increase the pH of the nutrient solution, can add any of these Potassium hydroxide (KOH), Sodium hydroxide (NaOH), Bicarbonate of soda ($NaHC0_3$). To decrease the pH of the nutrient solution, can add any of these- Phosphoric acid (H_3P0_4), Sulfuric acid (H_2S0_4), Nitric acid ($HN0_3$).

Temperature & Humidity required to grow tomatoes hydroponically

Maintain a optimal day temperature 18-25°C and optimal night temperature 16-22°C. Tomatoes do well up to 32°C beyond that yield will be reduced because of drying of pollen. Relative atmospheric humidity should be 50-60%. Choose an exhaust fan having the capacity to exchange the air within the growing area in half a minute, ambient temp can vary up to -15°C.

Light

12- 18 hours of light each day is optimum. Both high pressure sodium lights and light emitting diodes can be used to provide supplemental light to tomatoes. For overhead lighting- HPS is better than LEDs for tomato production. Alternatively, LEDs are most useful for inter-canopy lighting and promoting photosynthesis in functional leaves. A combination of overhead HPS and inter canopy LED lighting- increasing productivity.

Training and pruning

Indeterminate tomato plants can grow and bear fruit continuously throughout the season, often reaching heights of 6-8 feet or even taller. Just remove all side shoots or suckers early that grows between the main stem and each leaf stem. Train vertically let the single main stem grow. To support the plant use plastic twine & stem clips secured above a support wire. To wrap the plant, follow one direction clockwise/Anticlockwise. Place stem clips every foot just under the leaf stem joining the main plant stem for best hold. Leave extra 1ft of the string above the support wire so that the plants can be lowered once they reach the height of the wire. Don’t clip under the fruit cluster as it may break the cluster.

Pollination

When the tomato plants bloom, since there are no insects in the hydroponics environment to pollinate them. Wait until the petals bend back to expose the round pistil and the pollen-covered stamens or long, thin sticks at the flower center. Touch a soft paintbrush to each of the pollen-covered stamens, then touch the rounded end of the pistil. So pollinating tomato flower with brush or hand within 2 days of flowering between 10 am to 4 pm. Remember no pollination means flower drop.

Harvest and yield

The best time to harvest your hydroponic tomatoes will depend on the variety. However, most hydroponic tomatoes will be ready to harvest within four to six weeks of planting. Once the tomatoes are ripe, they can be picked by hand or a tomato knife. Yield is approximately 180-200 t/acre whereas traditional system yields 10-12 t/acre.

Conclusion

Hydroponic cultivation is currently one of the most intensive crop production methods, utilized extensively in both developed and developing nations for efficient food production in constrained spaces. This method is highly productive, water-efficient, environmentally friendly and suitable for limited land areas. By supplying consistent and accessible nutrients, hydroponics can accelerate plant growth by up to 50% compared to traditional soil methods and often yields more produce.

Reference

Prakash, S., Singh, R., Kumari, A. R., & Srivastava, A. K. (2020). Role of hydroponics towards quality vegetable production: An overview. *International Journal of Current Microbiology and Applied Sciences*, 10, 252-259.

Sharma, P., Acharya, S., Kumar, K., Singh, N., & Chaurasia, O. P. (2018). Hydroponics as an advanced technique for vegetable production. *Journal of Soil and Water Conservation*, 17(4), 364-371.

Solankey, S. S., Kumari, M., & Kumar, M. (2019). *Innovative horticultural practices: Production and improvement.* Narendra Publishing House.

Stegelmeier, A. A., Rose, D. M., Joris, B. R., & Glick, B. R. (2022). The use of PGPB to promote plant hydroponic growth. *Plants*, 11, 2783.

Swain, A., Chatterjee, S., Viswanath, M., Roy, A., & Biswas, A. (2021). Hydroponics in vegetable crops: A review. *The Pharma Innovation Journal*, 10(6), 629-634.

Velazquez-Gonzalez, R. S., Garcia-Garcia, A. L., Ventura-Zapata, E., Barceinas-Sanchez, J. D. O., & Sosa-Savedra, J. C. (2022). A review on hydroponics and the technologies associated for medium- and small-scale operations. *Agriculture*, 12, 646.

Grow Hydroponic Tomato: The complete guide- AGrowTronics.2019. retrieved from https://www.agrowtronics.com/grow-hydroponic-tomatoes-the-complete-guide/

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APOMIXIS – CLASSIFICATION AND APPLICATION

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Introduction

Asexual Reproduction is considered into two categories only, vegetative propagation and apomixis. Vegetative propagation involves multiplication of the plant using a somatic tissue such as the root, stem or leaves. In apomixis, seed is produced, but the embryo develops without fertilization (i.e, without the fusion of male and female gametes) from one of the unreduced cells of the ovule.

Apomixis

Apomixis, derived from two Greek words “APO” (away from) and “MIXIS” (the act of mixing or mingling. Embryo develops without fertilization. The term apomoxis was first given by Winkler [1908]. Thus apomixis is an asexual means of reproduction. Apomixis is found in many crop species.

Classification of Apomixis

1. **Based on the frequency**

   I. **Obligate Apomixis:** Reproduction in some species occurs only by apomixis. This apomixis is termed as obligate apomixis.

   II. **Facultative Apomixis:** In some species sexual reproduction also occurs in addition to apomixis. Such apomixis is known as facultative apomixis.

2. **Based on the occurrence**

   According to famous Indian embryologist P Maheshwari, Apomixis is classified as mentioned below

I. **Recurrent Apomixis:** In recurrent apomixis the embryo sac develops from diploid cells. There is no reduction in the chromosome number and all the cells of embryo sac are diploid. This process is repeated from generation to generation and hence it is called recurrent apomixis. It includes: (1) diploid parthenogenesis, (2) diploid apogamy and (3) apospory.

II. **Non- Recurrent Apomixis:** In non-recurrent apomixis, the embryo sac consists of usual haploid cells. The plants produced by this method contain haploid set of chromosomes and are usually sterile. This process is not repeated from one generation to another and hence is called non recurrent apomixis. It includes haploid parthenogenesis and haploid apogamy.

III. **Adventive Embryony:** The development of embryo directly from the diploid cells of ovule lying outside the embryo sac belonging to either nucellus or integuments is referred to adventive embryony.

Forms of Apomixis

1. Parthenogenesis:

Parthenogenesis refers to development of embryo from the egg cell without fertilization. It is of two types viz. (1) haploid and (2) diploid.

When the embryo develops from a haploid egg cell, it is known as haploid parthenogenesis. The plants which develop from such embryos are haploid and sterile. Haploid parthenogenesis is found in *Solanum nigrum.* Sometimes, embryo sac develops without reduction division. Such embryo sac and all cells within it are diploid. It gives rise to diploid embryos. Such parthenogenesis is known as diploid parthenogenesis and has been reported in grasses like *Taraxacum*.

There are several causes of parthenogenesis. The main causes include:

(1) inability of the pollen tube to discharge the contents inside the embryo sac,

(2) insufficient attraction between male and female gametes,

(3) early degeneration of the sperm,

(4) very long style,

(5) schlerenchymatous style,

(6) short pollen tube,

(7) slow rate of pollen tube growth,

(8) stimulation of pollination in the absence of pollen tube, and

(9) incompatibility.

Parthenogenesis can be artificially induced by four main ways:

(1) by the stimulation of widely related pollen or foreign pollen,

(2) by low temperature,

(3) by pollinating with X-ray irradiated pollens and

(4) by treatment with certain chemicals like belviton.

All these help in inducing parthenogenetic development of egg cell.

2. Apogamy:

The origin of embryo from either synergids or antipodal cells of the embryo sac is called apogamy. It is of two types: viz.

(1) haploid apogamy and

(2) diploid apogamy.

The synergids or antipodal cells may be haploid or diploid. If embryo develops from haploid synergids or antipodal cells, it is known as haploid apogamy. When the embryo develops from diploid synergids or antipodal cells, it is called as diploid apogamy. Diploid apogamy has been reported in *Allium*, *Iris* and many other species.

3. Apospory:

In apospory, first diploid cell of ovule lying outside the embryo sac develops into another embryo sac without reduction. The embryo then develops directly from the diploid egg cell without fertilization. Apospory is of two types: viz.

(1) generative apospory and

(2) somatic apospory.

Origin of embryo from the embryo sac that has developed from the cell of archesporium is known as generative apospory as in *Parthenium*. When the embryo originates from the embryo sac that has developed from the cell of either nucellus or integument, it is known as somatic apospory. This is found in *Malas*, *Crepis*, *Poa* and many other crop species.

4. Adventive embryony:

The development of embryo directly from the diploid cells of ovule lying outside the embryo sac belonging to either nucellus or integuments is referred to adventive embryony. There is no production of another embryo sac like apospory. This is a type of sporophytic budding which is very common in Citrus and Mango.

5. Androgenesis

In plant species like tobacco and rice, pollen grains may be induced to develop into embryos. This development of embryos from pollens or anthers is termed as androgenesis.

Application of Apomixis

Apomixis is an asexual form of reproduction that allows plants to produce seeds without fertilization. This phenomenon has significant implications for agriculture and plant breeding, offering various potential benefits

1. **Hybrid Seed Production:**

   Apomixis can help maintain hybrid vigor by consistently producing seeds that are genetically identical to the parent plant. This is crucial for crops where hybrid seeds demonstrate superior traits such as higher yield, disease resistance, and improved quality.

2. **Cost Reduction:**

   By eliminating the need for repeated hybridization processes, apomixis can reduce the cost of hybrid seed production. Farmers can save seeds from apomictic plants and replant them, ensuring uniformity in successive generations.

3. **Preservation of Elite Genotypes:**

   Apomixis ensures the preservation of desirable genotypes without genetic segregation. This stability is beneficial for maintaining specific traits that have been selected for over time, such as drought tolerance or pest resistance.

4. **Reduced Need for Cross-Pollination**:

   In crops where cross-pollination is challenging or unreliable, apomixis can provide a stable method for reproduction, ensuring crop yields and quality remain consistent.

5. **Faster Cultivar Development:**

   Apomixis can expedite the development of new cultivars by allowing rapid multiplication of selected genotypes, bypassing the lengthy process of generating and testing new hybrids.

6. **Conservation of Rare and Endangered Species:**

   Apomixis can be used to conserve rare and endangered plant species by allowing the propagation of identical offspring. This technique ensures the genetic integrity of the species is maintained while increasing their population.

7. **Seed Production in Sterile Hybrids:**

   In crops where hybrids are sterile or have low fertility, apomixis can be a valuable tool for seed production. By bypassing the need for sexual reproduction, sterile hybrids can still produce viable seeds.

8. **Application in Polyploid Crops:**

   Many polyploid crops (plants with multiple sets of chromosomes) exhibit sterility. Apomixis can facilitate seed production in these crops, ensuring the propagation of desirable traits

References

Plant Breeding Theory and Practical 2nd Edition by V. L. Chopra – Breeding of Vegetatively Propagated Plants.

Essentials of Breeding by Phundan Singh – Apomixis – Modes of Reproduction – Pg.64,65,69

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PLANT QUARANTINE

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Introduction

A quarantine is a restriction on movement of people or goods so that spread of disease can be prevented.so a period of time when a person, plant or animal that has or may have an infectious disease must be kept away in isolation from other.

Plant Quarantine:

- A legal restriction on movement of agricultural commodities for the purpose of exclusion, prevention or delay in the establishment of plants, disease or parasites in the area where they are not present.
- Plant quarantine is a technique for insuring disease and pest-free plants by isolating them until they are confirmed healthy. Thus, plant quarantine is designed as a safe guard against harmful pests or pathogens exotic to a country or a region and the newly imported plants are isolated to ensure that they are not introducing any foreign parasites.
- The term quarantine may refer to the quarantine station itself, or to the process of testing and purifying the plant material.
- A 40 days quarantine period is in rule for isolating the plant material.

Need of Plant Quarantine:

- A new pest, after arrival and establishment, can rapidly develop into destructive proportions.
- Because of the absence of natural enemies in the new environment.
- Plant pest epidemics could result in the loss of agricultural produce.
- This may adversely affect the food production or an existing export trade.

- Therefore, the main aim of plant quarantine is to prevent the entry of exotic pests into the country by enforcing laws without which it is hard to obtain compliance.

Plant Quarantine is equipped into 3 divisions:

1. **Domestic quarantine**
    - Restriction to entry of plant and plant related material form one state to another state, which is associated with sate machinery production.
    - There are many infected materials which are prohibited to transport to other state for trade and export, like;
    - Banana bunchy top virus (Assam, W.B., Kerala); Potato cyst nematodes (Nilgiri dist. of TN); Apple scab (JK and HP).
2. **International quarantine;**
    - Legal restriction on pant and plant related products between one country to country to ensure pest and diseases free materials.
3. **Embargo:**
    - Official ban on trade or other commercial activity with a particular country
    - When the pest risk is very high and the safe guards available in the country is not adequate and, therefore, import is prohibited.

Quarantine Regulation:

- Whatever the type of introduced plant are, i.e. seeds, vegetables, fruits etc. bulk introductions are always risky as thorough examination and treatment in such cases is very difficult and planting area is far too large to prevent the establishment and spread of the introduced pest/disease.

Based on these factors, plant quarantine regulates the introductions as follows:

1. Complete embargo/prohibition: When the pest risk is very high, the safeguards available in the country are not adequate and, therefore, import is prohibited.
2. Post-entry quarantine: The risk is very high but adequate safeguards in the form of post-entry isolation growing facilities are available.
3. Restricted: Pest risk is not high and import permit is required stipulating conditions for entry, inspection and treatment.
4. Unrestricted: Import permit is not required, and material may enter without restriction.

Objectives of the Scheme:

1. To prevent the introduction and spread of exotic pests that are destructive to crops by regulating/restricting the import of plants/plant products
2. To facilitate safe global trade in agriculture by assisting the producers and exporters by providing a technically competent and reliable phytosanitary certificate system to meet the requirements of trading partners.

The major activities under the scheme include:

- Inspection of imported agricultural commodities for preventing the introduction of exotic pests and diseases inimical to Indian Fauna and Flora
- Inspection of agricultural commodities meant for export as per the requirements of importing countries under International Plant Protection Convention (IPPC)
- Detection of exotic pests and diseases already introduced for containing/ controlling them by adopting domestic quarantine regulations.
- Undertaking Post Entry Quarantine Inspection in respect of identified planting materials.
- Conducting the Pest Risk Analysis (PRA) to finalize phytosanitary requirements for import of plant/plant material.

Inspection Procedures followed in quarantine station:

- Visual inspection - To detect sclerotia, nematode galls, bunt galls, smuts, insect infestations, weed seeds, insect eggs, inert mater etc.
- X-ray test - Insect infestation
- Washing test - Spores of fungus eggs of insect adhering to seeds, nematode galls
- Sedimentation test - Stem eelworm (Ditylenchusdipsaci) (Baerman Funnel Test)
- Incubation test - Seed borne fungi/ bacteria (Blotter/agar test)
- Grow out test - Seed borne bacteria/viruses/downy mildews
- Electron microscopy - Potentially used for identification and characterization of all plant viruses.
- Serological methods: ELISA, DIBA, ISEM, Agglutination test. Nucleic acid hybridization • Polymerized Chain Reaction (PCR)

Plant Quarantine Treatments:

1.Fumigation:

- Under atmospheric or under reduced pressure methyl bromide for fruits, vegetables, plants, nuts, railroad cars, ships, wood products, etc.
- Other fumigants like HCN, phosphine and EDCT (ethylene dichloride + carbon tetrachloride mixture) are commonly used.

2. Heat treatment:

- Hot water treatment or hot air treatment are also used in quarantine for eradication of insects, mites, nematodes, fungi, bacteria and viruses.
- The basic principle treatment temperature should be sufficiently high to kill the associated pest/pathogen but not the host.
- Against nematodes: Flower buds, 44° C for 240 min; chrysanthemum, 48° C for 25 min; potato tubers, 45° C for 5 min;
- Against insects and mites: strawberry runners, 46° C for 10 min;

3.Cold treatment:

- Atmospheric cold plasma jet is capable of disinfecting fungus infected plant leaves and controlling the spread of infection.

4.Chemical treatment:

- Chemicals may be applied as dust, slurry, spray or as dip.
- Dosages of chemicals should be enough to eradicate the inoculums but should not kill the host.
- Chemical should not be hazardous to personal handling the treated seeds.

5.Tissue culture:

- Tissue culture technique reduces the pest/pathogen introduction risk in two ways:

(i) Since the introductions are represented by meristem tips, excised buds or embryos the size of infection is very much reduced.

(ii) the aseptic plantlet system has built-in pest/pathogen detection capability.

Agencies involved in Plant Quarantine:

- Directorate of Plant Protection, Quarantine and Storage, Faridabad.
- National Bureau of Plant Genetic Resources (NBPGR), New Delhi.

- Crop specific Research Institutes of Indian Council of Agricultural Research (ICAR).
- Head of Plant Pathology Division of State Agricultural Universities (SAU). ❖ State Agricultural and Horticultural Departments.

Plant Quarantine Stations in India:

- National Plant Quarantine Station (NPQS), Rangpuri, New Delhi
- Regional Plant Quarantine Stations: Amritsar, Chennai, Kolkata, Mumbai
- 75 Notified points of entry at various
    - Seaports (42)-Bhawnagar, Kandla, Mumbai, Vishakhapatnam etc.
    - Airports (19)- Amritsar, Delhi, Mumbai, Kolkata, Chennai etc.
    - Land frontiers (14)-Hussainwala, kalingpong, Bangaon, Attari wagha etc.
- 65 Inland Container Depots and 11 Foreign Post Offices.

Plant Quarantine organizations in India:

- Central Directorate of Plant Protection, Quarantine & Storage was established in 1946 and the Head quarter is in Faridabad.

Plant Quarantine related laws:

- 1914 – DIP Act; Destructive Insects and Pests Act.
- 1951 - UP Locust Destruction Act - by UP Govt.
- 1954 – UP Agricultural Disease and Pest Bill by UP Govt.
- 1961-Plant introduction Division established in IARI.
- 2003-Plant Quarantine (Regulation of Import into India) Order.

Disease Controlled by Plant Quarantine:

- Bunchy Top of Banana – Kerala
- Mosaic of Banana – Kerala
- Apple Scab – H. P.
- Wart of Potato - W. B.

International Quarantine:

- International Plant Protection Convention: International Standards for Phytosanitary Measures are prepared by the Secretariat of the International Plant Protection Convention as part of the United Nations Food and Agriculture Organization's global programme of policy and technical assistance in plant quarantine.

- The standards, guidelines and recommendations are made to achieve international harmonization of phytosanitary measures, with the aim to facilitate trade and avoid the use of unjustifiable measures as barriers to trade.

The International Plant Protection Convention (IPPC):

- IPPC is a multilateral treaty for international cooperation in plant protection.
- It was formed in 1952.
- Headquarters: Rome, Italy.
- 182 countries of the world are its member.
- IPPC work: It works on,
    - standards on pest risk analysis.
    - requirements for the establishment of pest-free areas.
    - And others which give specific guidance on topics related to the SPS Agreement.

Import control:

- Regulations of importing country
    - Embargoes.
    - Inspection of seed lots.
- Post Entry Quarantine (PEQ).

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URBAN HEAT ISLAND: CAUSES, IMPACTS & MITIGATION STRATEGIES

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Introduction

An urban heat island (UHI) refers to the phenomenon where urban areas experience significantly higher temperatures than their rural surroundings. This effect is primarily caused by human activities and the built environment in cities.

CHARACTERISTICS OF UHI:

- **Temperature Difference**: Urban heat islands can cause temperatures in cities to be several degrees Celsius warmer than surrounding rural areas, particularly during night time.
- **Spatial Variation**: UHI intensity varies across cities due to factors such as land use, building density, surface materials, and local climate conditions.
- **Heat Retention**: Buildings, roads, and other urban infrastructure absorb solar radiation during the day and release it as heat at night, leading to higher night time temperatures.

CAUSES:

i **Human Activity**: Urban areas have higher concentrations of human activities such as transportation, industrial processes, and energy consumption. These activities release heat, contributing to higher temperatures.

ii **Modified Surfaces**: Urban areas replace natural landscapes with buildings, roads, and other infrastructure that absorb and retain heat differently than natural vegetation and soil. Materials like asphalt and concrete tend to absorb and re-emit solar radiation, leading to elevated temperatures.

iii **Reduced Vegetation**: Urbanization often leads to the removal of trees and other vegetation, which provide shade and cool the environment through evapotranspiration (the process where plants release water vapor). The loss of vegetation reduces cooling effects and increases temperatures.

iv **Heat Absorption**: Urban areas have extensive surfaces covered with materials like asphalt and concrete, which absorb and retain heat more efficiently than natural landscapes such as vegetation and soil.

v **Altered Wind Patterns**: Buildings and other structures in cities can disrupt natural wind patterns, which can contribute to trapping heat and pollutants in urban areas.

vi **Weather Patterns**: UHIs can also be influenced by local weather patterns and geographical factors. For example, valleys or coastal areas can exacerbate the UHI effect due to specific atmospheric conditions.

IMPACTS OF UHI:

i **Temperature Increase:**

- **Daytime:** Urban areas can be several degrees Celsius warmer than surrounding rural areas during the day due to heat absorption and retention by buildings, roads, and other infrastructure.
- **Nighttime:** One of the most significant impacts is the elevated night time temperatures in cities compared to rural areas. This phenomenon reduces the cooling period at night, affecting human comfort and energy use for cooling.

ii **Energy Consumption:**

- UHIs contribute to increased energy demand for air conditioning during hot weather, leading to higher electricity consumption and costs for cooling buildings. This can strain energy infrastructure and increase greenhouse gas emissions.

iii **Air Quality:**

- Higher temperatures in urban areas can exacerbate air pollution levels, particularly ground-level ozone (smog), which forms more readily under warmer conditions. This poses health risks, especially for vulnerable populations such as children, elderly, and individuals with respiratory conditions.

iv Public Health:

- **Heat-related illnesses:** UHIs can lead to an increased incidence of heat-related illnesses such as heat stroke and dehydration during heatwaves.
- **Exacerbation of existing health conditions:** Higher temperatures and poorer air quality associated with UHIs can worsen conditions like asthma and cardiovascular diseases.

v Water Management:

- UHIs affect water resources and management. Higher temperatures increase water demand for cooling purposes and can strain water supplies during heatwaves. Additionally, UHIs can alter local precipitation patterns and increase the risk of urban flooding.

vi Ecological Impacts:

- Urbanization and UHIs can fragment natural habitats and reduce biodiversity. They can also disrupt ecosystems by altering temperature regimes and affecting plant and animal species adapted to specific climatic conditions.

vii Economic Impact:

- Increased energy costs for cooling and healthcare expenses related to heat-related illnesses can impose financial burdens on individuals, businesses, and governments. Decreased worker productivity during extreme heat events can affect economic output in urban areas. Vulnerable populations, including low-income communities and the elderly, are often disproportionately affected by UHIs due to factors such as limited access to air conditioning and green spaces.

MITIGATION

Mitigating the urban heat island (UHI) effect involves various strategies aimed at reducing temperatures, improving air quality, enhancing energy efficiency, and promoting overall urban resilience.

I. Increasing Vegetation and Green Spaces:

Urban Greening: Planting trees, creating parks, and establishing green roofs and walls help increase vegetation cover, which provides shade, reduces surface temperatures through evapotranspiration, and enhances air quality by absorbing pollutants.

Permeable Surfaces: Using permeable materials for pavements and sidewalks allows water infiltration, reducing surface heat and contributing to cooling through evaporation.

Cool Roof and Pavement Technologies:

Reflective Surfaces: Installing cool roofs (which reflect sunlight) and cool pavements (which reduce heat absorption) can significantly lower surface temperatures and decrease the overall UHI effect in urban areas.

Cooling Islands: Creating specific areas with high-albedo materials (reflective surfaces) strategically placed throughout the city can help mitigate local temperature increases.

Energy-Efficient Building Design:

Green Building Practices: Implementing energy-efficient building materials and designs such as proper insulation, shading devices, and natural ventilation reduces the need for artificial cooling, thereby lowering energy consumption and heat emissions.

Urban Design: Orienting buildings to optimize natural shade and ventilation, and designing urban layouts that promote airflow can help mitigate localized heat buildup.

Promotion of Sustainable Transportation:

Public Transit: Enhancing public transportation networks and encouraging their use reduces traffic-related heat and emissions, improving air quality and reducing overall energy consumption.

Active Transportation: Creating pedestrian and cycling-friendly infrastructure reduces reliance on cars, further reducing heat emissions and promoting physical activity.

Heat-Resilient Infrastructure and Urban Planning:

Climate-Sensitive Urban Planning: Incorporating UHI mitigation into urban planning strategies such as zoning regulations, green infrastructure mandates, and sustainable development practices.

Water Management: Implementing water-sensitive urban design approaches that include sustainable drainage systems (SuDS) can help manage stormwater, reduce flooding risks, and mitigate UHI effects.

Community Engagement and Education:

Awareness Programs: Educating residents and stakeholders about the impacts of UHIs and promoting behavior changes, such as reducing energy consumption and increasing green space utilization.

Partnerships: Collaborating with communities, businesses, and nonprofits to implement and sustain UHI mitigation initiatives can enhance their effectiveness and ensure long-term benefits.

Conclusion

The consequences of UHI include increased energy consumption for cooling, heightened air pollution levels, and potentially adverse impacts on public health, particularly for vulnerable populations. Efforts to mitigate UHIs often involve urban planning strategies like increasing green spaces, using reflective or cool roofing materials, and promoting sustainable building designs to reduce heat absorption and improve local climate conditions.

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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN SOIL SCIENCE: TRANSFORMING SOIL MANAGEMENT

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Abstract

Artificial Intelligence (AI) and Machine Learning (ML) are transforming soil science by providing advanced tools for data analysis, prediction, and decision-making. These technologies enhance soil health understanding, optimize soil management, and promote sustainable agriculture. AI and ML process extensive data from satellite imagery, sensors, and historical records to create detailed soil maps and classify soils based on key properties. They streamline soil health assessment by integrating data from various sources, allowing for timely interventions through predictive modelling and anomaly detection. Optimized fertilizer application via Variable Rate Technology (VRT) and smart irrigation systems improve nutrient efficiency and water management. AI and ML also aid in predicting and mitigating soil erosion, monitoring soil carbon levels, and evaluating carbon sequestration practices. In soil microbiology, these technologies analyze microbial diversity and support bioremediation by predicting pollutant degradation rates. Decision support systems (DSS) and farm management software provide real-time insights and recommendations, enabling precise soil management. As AI and ML continue to evolve, their impact on soil science and agriculture will grow, driving advancements and contributing to global food security and environmental sustainability.

Keywords: Artificial Intelligence - Machine Learning - Soil science – Applications.

Introduction

Soil science, focusing on the study of soil as a natural resource, encompasses its formation, classification, mapping, and various properties such as physical, chemical, biological, and fertility aspects. The integration of Artificial Intelligence (AI) and Machine Learning (ML) into soil science has revolutionized the field by enhancing soil health understanding, fertility management, and overall agricultural productivity. AI and ML analyze complex data sets, improve precision in soil management, and provide actionable insights for sustainable agriculture.

Soil Data Collection and Analysis

1. Soil Mapping and Classification

AI and ML algorithms process extensive data from sources like satellite imagery, remote sensors, and historical soil data to create detailed soil maps, classifying soils based on texture, organic matter content, moisture levels, and nutrient availability. AI-driven Geographic Information Systems (GIS) and remote sensing technologies enable the collection and analysis of spatial soil data. Machine learning models analyze satellite images and sensor data to classify soil types and identify areas requiring specific management practices.

2. Soil Health Assessment

Assessing soil health involves analyzing physical, chemical, and biological indicators. AI and ML streamline this process by integrating data from multiple sources such as soil samples, field sensors, and laboratory tests. Machine learning models predict soil health indicators like nutrient levels, pH, and microbial activity, allowing for timely interventions. AI algorithms detect anomalies in soil data, such as sudden changes in moisture levels or nutrient deficiencies, enabling prompt corrective actions to maintain soil health.

Precision Agriculture and Soil Management

1. Optimized Fertilizer Application

AI and ML optimize fertilizer application by analyzing soil data and determining precise nutrient requirements for different field areas, enhancing nutrient use efficiency, reducing waste, and minimizing environmental impact. Machine learning models analyze soil nutrient levels and crop requirements to generate variable rate application maps, ensuring each part of the field receives the appropriate amount of nutrients.

2. Irrigation Management

AI and ML technologies analyze soil moisture data, weather forecasts, and crop water requirements to optimize irrigation schedules. AI-driven smart irrigation systems adjust water application in real-time based on soil moisture levels and weather conditions, preventing over-irrigation, reducing water waste, and maintaining optimal soil moisture for healthy plant growth. Machine learning models predict drought conditions by analyzing historical weather data and soil moisture trends, enabling farmers to implement water-saving measures and protect their crops.

Soil Conservation and Sustainable Practices

1. Erosion Control

Soil erosion is a major threat to soil health and agricultural productivity. Machine learning models generate erosion risk maps by analyzing terrain features, rainfall patterns, and soil characteristics, identifying areas susceptible to erosion and enabling targeted conservation efforts. AI algorithms recommend erosion prevention strategies like contour plowing, terracing, and cover cropping based on specific field conditions.

2. Soil Carbon Sequestration

Remote sensing and AI technologies monitor changes in soil organic carbon levels over time, helping assess the impact of conservation practices like no-till farming and cover cropping on soil carbon sequestration. Machine learning models predict the potential of different agricultural practices to sequester carbon in the soil, guiding farmers in adopting practices that enhance soil carbon storage and reduce greenhouse gas emissions.

Soil Microbiology and Bioremediation

1. Microbial Diversity Analysis

AI and ML technologies analyze microbial diversity and identify key microbial communities that contribute to soil fertility. Machine learning models analyze metagenomic data to identify microbial species and their functions in the soil ecosystem, providing insights into complex interactions between soil microbes and their impact on soil health. AI algorithms identify microbial indicators of soil health, such as specific bacteria or fungi associated with nutrient cycling or disease suppression, helping monitor soil biological activity and fertility.

2. Bioremediation

AI and ML technologies support bioremediation efforts by predicting the effectiveness of different bioremediation strategies and monitoring the progress of soil remediation. Machine learning models predict the degradation rates of pollutants like pesticides and heavy metals by soil microbes, guiding the selection of bioremediation strategies that enhance pollutant degradation. AI algorithms analyze soil data to monitor the progress of bioremediation efforts, ensuring that remediation targets are met and soil health is restored.

Decision Support Systems and Farm Management

1. Decision Support Systems (DSS)

AI and ML-powered decision support systems integrate soil data with other agricultural data, such as weather forecasts, crop health, and market trends, providing comprehensive recommendations for soil management. DSS generate customized soil management plans based on soil properties, crop requirements, and environmental conditions, optimizing nutrient application, irrigation, and conservation practices.

Machine learning models assess risks associated with soil management practices, such as nutrient leaching or erosion, helping farmers implement risk mitigation strategies and ensure sustainable soil management.

2. Farm Management Software

AI-driven dashboards display real-time soil health metrics like moisture levels, nutrient status, and microbial activity, enabling farmers to monitor soil conditions and make informed decisions. Machine learning algorithms generate automated reports on soil health and management practices, helping farmers track the effectiveness of their soil management strategies and make necessary adjustments.

Conclusion

AI and ML are revolutionizing soil science by providing advanced tools for data analysis, prediction, and decision-making. These technologies enhance the understanding of soil health, optimize soil management practices, and promote sustainable agriculture. By leveraging AI and ML, farmers can achieve higher productivity, efficient resource use, and improved soil health, ultimately contributing to global food security and environmental sustainability. As AI and ML technologies continue to evolve, their impact on soil science and agriculture is expected to grow, driving further advancements in the field.

References

Smith, P., et al. "Remote Sensing in Soil Mapping and Classification." Journal of Soil Science, 2020.

Johnson, K., and Miller, R. "Predictive Modeling in Soil Health Assessment." Soil Health Journal, 2019.

Brown, L., et al. "Variable Rate Technology for Optimized Fertilizer Application." Precision Agriculture, 2021.

Zhang, H., and Wang, J. "Smart Irrigation Systems and AI." Agricultural Water Management, 2022.

Davis, C., et al. "Erosion Risk Mapping Using Machine Learning." Soil Conservation Review, 2020.

Gupta, R., and Sharma, S. "Monitoring Soil Carbon Sequestration with AI." Environmental Science & Technology, 2019.

Lee, Y., et al. "Metagenomics and Soil Microbial Diversity Analysis." Microbial Ecology, 2021.

Thompson, A., et al. "Machine Learning in Bioremediation of Soil Pollutants." Journal of Environmental Management, 2020.

Clark, J., and Roberts, D. "Decision Support Systems for Soil Management." Agricultural Systems, 2019.

Evans, P., et al. "Farm Management Software and AI-Driven Dashboards." Journal of Agricultural Informatics, 2021.

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RAIN-BEARING CLOUDS

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Introduction

Rain-bearing clouds are a vital component of the Earth's hydrological cycle, influencing weather patterns, ecosystems, and agriculture. Cumulus, nimbus, and stratus clouds are called as rain- bearing clouds. They play an important role in the distribution of freshwater, sustaining life on our planet. Understanding their formation, characteristics, and impact is essential for grasping the particulars of our climate system.

Formation and Characteristics

As warm air rises, it cools, causing water vapour to condense into tiny droplets. When these droplets aggregate, they form clouds. The primary types of rain-bearing clouds are cumulonimbus, nimbostratus and stratocumulus.

• **Cumulonimbus Clouds**:

Cumulonimbus clouds typically form through strong upward convection of warm, moist air. They have a towering appearance with a distinct anvil-shaped top, often reaching high into the atmosphere, sometimes up to the tropopause (the boundary between the troposphere and the stratosphere). These clouds have a dense and massive structure, with a base that can extend horizontally over large areas.

Cumulonimbus clouds are associated with thunderstorms, which occur when warm, moist air rises rapidly within the cloud, leading to the formation of strong updrafts and downdrafts. Lightning, thunder, and heavy precipitation are common during thunderstorms associated with cumulonimbus clouds. Cumulonimbus clouds can produce severe weather phenomena such as hail, strong winds, and tornadoes, particularly when conditions favour intense updrafts and rotation within the cloud.

Cumulonimbus clouds often bring heavy rainfall, which can be beneficial for crop and seed production by providing adequate moisture for germination and crop growth. However, excessive rainfall from intense thunderstorms can also lead to flooding, soil erosion, and waterlogging, which may damage crops and affect seed quality. Some cumulonimbus clouds produce hail, which can cause significant damage to crops, especially during sensitive growth stages. Hailstones can physically injure plants, reducing seed yield and quality. Cumulonimbus clouds generate strong downdrafts and gusty winds near the surface, which can cause lodging (flattening of crops), stem breakage, and other mechanical damage to plants.

Cumulonimbus clouds are closely monitored by meteorologists using weather radar, satellite imagery, and ground observations to predict severe weather events. Early detection and warning systems help mitigate risks to agriculture, infrastructure, and human safety associated with severe thunderstorms.

- **Nimbostratus Clouds**:

Nimbostratus clouds are a type of cloud associated with steady, widespread precipitation. Nimbostratus clouds form at mid to low levels of the atmosphere (typically between 2,000 to 10,000 feet or 600 to 3,000 meters). They are characterized by their uniform, thick layer of gray or dark gray clouds that often cover the sky. These clouds have a dense and opaque appearance, which blocks sunlight and creates overcast conditions. They are typically non-convective, meaning they do not have strong updrafts or downdrafts like cumulonimbus clouds.

The precipitation from nimbostratus clouds is usually light to moderate but can be continuous for several hours or even days. Unlike cumulonimbus clouds, nimbostratus clouds do not typically produce thunderstorms or severe weather. Instead, they bring steady, gentle rain or snow over large geographical areas.

Nimbostratus clouds are important for their role in providing steady precipitation essential for seed production, agriculture, and ecosystem health. While they do not typically bring severe weather like thunderstorms, their sustained rainfall or snowfall contributes significantly to water resources and environmental balance. Agricultural planning and adaptation strategies often take into account the predictable patterns of nimbostratus clouds to optimize crop management and yield.

- **Stratocumulus Clouds**:

While not as prolific in producing rain as nimbostratus or cumulonimbus clouds, stratocumulus clouds can still produce light rain or drizzle. Stratocumulus clouds are low-level clouds that exhibit a distinct layered or stratified appearance with some cumulus-like characteristics.

Stratocumulus clouds form in stable atmospheric conditions within the lower troposphere, typically below 6,500 feet (2,000 meters) but can extend higher in some cases. They appear as low, grayish or whitish clouds that often cover large portions of the sky in a continuous layer or patches. They have a clumpy or puffy appearance and can merge to form extensive cloud decks.

Stratocumulus clouds are generally associated with dry weather or light precipitation, such as drizzle. They do not usually produce heavy rainfall or thunderstorms. These clouds can bring periods of overcast skies and reduced visibility, especially when they cover large areas.

Stratocumulus clouds can reflect sunlight and help regulate surface temperatures by shading the Earth's surface. They often occur in regions where temperature inversions trap moisture and cool air near the ground. During the day, they may limit surface heating, keeping temperatures cooler. At night, they can act as a blanket, trapping heat and preventing rapid cooling of the Earth's surface.

These clouds have greater impact on seed production by means of temperature moderation, contributing towards humidity and reducing light intensity. Stratocumulus clouds can moderate temperature extremes, protecting crops from excessive heat during the day and frost during the night. While stratocumulus clouds do not typically produce heavy precipitation, they can contribute to humidity levels and provide some moisture to plants through light drizzle or mist. Their presence can reduce direct sunlight exposure, affecting photosynthesis rates and crop growth, depending on the specific light requirements of plants.

Conclusion

Rain-bearing clouds are more than just atmospheric phenomena; they are essential for agricultural progress. Their ability to distribute water through precipitation sustains ecosystems, supports agriculture, and regulates climate. As we face the challenges posed by climate change, understanding and monitoring these clouds will be crucial for predicting weather patterns and managing water resources effectively. Safeguarding our environment requires a comprehensive understanding of the processes that govern rain-bearing clouds, ensuring a sustainable future for all living beings.

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DIARA CULTIVATION: A MEANS OF LIVELIHOOD

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Introduction

In recent years, the agriculture sector has been adversely affected by climate change, and the rural poor are becoming more vulnerable to unsustainable livelihoods. River areas are known as "Diara". Diara land cultivation continues to be carried out traditionally. The ancient practice of diara cultivation was started during the Mughal period predominantly with various cucurbits. It was selected as an entry point to promote inclusive economic growth for the benefit of the landless people. A piece of land created inside a river due to the deposition of sand is known as Diara land or river bed. Cultivation in riverbeds facilitates off-season production which is a type of vegetable forcing in many cucurbitaceous vegetables which is purely an indigenous and innovation of Indian vegetable grower. In a survey, it was observed that out of the total area under cucurbits cultivation, 60 % area is under riverbed cultivation during the summer season around 75-80 % of total cucurbits production is being produced in river beds or diara land area which is available in the market from February – June. Such land is also known in different areas of India as khaddar lands, char lands, dariayi, kachhar, doab, kochar, nad, riverine area and nadiari.

Features

The technology works well on marginal lands, in topographically flat areas with river beds that are dry for one crop cycle (approximately 6 months) with arable land silted over and or washed away by floods. Distance or adjoining the village should not be 30 minutes on foot. Sand must be fine and small-grained and the groundwater table should be less than 1 m. Riverbeds or riverbanks may be cultivated. Riverbeds have a higher soil moisture content compared to riverbanks.

Properties of riverbed soil

The soil in river beds contains mostly sand and moisture seeped from the adjacent river. Well drained loamy soils are preferred for cucurbit cultivation. Sub-terranean moisture of river streams and alluvial substrate in sandy riverbeds support the growth of cucurbits. The soils should not form cracks and should not be water-logged in the summer and rainy seasons, respectively. It should be provided with adequate organic matter. A long tap root system is adapted to the growth of cucurbits in riverbeds. Most of the cucurbits prefer a soil pH between 6-7. The diara land can be classified based on the precise location from the mainstream as quoted below.

Main riverbed (lowland) diara

The actual riverbeds, which have fine sand to coarse deposits on the surface, become available during non-monsoon seasons, i.e. December-January to May-June until early rains set in.

Mainland (medium land) diara

These areas are located on the bank of the river and its width varies considerably. They are frequently inundated during the rainy season by the swelling of flood water. The depth of the main diara region varies considerably at different locations.

Upland diara

Due to continuous deposition, such areas have been elevated and are relatively less frequently flooded than the mainland diara areas. For all operational purposes, these areas are not very different from the normal (non-diara) lands.

Advantages of diara land cultivation

- High net returns per unit land area
- Early and high yield
- Low cost of cultivation and highly fertile land reduce the external mineral requirements
- Limited weed growth
- Pest and disease are controlled by cultural practices and cost effective
- Income and food security of landless and marginal farmers

- Local adaptation to climate change

Cultivation practices

Land preparation

Riverbed plots are chosen by farmers, with plots perpendicular to the river's flow. After the recession of flood during October-November and the cessation of the southwest monsoon, pit trenches or channels are prepared.

Systems of planting

The majority of farmers choose the following system of planting depending on personal preferences and the availability of labor. Common planting systems are

Pit system of planting

Pits of 0.5 m in diameter, 1 m deep, and 1 to 3 m apart are dug depending on the crops, and planted with numerous seeds, the feeble of which are thinned out. Sometimes circular pits with a diameter of about 35-45 cm and a depth of 90 cm are prepared.

Ditch system of planting

The trenches are dug in a North-West direction to manage the availability of moisture and higher temperatures. A trench of 1 m deep is dug along the row, with 1 to 2 m (cucumber, bitter gourd) or 3 m (watermelon, bottle gourd, pumpkin) space between rows. Seeds are planted/spaced 1 m (watermelon, bottle gourd, and pumpkin) and 0.5 m (cucumber, bitter gourd) apart in the ditch. The pits or trenches are filled with organic decomposed waste oil cakes or FYM which is mixed in the soil. Most of the cucurbits are sown in November and December. Before sowing, the trenches are manured with FYM or any other organic decomposed waste or oil cakes.

Crops

Some of the important riverbeds cultivated crops are Cucumber, Musk melon, Watermelon, Pumpkin and squashes, Bottle gourd, long melon, sponge gourd, ridge gourd, bitter gourd *etc*., are successfully grown in riverbed cultivation.

Seed rate, seed treatment and sowing/ transplanting

The seed rate varies according to the crops to be grown. Sowing is usually done for early crops in 1st fortnight of November and 1st week of December. 1st week of January is the best time for late sowing. The seeds are sown in a trench at a distance of 45-60 cm and a depth of 3 to 4 cm. Two seeds are usually sown in one place. Pre-sprouted seeds are sown for smooth germination when the temperature is very low. For this, pre-soak the seeds for 24 hours place the moist seeds in a gunny bag cover them with a cotton cloth, and keep them in a warm place for about a week for sprouting to start. Sometimes the moistened seeds wrapped in gunny bags are left near the fire for quick germination and in this way sprouting starts after 5-6 days. As soon as sprouts emerge outside the seed coat they are planted. Generally, 2-3 pre-germinated seeds/hill area sown in pits.




Nutrient management

Well-decomposed FYM or compost, caster cake or groundnut, neem cake is applied first. To enhance moisture retention in the feeding zone, river silt is generally used. Germinating seeds or growing transplants are provided with warmth from the organic manure. After 25-30 days of sowing, depending on weather conditions and growth, chemical fertilizers are top dressed in two split doses, especially fertilizer mixtures or nitrogenous fertilizers like urea. This top dressing is applied in shallow trenches away from the plants.

Water management

The deep root system in cucurbits enables the plant to survive in diara land. Pitcher irrigation is given in the initial stages of germination and growth till the roots of the plants touch the water regime below the sand or left as such. A trickle or sprinkler irrigation system is quite advantageous to avoid leaching losses of nutrients in sandy soils.

Weed management

Major weeds in diara land areas are *Euphorbia hirta*, *Polygonum* sp., *Eclipta prostrata*, *Fimbristlylis dichotoma*, *Sida* sp., etc. These weeds can be eradicated manually by pulling since the soil is quite loosened due to excess sand. Herbicides should be avoided completely as they may prove to be hazardous to humans, animals and fish when mixed with running river water.

Thatch preparation

When the temperature goes down to 1-2°C in December-January, young plants should be protected from low temperatures and frost in their early stages. The thatch screen made of locally available material like paddy straw, Saccharam grass or sugarcane leaves protects the young seedlings. Grass is spread in February over the sand as bedding and mulch, to protect the tender and young plants and fruits from the scorching heat of sand during summer and also stops the vines from drifting during strong winds.

Cropping pattern

Mixed cropping is usually practiced in riverbeds. Water melon and Musk melon generally go together. Other cucurbits mainly grown together are summer squash, bottle gourd, round melon, cucumber, sponge gourd, bitter gourd, long melon in north India, ridge gourd in Rajasthan, Madhya Pradesh, and Uttar Pradesh, and pointed gourd in Bihar.

Harvesting and yield

Harvesting should be done when fruits are quite tender and edible. Fruits that attain edible maturity should be harvested at 2-3 days intervals, or else, the quality deteriorates and fruits are hardened due to seed maturity. By the end of June to the end of October, harvesting at regular intervals can be done. Harvesting of fruits starts in February-March (off-season) and gives early yield and higher return. After harvest, crops are transported to local market centers for sale.

Role of pollinators

The cucurbit crops are highly cross-pollinated and the yield of crops is influenced by the pollinators. Honey bees are the main pollinating agent of cucurbit crops. In Diara land, visits of honey bees are restricted due to dry weather and, the non-visibility of flowers as the crop is lying on the surface. Hence, Sunflower sowing @100-150 plants per hectare was done for better pollination.

Important Insects-pests

Insects like aphids, mites, white flies, root-knot nematode and red pumpkin beetles are usually noted in the early stages of crops. The fruit-fly incidence is more in pointed gourd and bitter gourd and mite infestation increases in arid situations, as the day temperature rises above 40°C.

Management

Spray of Azadirachtin 300 ppm @ 5-10 ml/L or Azadirachtin 5% @ 0.5 ml/L for red-pumpkin beetle. Use cuelure pheromone trap @25 trap/ha and change these traps after 35-40 days for fruit flies management. Spraying of water on the plant can manage the spread of the mites. Spray the mixture of *Verticillium lecanii* @ 2.5 g/L and neem oil @ 2.0 ml/L for control of white flies. For biological control of nematode, 50 g neem cake per pit at the sowing time and drenching of *Trichoderma harzianum* (2 g) + *Paecilomyces lilacinus* (2 ml) + *Pseudomonas fluorescens* (2 ml) in per liter of water three times at 30 days interval (first dose at sowing time) is found to be effective for nematode management.

Important diseases

The important diseases observed in cucurbit crops under diara land cultivation are downy mildew, gummy stem blight, powdery mildew and viral diseases.

Management

The crop should be grown with wide spacing. The air movement and sunlight exposure help in checking the disease initiation and development for management of downy mildew. Gummy stems can be managed by using healthy seeds, and quick decomposing of plant debris.

SUMMARY

Diara land farming is an easy-to-learn, cost-effective technology, that allows landless households to produce unused marginal lands. This type of cultivation is best suited for the small and marginal farmers who can work themselves along with their families in the fields, producing a large number of cucurbits and other vegetables economically. The future line of work should focus on the identification of suitable varieties/ hybrids of Cucurbitaceous crops and development of production protocol for better Livelihood of the River bed (Diara land) farming community. Diara farming is a pro-poor-focused program for the rural community to increase household income and improve the food security of landless and land-poor households in India.

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PORTABLE SENSOR BASED GRAVITY FED MICRO TUBE IRRIGATION: SMART SOLUTION FOR WATER SCARCE REGION

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Introduction

The agricultural sector plays a crucial role in the economy of Tamil Nadu, serving as the primary source of income and supplying essential goods and materials to industries. Despite the state's impressive crop productivity compared to others, growth is hindered by severe droughts caused by significant rainfall deficits. Mismanagement of water resources exacerbates the crisis, despite above-average rainfall for nine years. Consequently, farmers in Tamil Nadu and across India are forced to abandon agriculture due to inadequate irrigation systems and mechanization. The urgent need for effective water management strategies is highlighted by the significant losses caused by drought-induced water scarcity (Angaleeswari et al., 2020).

While Tamil Nadu farmers recognize drip irrigation as a feasible technology, the adoption rate is slow due to the significant initial capital investment required (Biswasi et.al., 2017). The successful adoption of irrigation methods depends on both technical feasibility and economic viability. Hence, a low-cost, portable sensor-based gravity-fed micro-tube irrigation system emerges as a highly efficient solution to tackle both water scarcity and financial constraints.

The gravity-fed micro-tube irrigation system is an energy-saving method that utilizes gravity to channel and distribute water through a network of small-diameter PVC pipes directly to the crop root zone via low-pressure emitting devices (Sherpa et.al., 2021). This system represents advancement in irrigation technology, particularly in the context of minimizing energy costs. As noted by Patil et al., (2020), the gravity-fed drip irrigation system eliminates the need for pumping, thereby reducing operational expenses. It is a cost-effective irrigation solution driven by gravitational force, making it suitable for small-scale land areas, as highlighted by Patil et al., (2021). Given the increasing water crisis, there is a growing imperative for efficient water management. In this regard, the gravity-fed micro-tube system emerges as an optimal choice for small landholders, enabling easy operation and cultivation of a diverse range of crops with minimal water usage (Sangma et al., 2020).

Material Procurement and Construction:

In the creation of a sensor-based gravity-fed drip irrigation system, the integration of traditional gravity-fed irrigation components with advanced sensor and control technology results in automated functionality. The procedural steps in this process are as follows:

1. Material Acquisition: The initial step involves obtaining all the necessary materials. These materials consist of plastic drip tubing with built-in emitters, PVC pipes for the mainline and distribution, as well as associated fittings like end caps, T-connectors, and elbow connectors. Additionally, hose clamps, a ball valve, a microcontroller with sensor inputs, soil moisture sensors, a solenoid valve for automated control, a battery or power supply, a hose connector or faucet adapter, and stakes or supports are required.

2. Design and Layout Planning: Subsequently, the layout of the field for irrigation must be strategically planned, considering the optimal placement of sensors. It is crucial to ensure that the water source is situated at a higher level in relation to the field to facilitate gravitational flow.

3. Mainline Installation: The mainline is set up using PVC pipes, ensuring a gradual downward slope from the water source to guarantee proper water flow.

4. Establishment of Distribution Lines: Distribution lines are created from the mainline to each section of the field using PVC pipes or tubing. Plastic drip tubing is attached to these lines using hose clamps, positioning them strategically around plants or rows within each bed.

5. Sensor Placement: This cost-effective portable sensor is designed for disposable use with a 6-month lifespan and resistance to soil corrosion. It offers significant benefits to farmers by being easily removable and reusable, without requiring permanent integration with the master controller. These sensors are buried near the roots of the plants. These sensors are then linked to a microcontroller or timer equipped with sensor inputs.

6. Configuration of Irrigation Parameters: The irrigation parameters are set on the microcontroller to trigger irrigation when soil moisture levels drop below a specific threshold.

7. **Automation of Irrigation:** The automation of irrigation involves the installation of a solenoid valve on the mainline, which is then connected to the microcontroller. This valve operates by opening and closing in response to signals received from the controller, thereby facilitating the automated regulation of water flow.

8. **System Testing and Validation:** To ensure the system's effectiveness, it is essential to conduct thorough testing and validation procedures using the water supply. This includes verifying the system's ability to accurately detect soil moisture levels and activate irrigation according to the programmed settings.

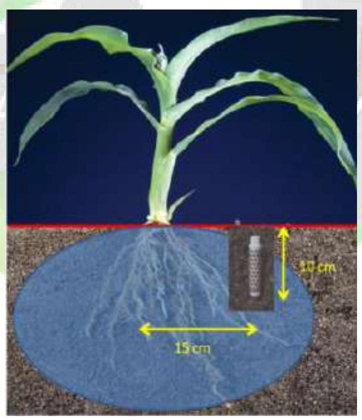

Fig. 1 Placement of soil moisture sensor

Basic Information for designing sensor based gravity fed drip irrigation system

1. Land Survey: It is crucial to conduct a thorough land survey to assess the topology and ensure the sustainability of a gravity-fed drip irrigation system. This will help in planning the layout according to the natural land contours.

2. Crop selection: The layout of the drip irrigation system, including lateral and emitter spacing, should be tailored to the specific crop being cultivated. Different crops have unique spacing and water requirements that must be considered.

3. Soil Characteristic: Understanding the soil's texture, structure, infiltration rate, water holding capacity, and bulk density is essential before installing the drip irrigation system. These factors significantly impact the system's efficiency and effectiveness.

4. Land slope: Evaluating the slope of the land is necessary to design the irrigation system properly. In hilly areas, laterals should be installed along the contours, while the main and sub-main lines should run perpendicular to them to utilize gravity effectively.

5. Climate data: Analyzing climatic records is important to determine the water requirements of crops throughout different seasons. This information helps in scheduling irrigation to match crop water needs accurately.

6. Water Source and Quality: The quality and source of water are vital considerations. The type of filter required for the system depends on the water quality, which is particularly relevant for water sourced from wells or tanks.

Working Process:

A portable sensor-based gravity-fed micro-tube irrigation system is proposed, which operates based on the soil moisture requirements. Automated Gravity fed micro tube irrigation system consists of three nodes: a sensor unit, a controller unit, and a valve unit.

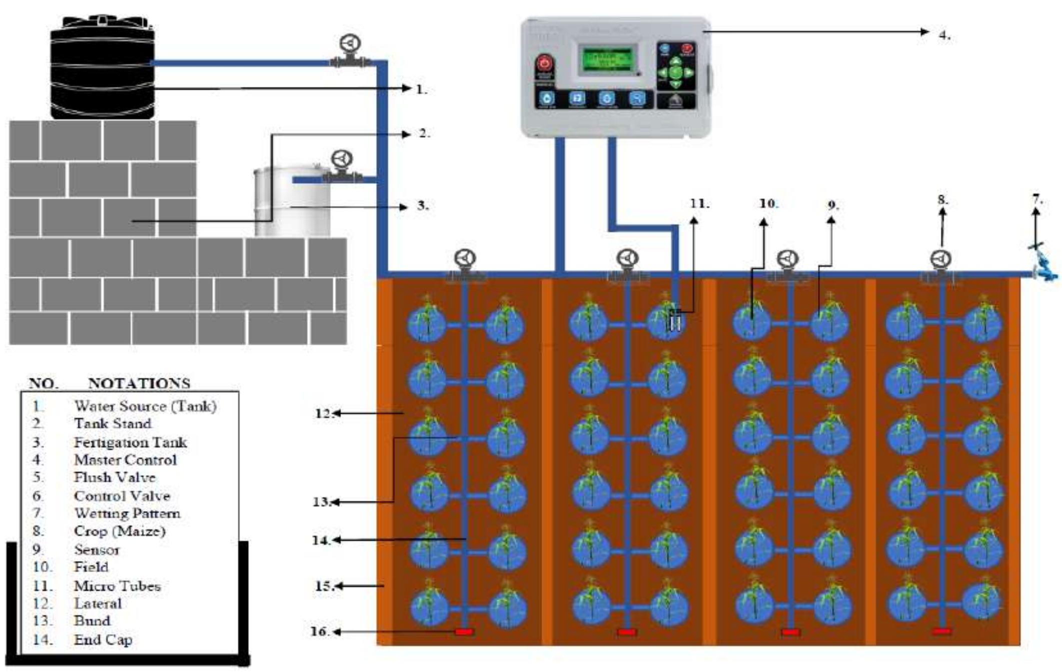

Fig.2. Layout of Automated Sensor Based Gravity Fed Micro tube Irrigation system

These nodes communicate with each other to automate the irrigation process in agricultural fields. To retrieve the data, the controller unit sends address data along with sensor numbers to the sensor unit. In response, the sensor unit sends moisture data along with the corresponding sensor number. The controller unit evaluates the moisture data by matching it with the sensor unit data. If necessary, the position of the valve can be adjusted accordingly. Subsequently, the controller unit sends address data to obtain new sensor values. Upon receiving instructions from the controller unit, the sensor unit measures the soil moisture and transmits the data. Based on this data, the valve unit changes its position, either turning on or off. This technology significantly reduces the investment cost of automation systems for farmers.

Conclusion

The gravity-fed drip irrigation technology offers an affordable and efficient solution for small-scale farmers. It facilitates optimal water usage, significantly reduces weed growth, and lowers the high energy costs associated with water pumping from wells or reservoirs. The system ensures a consistent distribution of water across the root zone, maintaining uniform application with minimal emitter variability. Additionally, the issue of emitter clogging is minimal, making the system reliable for long-term use. It is strongly recommended that this technology be introduced and adapted by small-scale farmers in Tamil Nadu, especially in hilly areas, to improve water conservation and management practices.

References

Adhikari, D. (2000). Simplified and low-cost drip irrigation manual. International Development Enterprises, Kathmandu, Nepal.

Angaleeswari, M., Valliammai, A., & Selvaperumal, A. (2022). Assessment of natural groundwater recharge in South Upper Odai watershed of Amaravathi basin in Tiruppur district. *Chemical Science Review and Letters*, 11(43), 373-377.

Biswasi, S. K., Bansude, S. K., & Ray, M. (2017). Performance of gravity-fed drip irrigation model for demonstration of small pomegranate orchard. *Indian Agriculturist*, 61(1:2), 1-4.

Isikwue, M. O., Ochedikwu, A. E. F., & Onoja, S. B. (2016). Small farm gravity-fed drip irrigation system for crop production. *Greener Journal of Science, Engineering and Technological Research*, 6(2), 48-54.

Patle, G. T., Kumar, M., & Khanna, M. (2020). Climate smart water technologies for sustainable agriculture: A review. *Journal of Water and Climate Change*, 11(4), 1455-1466.

Sangma, M. L. K., Reang, H. H., Patle, G. T., & Dabral, P. P. (2020). Analysis of rainfall data of Shilling and Agartala stations of northeast India. *International Journal of Environment and Climate Change*, 10(11), 134-142.

Sherpa, T. S., Patle, G. T., & Rao, K. V. R. (2021). Gravity head micro irrigation system for small landholders and its impact on livelihood: A review. *International Journal of Environment and Climate Change*, 11(2), 310-323.

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WEATHER IN SEED PRODUCTION

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Introduction

Weather plays a critical role in seed production, influencing the seed germination, growth, development, and yield of crops. Factors such as temperature, light, precipitation, humidity, cloudiness and wind significantly affect the health of plants and the quality of seeds produced. Understanding these influences is essential for taking timely actions to mitigate the effect of unfavourable weather on seed production. It is also important for the farmers and agricultural stakeholders aiming to optimize seed production and meet the demand.

KEY WEATHER FACTORS AFFECTING SEED PRODUCTION

1. Temperature

- **Optimum Temperature**: Each crop has a specific temperature range that is ideal for germination and growth. Extreme temperatures can hinder these processes, leading to poor yields. High temperatures can cause heat stress, reducing seed size and quality, while low temperatures may delay germination and growth.
- **Seed Dormancy and Breaking Dormancy**: Cold temperatures (stratification) are required for breaking dormancy in many seeds, particularly those of temperate plants. Stratification mimics winter conditions and is necessary for triggering physiological changes in seeds that allow them to germinate when environmental conditions become favourable.

- **Germination**: Different plant species have specific temperature ranges at which their seeds germinate optimally. Some seeds require warm temperatures to germinate (thermophilic species), while others prefer cooler temperatures (cryophilic species). Optimal germination temperatures promote quicker and more uniform seed germination, which is crucial for successful crop establishment and natural regeneration of plants.
- **Flowering and Pollination**: Many plants have specific temperature requirements for initiating flowering. Temperature cues also affect the synchronization of flowering with pollinator activity. For example, warm temperatures can accelerate flowering, ensuring that plants bloom when pollinators are most active, which enhances pollination and subsequent seed set.
- **Seed Development**: Temperature during seed development plays a crucial role in determining seed quality and characteristics. Optimal temperatures ensure proper development of seed structures, including embryo formation, storage tissue development, and seed coat formation. Temperature stress during seed development can lead to abnormalities, reduced seed viability, and lower seed quality.
- **Seed Yield and Crop Production**: Temperature extremes, both hot and cold, can negatively impact crop productivity by affecting flowering, pollination, seed set, and seed development. Optimal temperature conditions during critical stages of crop growth and seed production are essential for maximizing yield and quality.
- **Seed Storage and Longevity**: Proper storage conditions, typically cool and dry environments, help maintain seed viability over extended periods. High temperatures can accelerate seed deterioration and reduce viability, especially in storage.

2. Light:

Light plays a crucial role in seed production, influencing various aspects of plant growth, development, and reproductive processes.

Here are several key roles that light plays in seed production:

- **Photosynthesis**: Without sufficient light, photosynthesis is limited, which can affect overall plant health and seed production.
- **Initiation of Flowering**: Many plants require specific light conditions to initiate flowering. This phenomenon is known as photoperiodism, where the duration of light and darkness influences the transition from vegetative growth to reproductive growth. Some plants are long-

day plants (require longer periods of light to flower), short-day plants (flower when exposed to shorter periods of light), or day-neutral plants (not affected by day length).

- **Pollination**: Light can indirectly influence pollination by attracting pollinators such as bees, butterflies, and birds. Brightly colored flowers are often more attractive to pollinators, which increases the likelihood of successful pollination and subsequent seed production.
- **Seed Germination**: After seeds are produced, light can play a role in determining whether seeds germinate or remain dormant. Some seeds require exposure to light (light-dependent germination) to break dormancy and initiate germination. Others may require darkness (light-sensitive seeds) to germinate. This adaptation ensures that seeds germinate under optimal conditions for survival and growth.
- **Seed Quality**: Light exposure during seed development can influence seed quality attributes such as seed size, nutrient content, and dormancy. Adequate light during seed maturation ensures proper nutrient accumulation and storage, which affects the viability and vigor of the seeds.
- **Seed Maturation**: The timing and duration of light exposure during seed maturation can affect the physiological and biochemical processes that prepare seeds for dispersal and subsequent germination. Light regulates the synthesis of storage compounds (e.g., carbohydrates, proteins) and the development of seed coats, which protect seeds from environmental stresses.

3. **Precipitation**

Precipitation, which includes rain, snow, dew, sleet, and hail, plays a crucial role in seed production by influencing various aspects of plant growth, reproduction, and seed development. The several key roles that precipitation plays in seed production are

- **Water Supply**: Adequate rainfall is crucial for seed development. Insufficient moisture can lead to drought, severely affecting crop yields and seed viability. Intense rainfall can result in waterlogging, which may lead to root rot and other diseases that negatively impact seed production.
- **Germination**: Precipitation initiates the process of seed germination by providing the moisture necessary to soften the seed coat and activate enzymes that trigger germination. For many seeds, sufficient moisture from precipitation is crucial for germination to occur successfully.

- **Vegetative Growth**: Continuous precipitation supports vegetative growth, including the development of stems, leaves, and roots. This growth phase is vital for establishing healthy plants capable of producing seeds.
- **Flowering and Pollination**: Adequate precipitation ensures that plants have enough water to produce flowers and nectar, which attract pollinators such as bees, butterflies, and birds. Pollinators are essential for transferring pollen between flowers, which is necessary for fertilization and seed production.
- **Seed Development**: During seed development, consistent and moderate precipitation supports the growth of seeds within the plant's fruits or seed pods. Water uptake by the plant during this stage is critical for the accumulation of nutrients and the proper maturation of seeds.
- **Seed Dispersal:** Rainfall can trigger the dispersal of seeds by washing them away from the parent plant or by softening seed pods, facilitating the release of seeds.
- **Seed Quality and Viability**: Inconsistent or excessive precipitation during seed development may lead to irregular seed maturation, reduced seed size, and lower seed viability.

4. **Humidity**

Humidity does not directly influence seed development and germination as significantly as factors like water availability (precipitation) and temperature, it does affect the overall environmental conditions in which plants grow and reproduce. Here are several key roles that humidity plays in seed production:

- **Transpiration and Water Loss**: Humidity levels influence the rate of transpiration in plants. High humidity reduces the rate of transpiration because the air already contains a significant amount of water vapour, creating a less favourable gradient for water loss from plant leaves. This can be beneficial during periods of seed production by helping plants maintain adequate water balance.
- **Germination and Seedling Growth**: High humidity can aid in seed germination but may also promote fungal diseases. Conversely, low humidity can hinder seedling establishment.
- **Pollination Efficiency**: Humidity can affect the efficiency of pollination. Insects, birds, and other pollinators may be more active in moderate humidity conditions, which can enhance pollination rates. Adequate pollination is crucial for the formation of seeds.
- **Storage Conditions**: Humidity levels are critical for the storage and preservation of seeds. Proper humidity conditions help maintain seed viability and prevent deterioration during storage.

High humidity can lead to fungal growth and seed spoilage, while low humidity can cause seeds to dry out and lose viability.

5. **Wind**

Wind plays several important roles in seed production, particularly in the dispersal and distribution of seeds across landscapes.

- **Physical Damage**: Strong winds can physically damage crops, leading to broken stems and dislodged seeds.
- **Seed Germination**: In some plant species, exposure to wind or physical abrasion during wind dispersal can trigger seed dormancy breakage or enhance seed coat permeability, facilitating germination once seeds land on suitable ground.
- **Pollination**: Wind also plays a role in the pollination of certain crops, which is crucial for seed production. Wind can also play a role in pollination for certain plant species, particularly those with small, lightweight pollen grains that are easily carried by air currents. Wind-pollinated plants often produce large quantities of pollen to increase the chances of successful pollination. Sometimes, pollen grains may be washed out because of heavy wind leading to poor seed set and yield.
- **Seed Dispersal**: Wind is a primary agent for the dispersal of seeds from the parent plant to new locations. Many plants have evolved mechanisms to disperse their seeds by wind, such as lightweight seeds with structures like wings, parachutes, or hairs that facilitate their airborne transport over long distances.

6. Cloudiness:

- Cloudiness, or the amount of cloud cover in the sky, can influence seed production through several mechanisms related to its impact on light, temperature, and water availability.

ADAPTATION STRATEGIES

Farmers can adopt various strategies to mitigate the effects of weather on seed production:

1. **Crop Selection and Timing**:

- **Choose Suitable Varieties**: Select crop varieties that are adapted to local climate conditions, including temperature and precipitation patterns.
- **Planting Dates**: Adjust planting dates to optimize seed production based on historical weather patterns and forecasted conditions. This helps avoid extreme weather events during critical growth stages.

2. **Crop Diversification**: Growing a variety of crops can reduce risks associated with adverse weather conditions.
3. **Improved Irrigation Techniques**: Efficient irrigation systems can help manage water supply during dry spells.
    - **Irrigation Systems**: Install efficient irrigation systems to supplement precipitation during dry periods and ensure consistent water availability for seed development.
    - **Water Conservation**: Implement water conservation practices to minimize water loss and optimize water use efficiency in irrigated and rainfed systems.
4. **Soil Management**:
    - **Soil Health**: Maintain soil fertility and structure through practices such as crop rotation, cover cropping, and organic amendments. Healthy soils support robust plant growth and seed production.
    - **Mulching**: Use mulch to conserve soil moisture, moderate soil temperature, and reduce erosion risks, particularly during periods of extreme weather.
5. **Pollination Management**:
    - **Pollinator Habitat**: Enhance pollinator habitat diversity to support natural pollination processes. This includes planting native flowering species and providing nesting sites for pollinators.
    - **Pollination Timing**: Monitor weather conditions to ensure optimal pollination timing and maximize seed set, particularly for crops dependent on insect pollinators
6. **Selection of Resilient Varieties**: Utilizing crop varieties that are more tolerant to extreme weather can enhance seed production.

Conclusion

Weather is a fundamental factor influencing seed production, impacting everything from germination to harvest. By understanding and managing the effects of weather, farmers can improve yields and ensure the production of high-quality seeds, ultimately contributing to food security and agricultural sustainability.

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WHITE FRANGIPANI / PLUMERIA - WORLD'S BELOVED GARDEN PLANT

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Introduction

Plumeria is a beautiful tropical flowering plant that comes in a variety of different colours and can be kept indoors or outdoors. There are about 9 species of plumerias and all of them originated from Mexico and other regions of Central America. Plumeria flowers with their beautiful colours and fragrance symbolise natural beauty. Plumeria, which is otherwise known as Frangipani, Pagoda tree, Temple tree and West Indian Jasmine is the world's most beloved garden plant. It is a large shrub or a tree that can be grown in tropical and sub-tropical climates. There are about nine species of Plumerias and all of them originated from Mexico and other regions of Central America. The popular Plumeria species are *Plumeria rubra*, *Plumeria obtusa*, *Plumeria pudica* and *Plumeria alba*. Many cultivated varieties have been developed in the horticulture trade and now more than 1,000 flower colours are available in the international market.

Colour forms

Plumerias come in all colours of the rainbow – from pure white to deep red, from pale pink to butter lemon to the vibrant shades of yellows, golds, oranges, peach, mango, lilac, blood red and so on. They also come in bi-colours and tricolours with striped petals. And now there are many varieties developed with various shades of leaf variegations. Petal shapes also vary from thick, overlapping scalloped petals to thin, elongated ones. The fragrances of Plumeria flowers are diverse - ranging from coconut to jasmine, including citrus, rose, honeysuckle, raspberry, spice, apricot, peach etc. Each and every Frangipani variety has unique fragrance. The flowers are used for making scents and perfumes. Fresh flowers of Plumerias are scattered in pools and bowls for decoration. Plumerias are slow growing with swollen, succulent limbs with milky latex. The latex is not deadly except when taken in large quantities. The large, thick leaves are whorled around the tips of woody branches.

Colour forms in Plumeria

Utility

All the varieties are prolific bloomers and flowers bloom like bouquets at the tips of branches. Each flower is made of five waxy petals. Flowers secrete no nectar but are pollinated by moths that are attracted by the fragrance. Mature frangipanis can grow to around 10 metres high and 7 metres wide. There are both evergreen and deciduous varieties of Plumerias and the deciduous ones will shed their leaves during winter. Plumerias thrive with a little maintenance, are easy to propagate and look magnificent with large clusters of sweet-scented flowers almost throughout the year and hence make excellent garden plants. They are ideal for planting in home gardens, water gardens, patios, courtyards, planter boxes, roof-top gardens, balconies, as well as in groups, for privacy screen, for hedge, as specimen plants, beside a wall or in a bonsai form.

Propagation

Propagation of Plumerias through cuttings is easier when compared to many garden plants. They can also be propagated through layering, grafting and from seeds. The cuttings should be about 30 cm in length and taken from branches that are not in flowering stage. Place the cuttings out in the sunshine for a week. This will allow the cut end to dry out and form a callous.

Plumeria at seedling stage

Plumeria at flowering stage

Plumeria at leaf fall stage

Plumeria alba

Plumeria rubra

Plumeria pudica

Plumeria fruits and seeds

Mealy bug infestation

Make sure that the cuttings stay dry; keep them away from moisture. Dip the cutting tip into root growth hormone IBA, root growth hormone will help initial roots to grow. Dip the cut end of the cutting into a cup of water first, then dip 2.5–5.0 cm of the cutting into the root growth hormone powder. Plant the cuttings in raised nursery bed of sand. The beds should be watered well with proper drainage. After 15-20 days of time, the cuttings start to strike roots. It will take 4-8 weeks to take root.

Maintenance

Plumerias prefer bright sunlight and moderate humidity for optimum growth and require at least 6 to 7 hours of direct sun every day. No special care is required in the peak summer also. They grow well in light soils having good drainage but struggle in clay soils, where it is hard for water to drain away. For the old container plants, if their roots have filled the container, the plants to be repotted in spring to a slightly bigger pot. Top-dressing is needed every year by removing the top 2 to 3 inches of soil in the pot and replacing it with fresh soil mixed with manure.

Watering

Plumerias require profuse watering but the top soil shall be dried out before the next watering. On the onset of winter the frequency of watering shall be reduced and totally stopped after all the leaves are shed in the deciduous varieties and resumed in the spring as new growth begins.

Feeding

Plumerias will flower bigger and better, with the application of fertilizers during spring and summer. They should be fed with a high nitrogen fertilizer during spring when growth begins. To encourage the blooms, switch to phosphorous fertilizer in 2 to 3 doses from April to September.

Pruning

The size of the plant can be controlled by pruning, and by doing so more branching out and thereby more blooming occurs. Pruning operation can be done in late winter or early spring. While pruning, make a sharp and slant cut just above node. Thinning out about 20 per cent of the canopy of the mature plant is good to do every few years; it opens up the branches, allows light in and reduces stem rot.

Pests and diseases

Plumerias are very hardy and have very few insect or disease problems. During wet, cool weather frangipanis can be at risk of root / stem rot, caused by fungus. To reduce the risk, remove the spongy branches, reduce watering and spray fungicide. Plumeria rust is specific to plumeria plants caused by the fungus *Coleosporium plumeriae*. Plumeria rust affects the foliage of the plant but not the stems or flowers. Usually, the first noticeable symptom of rust on plumeria is yellow specks or spots on the upper side of the leaves. When flipped over, the underside of the leaves will have correlating powdery orange lesions. These leaves may curl, become distorted, turn brown-grey, and drop off the plant. If left unchecked, rust on plumeria leaves can defoliate the whole tree in under two months. It will also spread to other nearby plumerias. To control the rust, remove and destroy infected leaves, improve air circulation, avoid overhead watering, and apply fungicides labelled for rust control.

In cool and moist regions Plumerias are also susceptible to mealy bug, scale (insect) and rust (fungus) problems, which can be solved with minor doses of insecticide and fungicide sprays. The important pest in plumeria is mealy bug. Mealy Bugs can be treated in the following ways:

Manual removal: To eliminate the bugs on plumeria, rub alcohol by dipping a cotton swab into it. Another option is to use a brush, such as a toothbrush or soft-bristled brush, to remove the bugs.

Insecticidal soap: To get rid of the bugs, a mixture of insecticidal soap and water spray can be given. This solution is effective in killing both the bugs and their eggs. Repeating the treatment every week is recommended until all the bugs have been eliminated.

Neem Oil: Neem oil can be a helpful solution. To use it, mix neem oil with water and spray it on the affected plant. Repeat this process once a week until all the bugs have been eliminated.

Systemic insecticides: Spraying insecticides on the plant works by killing bugs when they feed on it are referred to as systemic insecticides. However, it’s important to note that it should only be used as a last resort as they can harm beneficial insects.

Prevention: To maintain the health and cleanliness of the plants, it is important to avoid overwatering and ensure that the area around the plant is kept clean. Inspecting new plumeria and plants thoroughly before planting them is also recommended to prevent any infestations or bug-related issues.

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HARNESSING BACTERIOPHAGES: A NEW FRONTIER IN VETERINARY MEDICINE

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Abstract

Bacteriophages, viruses that infect and kill bacteria, are emerging as a revolutionary tool in veterinary medicine. Phage therapy offers a targeted approach to combat bacterial infections in animals, addressing the growing concern of antibiotic resistance. This innovative treatment is particularly effective in managing chronic and antibiotic-resistant infections in livestock, companion animals, and aquaculture. Phages provide a natural, eco-friendly alternative to traditional antibiotics, promoting healthier animals and environments. Their specificity allows for precise targeting of harmful pathogens without disrupting beneficial microbiota. Applications range from treating bovine mastitis in dairy cows to controlling Vibrio infections in fish farming and managing chronic infections in pets. As regulatory approval and production challenges are addressed, phage therapy holds significant promise for enhancing animal health and welfare. Harnessing bacteriophages represents a new frontier in veterinary medicine, offering sustainable and effective solutions for bacterial disease management in various animal species.

Keywords: Bacteriophages, Phage Therapy, Veterinary Medicine, Antibiotic Resistance, Animal Health, Chronic Infections

Introduction:

Bacteriophages, or phages, are viruses that specifically infect and lyse bacterial cells. Their discovery and subsequent research have unveiled their potential as powerful tools in various fields, including veterinary medicine. The application of phages in veterinary practices is increasingly seen as a viable alternative to traditional antibiotics, particularly in the context of rising antibiotic resistance.

Types of Bacteriophages: Bacteriophages, or phages, are classified based on their morphology, genetic material, and replication strategies as follows:

1.Morphological Types:

Myoviridae: These phages have a contractile tail and an icosahedral head. They are known for their "sheath" that contracts during infection.

Siphoviridae: These have long, non-contractile tails and an icosahedral head. They are the most common type of phages.

Podoviridae: These possess short, non-contractile tails and an icosahedral head.

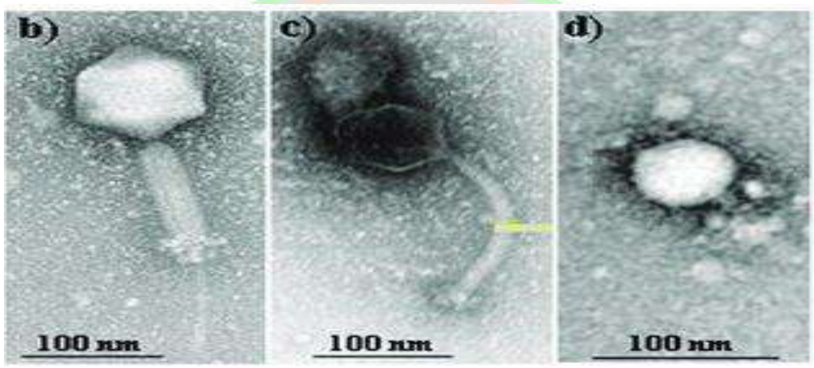


Figure 1. TEM micrographs showing the morphology of Myoviridae (b), Siphoviridae (c), Podoviridae (d)

1. **Genetic Material Types:**

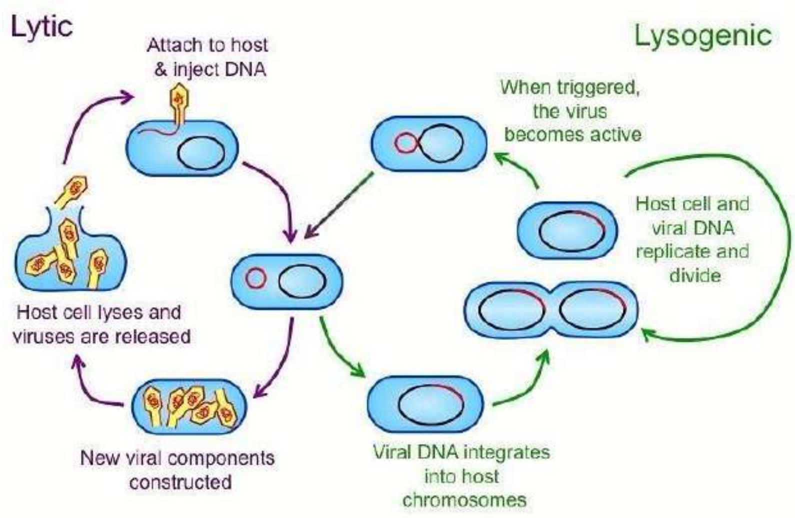
   DNA Phages: Most bacteriophages contain DNA as their genetic material, which can be single-stranded (ssDNA) or double-stranded (dsDNA).

   RNA Phages: Some phages have RNA as their genetic material, which can also be single-stranded (ssRNA) or double-stranded (dsRNA).

2. **Replication Strategies:**

   Lytic Phages: These phages replicate within the host bacterium and eventually cause the cell to lyse, releasing new phage particles.

   Lysogenic Phages: These can integrate their genetic material into the host's genome and replicate along with it without killing the host. Under certain conditions, they can switch to a lytic cycle.



Life cycle

The life cycle of a bacteriophage can be divided into several key stages. First, during adsorption (attachment), the phage recognizes and binds to specific receptors on the surface of the bacterial cell, mediated by the tail fibers or other specialized structures. Next, in the penetration (injection) stage, the phage injects its genetic material into the host cell, which can involve the contraction of the tail sheath (in Myoviridae) or other mechanisms to penetrate the bacterial cell wall and membrane. Once the genetic material is inside, replication (biosynthesis) occurs, where the phage hijacks the host's cellular machinery to replicate its DNA or RNA and produce phage proteins, disrupting the host's normal functions to prioritize the production of new phage components. Subsequently, in the assembly (maturation) stage, newly synthesized phage components, such as heads, tails, and tail fibers, are assembled into complete phage particles through precise interactions. Finally, during the release (lysis) stage, the host bacterial cell is lysed by enzymes produced by the phage, such as lysozyme, releasing the newly formed phages into the environment to infect other bacterial cells. Lysogenic phages, on the other hand, can enter a dormant state by integrating their DNA into the host genome, replicating along with the host cell until induced to enter the lytic cycle.

Applications of bacteriophages in the field of veterinary science:

1. **Treatment of Bacterial Infections:** Phage therapy is being explored as a treatment for bacterial infections in animals, especially those resistant to antibiotics. Phages can be used to target specific bacterial pathogens without disturbing the beneficial microbiota, making them a precise and effective treatment option.

Phage Therapy:

Bovine Mastitis: Mastitis in dairy cows, caused by bacterial pathogens such as Staphylococcus aureus, can be effectively targeted using phages. This reduces reliance on antibiotics, which helps mitigate the risk of antibiotic resistance and ensures the safety of dairy products.

Poultry Infections: Phages have been explored to treat bacterial infections in poultry, such as Salmonella and Campylobacter, which are also significant concerns for food safety.

Swine Infections: Phages can be used to combat bacterial diseases in pigs, such as those caused by E. coli, improving animal health and productivity.

2. **Prevention of Disease Outbreaks:** Phages can be used prophylactically to prevent bacterial infections in livestock, which is particularly beneficial in intensive farming environments.

Prophylactic Application:

Preventative Administration: Phages can be administered to healthy animals to prevent potential bacterial infections. This can be done through feed, water, or direct application to the animals.

Environmental Application: Phages can be applied to the environment where livestock are housed, such as in bedding, water sources, and surfaces, to reduce bacterial load and minimize the risk of infection.

Benefits:

Reduced Disease Incidence: By targeting harmful bacteria before they cause infections, phages can significantly reduce the incidence of disease outbreaks.

Lower Antibiotic Use: Prophylactic use of phages can decrease the reliance on antibiotics, helping to combat the rise of antibiotic-resistant bacteria.

Enhanced Animal Welfare: Healthier animals are less stressed and more productive, leading to improved overall welfare and better economic outcomes for farmers.

Implementation Strategies:

Routine Monitoring: Regular monitoring of bacterial populations in livestock environments can help identify when and where phage applications are needed.

Phage Cocktails: Using a mixture of different phages can enhance efficacy and reduce the likelihood of bacterial resistance.

Integration with Other Practices: Combining phage therapy with other best practices in biosecurity, hygiene, and vaccination can provide a comprehensive approach to disease prevention.

3. **Food Safety: Reducing Bacterial Contamination with Phages**

Phages play a crucial role in enhancing food safety by targeting and eliminating harmful bacteria in food products of animal origin.

Application in Meat Processing:

Surface Treatment: Phages can be sprayed or applied directly onto the surfaces of meat products to reduce contamination by pathogens such as Salmonella, E. coli, and Listeria.

Packaging: Incorporating phages into packaging materials can provide continuous protection against bacterial contamination during storage and transportation.

Application in Poultry Processing:

Pre-Slaughter Treatment: Administering phages to live poultry can reduce bacterial loads in the gastrointestinal tract, minimizing the risk of contamination during processing.

Post-Slaughter Treatment: Phages can be applied to carcasses, cuts, and poultry products to eliminate harmful bacteria on surfaces.

Application in Dairy Products:

Milk and Cheese: Phages can be used to target and reduce bacteria in raw milk, as well as during the processing of dairy products such as cheese and yogurt.

Safety of Dairy Products: Using phages helps ensure the microbial safety of dairy products, protecting consumers from foodborne illnesses.

Benefits: Phages are highly specific to their target bacteria, which means they can eliminate pathogens without affecting beneficial microorganisms. Phages are naturally occurring and considered safe for human consumption, making them an appealing alternative to chemical preservatives.By effectively controlling bacterial contamination, phages reduce the need for antibiotics in food production, helping to address antibiotic resistance issues.

Regulatory and Practical Considerations:

Regulatory Approval: Phage preparations must be approved by regulatory agencies to ensure their safety and efficacy for use in food products.

Integration into Processing Lines: Implementing phage applications in existing food processing lines requires careful planning to ensure optimal coverage and effectiveness.

Examples of Phage Application in Food Safety:

i. **Meat**: Phage-based products like ListShield™ have been developed to target Listeria in ready-to-eat meats.

ii. **Poultry**: Products such as EcoShield™ have been designed to reduce E. coli contamination in poultry.

iii. **Dairy**: Phages have been explored to control spoilage bacteria and pathogens in dairy processing, ensuring longer shelf life and safety.

By incorporating phage therapy into food processing, the food industry can enhance the safety and quality of products, protect public health, and reduce the economic impact of foodborne illnesses.

4. **Aquaculture: Phage Therapy in Aquaculture**

Phage therapy is gaining attention in aquaculture as a sustainable and effective method to manage bacterial infections in fish and shellfish. This approach not only addresses the issue of antibiotic resistance but also promotes healthier aquatic environments.

Managing Bacterial Infections: Phages can be used to specifically target and eliminate pathogenic bacteria without harming beneficial microorganisms in the aquatic environment. One of the common applications is the control of infections caused by Vibrio species, which are significant pathogens in fish and shellfish farming.

Benefits of Phage Therapy in Aquaculture: Phages are a natural and biodegradable alternative to chemical treatments and antibiotics, reducing environmental impact.By using phages, the reliance on antibiotics is minimized, helping to mitigate the development and spread of antibiotic-resistant bacteria. Phages can improve the overall health and survival rates of aquatic animals, leading to better yields and economic benefits for aquaculture operations.

Applications in Aquaculture: Phages can be administered through water or feed to control bacterial infections in fish. This is particularly useful for high-value species like salmon and trout. Phages can be used to manage bacterial diseases in shellfish, such as oysters and shrimp, enhancing their growth and quality.

Implementation Strategies:

i. **Water Treatment**: Phages can be added to the water in which fish or shellfish are cultivated, ensuring widespread distribution and contact with the pathogens.

ii. **Feed Additives**: Incorporating phages into feed allows for targeted delivery to the gut of the aquatic animals, where many infections originate.

iii. **Direct Application**: Phages can be applied directly to infected areas or wounds to control localized bacterial infections.

Challenges and Considerations:

Regulatory Approval: Ensuring phage products meet regulatory standards for safety and efficacy is crucial for their adoption in aquaculture.

Phage Stability: Maintaining the stability and viability of phages in various environmental conditions is essential for their effectiveness.

Bacterial Resistance: Similar to antibiotics, there is a risk of bacteria developing resistance to phages. Using phage cocktails can help mitigate this risk.

Case Study -Vibrio Control: Vibrio species, such as *Vibrio vulnificus* and *Vibrio parahaemolyticus,* are common pathogens in aquaculture, causing significant economic losses. Phage therapy has been successfully used to reduce Vibrio populations, improving the health and survival of cultured species. By integrating phage therapy into aquaculture practices, the industry can achieve more sustainable and effective management of bacterial diseases, ultimately leading to healthier and more productive aquatic farming systems

5. **Companion Animal Health:** Phages are also being explored for use in treating bacterial infections in companion animals, such as dogs and cats. They offer a targeted approach to combat pathogens like *Pseudomonas aeruginosa,* which can cause chronic infections in pets. Phage therapy could provide a solution for infections that do not respond well to conventional antibiotics.
6. **Environmental Applications:** Phages can be used to reduce bacterial pathogens in the environment, such as in water supplies and animal housing. By targeting specific bacteria, phages can help maintain a cleaner and safer environment for animals, reducing the overall disease burden.
7. **Research and Development:** The study of phages also contributes to our understanding of bacterial pathogenesis and antibiotic resistance mechanisms. By researching how phages interact with bacteria, scientists can develop new strategies to combat bacterial infections more effectively.

Conclusion

The application of phages in veterinary medicine offers a promising alternative to traditional antibiotics, addressing the growing concern of antibiotic resistance. Phage therapy's specificity, effectiveness, and eco-friendly nature make it a valuable tool in enhancing animal health, improving food safety, and ensuring sustainable veterinary practices. As research and development in this field continue to advance, the integration of phages into veterinary medicine is likely to expand, bringing about significant benefits to animal health and welfare.

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PARENTAL SELECTION STRATEGIES IN PLANT BREEDING

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Introduction

Parental selection is a foundational aspect of plant breeding, aimed at choosing the most suitable parent plants to produce improved progeny. This process involves various strategies to identify and combine desirable traits from different plants. Below are detailed explanations of the key strategies used in parental selection:

1. Phenotypic Selection

a. Phenotypic selection: involves choosing parent plants based on observable traits and characteristics. This strategy is straightforward but can be influenced by environmental factors.

b. Visual Assessment: This involves selecting plants based on visible traits such as plant height, leaf shape, flower color, and fruit size. Breeders visually assess these traits in the field or greenhouse.

c. Trait Measurement: More precise than visual assessment, trait measurement involves quantifying specific characteristics. For example, yield can be measured in kilograms per hectare, and disease resistance can be assessed through infection rates under controlled conditions.

2. Genotypic Selection

a. **Genotypic selection**: focuses on the genetic makeup of the plants, allowing for more precise and efficient selection.

b. Marker-Assisted Selection (MAS): This technique uses molecular markers (specific DNA sequences linked to desired traits) to identify and select plants carrying these markers. It accelerates the breeding process by allowing early and accurate selection.

c. Genomic Selection (GS): This approach uses genome-wide markers to predict the breeding value of plants. It involves genotyping a large number of markers spread across the genome and using statistical models to predict the performance of plants based on their genetic profile.

3. Pedigree Selection

- Pedigree selection involves choosing parents based on the performance and characteristics of their ancestors and relatives.
- By maintaining detailed records of the lineage of plants, breeders can select individuals with proven desirable traits. This method leverages historical data to make informed decisions about which plants to cross.

4. Combining Ability

Combining ability refers to the ability of a plant line to contribute favorable traits when crossed with other lines.

a. General Combining Ability (GCA): This measures the average performance of a line in hybrid combinations. It reflects the additive genetic effects.

b. Specific Combining Ability (SCA): This measures the performance of a specific hybrid combination relative to other combinations. It captures non-additive genetic effects such as dominance and epistasis.

5. Hybridization

Hybridization is the process of crossing different plants to combine desirable traits from both parents.

a. **Intraspecific Hybridization:** Crossing between individuals of the same species. This is common in plant breeding and aims to combine beneficial traits such as high yield and disease resistance within a species.
b. **Interspecific Hybridization:** Crossing between different species to introduce new traits that are not present in the existing species. This can result in hybrid vigor or heterosis, where the hybrid exhibits superior traits compared to its parents.

6. Recurrent Selection

- Recurrent selection is a cyclical process of selecting and intercrossing the best individuals from a population to improve a specific trait over generations.
- This method involves repeated cycles of selection and breeding, gradually increasing the frequency of desirable alleles in the population.

7. Backcrossing

- Backcrossing is used to recover a specific desirable trait in a hybrid.
- This involves crossing a hybrid with one of its parents or an individual genetically similar to its parent. It is commonly used to transfer a desirable trait from one line to an elite breeding line while retaining most of the elite line's genetic background.

8. Selection Index

- A selection index combines multiple trait values into a single index to select parents with the best overall performance.
- This method involves assigning weights to different traits based on their economic importance and breeding goals. It allows breeders to make balanced selections considering multiple traits simultaneously.

9. Participatory Breeding

- Participatory breeding involves farmers and other stakeholders in the selection process to ensure that selected traits meet end-user needs.
- This approach is particularly useful in developing countries where local farmers have valuable knowledge about the specific requirements and conditions of their environment. By involving them in the selection process, breeders can develop varieties that are more likely to be adopted and successful.

10. High Throughput Phenotyping

- High throughput phenotyping uses advanced technologies to rapidly and accurately measure traits in large populations.
- Technologies such as drones, imaging, and sensors are used to collect data on traits like growth rate, canopy structure, and stress responses. This allows for the efficient screening of large numbers of plants, speeding up the breeding process.

Conclusion

Effective parental selection in plant breeding involves a combination of these strategies to maximize genetic gain and develop plant varieties with enhanced performance, adaptability, and resilience. By leveraging both phenotypic and genotypic information, breeders can make more informed decisions and accelerate the development of improved plant varieties.

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DEVELOPMENT OF POWER OPERATED LOWLAND RICE SEEDER

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Introduction

Rice is the staple food Crop for the millions of people. In Tamil Nadu it occupies an area of 21M ha with a production and productivity of 5.2 mt and 2.5 t/ha respectively. For raising the rice production and productivity, implements and machines play a major role by way of enhancing the input use efficiency and reducing the requirement of labour, cost and time. Presently, in rice production, transplanting and weeding operations are carried out mostly manually, other operations like land preparation are carried out with the tractor or power tiller, while harvesting and threshing are carried out either with combine or by manual harvesting followed by the use of threshers. Direct seeding and transplanting are the two general methods for planting rice.

The transplanting of rice seedlings being a high labour-intensive and expensive operation needs to be substituted by direct seeding which could reduce labour needs by more than 20 per cent in terms of working hours (Pradhan, 1969; Fujimoto, 1991; Santhi *et al*., 1998.).The use of direct seeding method further increases income by eliminating cost of excessive seeds, labor for pulling and transplanting, reduce stress on pulling resulting too much higher percentage of germination and survival rate (Tajuddin, 1996). It could reduce the labor needed by 20 % (Sivakumar, *et al.* 2004). Therefore a self propelled direct paddy seeder was developed and evaluated for line sowing of pre-germinated paddy in lowland.

Materials and Methods

Development of self-propelled lowland rice seeder

The functional components of self-propelled lowland rice seeder are engine, gear box assembly, rubber moulded iron lugged wheel, frame assembly, seed metering assembly and float. The idle and operational view of the self-propelled lowland rice seeder is shown in Plate 1..

Plate 1 Idle view of the self-propelled lowland rice seeder

Seed determination tests

Tests were conducted with paddy seeder to find the effect of continuous rotation of the cup feed disc on the germination of seeds for BPT 5204 paddy variety. The drum filled with pre-germinated paddy seeds were rotated by an electric motor operated adjustable speed drive at the rotational speeds of 18, 21 and 24 rev/min to stimulate the forward speed of 1.75, 2.0 and 2.25 km/h. The seeds were collected from the continuously rotating drum at 5 min intervals. The collected seeds were sown in the soil. After 7 days the germinated seedling were counted.

Seed germination tests

The paddy seeder could give a seed rate of 9 kg/ha for 250 x 250 mm spacing and 7 kg/ha for 300 x 300 mm spacing of paddy crops for the variety BPT 5204. Germination tests conducted with BPT 5204 paddy variety at 10,20,20 rev/min rotational speeds of the seed drum revealed that germination of paddy was not affected by continuous rotation of the seed drum at all the three rotational speeds of the drum (Tajuddin *et al*., 1994).

Plate 2 Operational view of the self-propelled lowland rice seeder

Results and Discussions

The self-propelled direct paddy seeder was developed and tested in the laboratory for finding the seed rate. The paddy seed in the gunny bag was soaked in water 24 hours and incubated in the gunny bag for another 24 hours. The pre germinated seeds were filled in the drums upto 2/3 capacity and the ground wheel was rotated at 10, 20 and 30 revolutions The seed dropped from the drums were collected from each funnel. Three replications were made. From the data the seed rate of the paddy seeder was determined. Operational view of the self propelled lowland rice seeder is presented in the fig. 2 & 3

The field test conducted with the self propelled paddy seeder showed the average effective field capacity was 0.18 ha/hr with 76 per cent field efficiency. The average seed rate of the self propelled direct paddy seeder obtained in field was 9 kg/ha. Initial cost of the self propelled direct paddy seeder Rs.90, 000. The self propelled low land rice seeder facilitates line sowing of pre germination paddy seeds uniformly. The paddy seeder is thus promising inview of the good crop stand, case of inter cultural operations and in particular drastic reduction in cost of labour. The cost of direct seeding by the self propelled lowland rice seeder is Rs.735/ha

References

Tajuddin.A, 1996.Cost effective tools for farms. Science tech Enterprenur, pp.no.9-11.

Tajuddin.A, Karunanithi. R., Asokan.D, and Shanmugam.a, 1994. Lowland direct paddy seeder. J.Agric.Engng., ISAE, Vol.XXXI, No.1-4.

Pradhan, S.N., 1969. Mechanization of rice cultivation. *Oryza*, 6: 67-71.

Fujimoto, A. 1991.Technology and economics of rice direct-seeding in Tokai district:

Santhi, P., Ponnuswamy, K and Chetty, N.K. 1998. Effect of seeding methods and efficient nitrogen management practices on the growth of lowland rice. *Journal of Ecobiology*. 10(2): 123-132.

Sivakumar, S.S., Manian, R and Kathirvel, K. 2004. An Improved Direct Seeder. Department of Farm Machinery, College of Agricultural Enginering. Tamil Nadu Agricultural University, Coimbatore 641003, India

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DEVELOPMENT OF TRACTOR OPERATED ROTOVATOR CUM FLAIL MOWER

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Introduction

Wild shrubs are very common in an open area. Even when left unattended for a few days grass, weeds and wild shrubs cover the ground. A lot of grass cutter machines are available in market for cutting grass but these machines are not able to cut thick shrubs. Therefore, these shrubs have to be cut manually or by using some special machines like brush cutters, rotavator, mowers etc.

The effective mechanization contributes to increase in production in two major ways

1. The timeliness of operation and
2. A good quality of work.

The requirement of power for certain operation like seed bed preparation, cultivation & harvesting becomes so great that the existing human and power is becoming inadequate. Tillage is the most important unit operation in agriculture. It is done mainly to loosen the upper layer of soil, to mix the soil with fertilizer and to remove weeds. As a result of this processing the water-air, thermal and nutrient regimes of the soil are improved in the interest of the growth and development of crops.

1.1 Evolution of Rotavator

In India, the total area under irrigated rice is about 22.00 million hectares, which accounts about 49.5 per cent of the total area under rice crop in the country. Rice is grown under irrigated conditions in the states of Punjab, Haryana, Uttar Pradesh, Jammu & Kashmir, Andhra Pradesh, Tamil Nadu, Sikkim, Karnataka, Himachal Pradesh and Gujarat. For paddy field preparation we use rotavators. Rotavator is a cultivator that works on the soil by means of rotating blades. It is a tractor-operated implement attached to a three point linkage of the tractor and are driven by a power take off shaft. Unlike tractor drawn implements, the power is directly transmitted from engine, so it pulverizes the soil with minimum draft. Generally it is considered as a secondary tillage implements and also it is commonly used for primary tillage. It consists of gearbox, (wear resistant blades), P.T.O. shaft with shear bolt for overload protection, option of side chain drive or side gear drive, adjustable trailing board, sealed bearing, adjustable depth control skid and many more.

1.2 Mowers

Flail-mower is the only machine that can be used for mowing in stony, undulated or rough terrain. The flail-mower has the following advantages, (a) low initial cost, (b) less maintenance, (d) easy to handle, (e) can be operated at relatively greater speeds resulting in higher field capacity and (f) cutting elements are not damaged when obstructions are encountered during operation.

The flail mower gets its name from the use of "flails" attached to its rotating horizontal drum (also called tube, rotor, or axle). Many implement companies also refer to the flails as knives or blades. The rows of flails are usually staggered to provide a complete cut. The flails are attached to the drum using chain links or brackets, depending on the manufacturer. The rotating drum is perpendicular to the axis of the tractor. The PTO driveshaft along the tractor's axis must make a right angle through the use of a gearbox in order to transfer its rotational energy to the drum. As the drum rotates, centrifugal force pushes the flails outward.

Flail mowers tend to have higher horsepower requirements than rotary mowers and can be narrower, thus requiring more passes through the orchard. Some flail mowers include hydraulically operated sweepers that push debris in the tree row into the mower path for better coverage. Many are also offset to extend under the drip line of the trees, with some including a hydraulically operated offset to adjust to differing tree row widths.

Clearing the land from bushy plants by manual labour is tedious and time consuming. The land infested with noxious parthenium weeds pose serious problems because physical contact with these plants may cause allergy to human labourers engaged in cutting the plants. If machines such as cutter bar mowers or rotary blade mowers are used for such purposes, the cutting elements are likely to be damaged if encountered with stones or any other hard material. Then there are many orchards in which the weeds are growing should be removed without disturbing the soil.

It consumes more time, labors and cost, More over bush cutter engine is imported one which can't be repaired here. So to avoid these problems there is an urgent need to develop an indigenous technology for cutting of bushes in the orchards without disturbing the soil. Various shortcomings of the machine were carefully examined and machine was customized to meet the requirements of a shrub cutter machine. Keeping the above view, this project is aimed to develop a tractor operated rotavator cum flail mower for minimizing the cost of the implement as well as increase the usage of tractor.

2 Importance of rotavator

Rotary tiller is a tillage machine designed for preparing land suitable for sowing seeds (without overturning of the soil), for eradicating weeds, mixing manure or fertilizer into soil, to break up and renovate pastures for crushing clods etc. It offers an advantage of rapid seedbed preparation and reduced draft compared to conventional tillage. It saved 30-35 % of time and 20-25 % in the cost of operation as compared to tillage by cultivator. It gave higher quality of work (25-30 %) than tillage by cultivator. The Rotavator is the most efficient means of transmitting engine power directly to the soil with no wheel slip and a major reduction in transmission power loss.

Rotavators are accessible with modern technologies and creative designs which support excellent performance. The rotavators can be self-propelled and driven forward on wheels. Featuring a gearbox, the rotavators gears empower one to gain the rotation speed of the blades more than the forward speed of the equipment. These rotavators Gears have become world popular for development of seedbed in fields. These equipment's are regularly used for Ploughing or tearing the soil in farmland, fields, etc. agriculture rotavators are used for the Ploughing the field in your farms.

3. Development of Rotavator cum flail mower

The rotavator cum flail mower is developed with the following components and the presented in Plate 1.

Plate 1. View of the Rotavator cum flail mower

3.1 Main frame

The main frame is a square section (1600 x 315 mm) made of 100 x 4.2 mm hollow square pipe. The three point linkage connection is provided in the front portion of the frame for attaching the unit with the tractor. Three flats (315 x 100 x 12.5 mm) are provided on top of the main frame to fit the mast and braces for the support.

3.2 Multi Speed Gear Box

A gear box with bevel gears, spur gears with inner splines, main shaft and pinion shaft with outer splines, heavy duty roller bearings combine form a unit to increase the standard PTO 540 rpm to 2400 rpm for flail mower whereas for roto tilling operation standard PTO 540 rpm is reduced to 340 rpm. It enables the rotor shaft to rotate in the direction of travel. This helps in throwing the material behind the rotavator, which facilities in preventing the clogging of rotavator as well as flail mower. For increasing and decreasing the speed a gear shifting lever is attached to the top of the multi speed gearbox.

3.3 Chain transmission drive

A chain transmission drive is fitted at the right side of the implement for transmission of power from gear box to the rotary unit. A power from gear box is transmitted to rotary unit with the help of chain and sprocket mechanism. A pitch of 40 mm roll on chain was used to transmit the power to rotary unit.

3.4 Rotary unit

Rotary unit is used for rototilling the puddle soil in wetland and cutting the grasses by impact cutting without disturbing the soil in the orchards. The rotary unit is mounted below the frame with the ball bearings at the two ends of the hollow shaft of diameter 90mm and 6 mm thickness. Six flanges of diameter 220 mm and 10 mm thickness is welded over the hollow circular pipe with the distance of 240 mm each. A two rectangular flat is made as 'C' section of thickness 12.5 mm of length 240 mm is bolted between the two flanges. In one C section three chains of length 100 mm are welded at a distance 100 mm. In another 'C' section two chains of length 100 mm are welded at a distance 100 mm.

3.5 Depth control wheel

Depth wheel is fitted at both the sides of the implement by means of bolt and nut. In the depth wheel lever is fixed and that lever can be used to maintain the gap between soil and blade contact. Wheel is made of mild steel of diameter 300 mm and thickness 6 mm. This depth wheel is also used for arresting the vibration of the implement. The minimum and maximum height can be adjusted from 100 mm to 220 mm. The depth wheel is shown in plate 3.5.

4. Performance evaluation of tractor operated rotovator cum flail mower

4. Field trail

A field trail was conducted in the playground after developing the tractor operated rotovator cum flail mower. Before carrying the field trial the stones were removed and the field area should be in the levelled condition to carry out the bush cutting operation.

Plate 2 Operational view of the implement

After checking the field the implement is operated at 2400 rpm for cutting the bushes in the field without disturbing the soil. The operation view of the tractor operated rotovator cum flail mower is presented in Plate 2. The view of the field before and after the operation is presented in the Plate 3 & 4

Plate 3 View of the field before operation of the implement

Plate 4 View of the field after operation of the implement

4.2. Field evaluation

4.2.1 Fuel Consumption

The tank is filled to full capacity before and after the tests. Amount of refueling after the test is the fuel is the fuel consumption for the test. When filling up the tank careful attention should be paid to keep the tank horizontal and not to leave empty space in the tank.

4.2.2 Theoretical Field Capacity, C

$$C = \frac{S \times W}{10}$$

Where , C= Theoretical field capacity; ha.h

S= Forward speed, km.h

W=width, m

C = 3× (1.95) /10

= 0.585 ha/h

4.2.3. Effective field capacity, EFC

The effective field capacity of will include time lost during the actual field operation such as time lost due to turning ,loading, adjustment and other time losses during the operation.

$$EFC = \frac{A}{T}$$

Where:

EFC= Effective field capacity, ha.h

A=area, hectare

T=time to finish the area, hr

= 0.004875/0.009722

= 0.5014 ha/h

4.2.4 Field Efficiency (FE), %

$$FE = \frac{EFC}{C} X\,100$$

Where, EFC= Effective field capacity, ha.h

C= Theoretical field capacity; ha.h

FE = (0.5014/0.585)×100

= 85.71 %

5. Conclusion

The field test conducted with the tractor operated rotovator cum flail mower showed the average effective field capacity was 0.50 ha/hr with 86 per cent field efficiency. Initial cost of the Tractor operated flail mower Rs.98, 500. The cost of bush cutting with this machine including tractor is Rs.1040/ha. Fuel Consumption of the tractor for bush cutting operation is, 4 l/h. while using this tractor operated rotavator cum flail mower for bush cutting 67 per cent of cost is saved when compared to the manual bush butting.

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MAJOR DISEASES OF GROUNDNUT AND THEIR INTEGRATED DISEASE MANAGEMENT PRACTICES

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Introduction

Groundnut (*Arachis hypogaea* L.), a globally significant oilseed crop, contributes substantially to the livelihoods of millions. However, its production is significantly challenged by diseases, which can lead to substantial yield losses. These diseases are primarily caused by a complex interplay of biotic (fungi, bacteria, viruses, nematodes) and abiotic (soil type, climate, nutrient deficiencies) factors. Integrated Disease Management (IDM) emerges as a holistic approach to mitigate disease impact. Unlike traditional methods solely reliant on chemical control, IDM emphasizes a synergistic combination of cultural practices, host resistance, biological control agents, and judicious chemical application. This strategy aims to minimize the development of pathogen resistance, reduce environmental pollution, and ensure sustainable groundnut production. The major diseases of groundnut and its integrated disease management practices are as follows,

Early Leaf Spot

Early leaf spot, caused by *Cercospora arachidicola*, typically manifests approximately three weeks post-sowing. Circular, brown lesions develop on the adaxial leaf surface, surrounded by a distinct yellow halo. Lesions exhibit a smooth texture and may coalesce under severe conditions, leading to premature leaf senescence and abscission. Abaxial leaf surfaces display light brown discolorations. Symptomatic lesions can also be observed on petioles, stems, and stipules (Kumari et al., 2020).

Late Leaf Spot

Late leaf spot, attributed to *Phaeoisariopsis personatum*, commences around 45 days after sowing. Nearly circular, black spots emerge on the abaxial leaf surface. Lesions are characterized by a rough texture and can coalesce, resulting in premature leaf senescence and abscission.

Disease Favourable Condition

Optimal conditions for leaf spot development include temperatures ranging from 18 to 30°C, high humidity, and prolonged wet periods. Magnesium deficiency and excessive nitrogen and phosphorus fertilization have been associated with increased disease severity.

Disease Management

Cultural Practices:

- Sanitary measures, such as the destruction of infected plant debris, can effectively reduce disease incidence.

Biological Control:

- Intercropping groundnut with green gram (*Vigna radiata*) in a 4:1 ratio has shown promise in disease management.
- Seed treatment with asafoetida solution may provide some level of control.
- Cultivation of tolerant varieties, including T-64, C-501, MH-4, TMV-6, and TMV-10, is recommended.

Chemical Control:

- Foliar application of carbendazim (500 g/ha), mancozeb (1000 g/ha), or chlorothalonil (286 g/ha) can be employed. A second application may be necessary after 15 days if required.
- For combined infections of leaf spot and rust, 10% calotropis leaf extract, carbendazim (250 g/ha) + mancozeb (1000 g/ha), or chlorothalonil (1000 g/ha) can be applied. Repeat application after 15 days if necessary.

Rust

Rust disease caused by the fungal pathogen *Puccinia arachidis*, manifests as distinct orange-coloured pustules on the abaxial leaf surface. In advanced stages, pustule rupture releases reddish-brown urediniospores, facilitating disease dispersal to adjacent plants (Mondal et al., 2014). Yield losses can be substantial, reaching up to 65% in regions with high precipitation (Cole, 1987). Due to the short viability of urediniospores, prolonged crop-free periods are unfavorable for pathogen survival.

Favourable Conditions

Optimal conditions for disease development include high relative humidity (>85%), abundant rainfall and moderate temperatures (20-25°C).

Management

Cultural Practices

- Removal and destruction of infected plants to reduce inoculum load.
- Weed control to minimize favorable microclimates for pathogen development.
- Crop rotation to disrupt the disease cycle.

Chemical Control

Application of fungicides can effectively manage leaf rust. Recommended fungicides include mancozeb (1000 g/ha), chlorothalonil (1000 g/ha), wettable sulfur (2500 g/ha), and tridemorph (500 ml/ha). Repeat applications may be necessary at 15-day intervals if disease pressure persists.

Stem rot/Southern blight

Stem rot or southern blight caused by the necrotrophic pathogen *Sclerotium rolfsii*. *S. rolfsii* is a soil-borne pathogen that overwinters as mycelium or sclerotia within infected plant residues. Under favourable environmental conditions, these structures germinate, and the resulting hyphae infect host plants. Subsequent colonization and invasion of root and stem tissues by the pathogen are characterized by the development of a distinctive silky white mycelium (Hawaladar et al., 2022). Infected plants exhibit initial symptoms of yellowing followed by wilting. The collar region of the stem undergoes a process of browning and subsequent decay. Yield losses due to pathogen infection typically range from 25% to a severe 80-90%.

Disease Epidemiology

S. rolfsii thrives in tropical and subtropical regions characterized by elevated temperatures during the rainy season and irrigated agricultural practices. The pathogen's development is favored by a combination of high humidity, dense plant populations, warm temperatures, and frequent irrigation events. Optimal conditions occur in humid and warm soil environments throughout the crop's growth cycle.

Disease Management

Cultural Practices

- Deep ploughing to incorporate and bury surface crop residues.
- Cultivation of groundnut on flat or slightly raised beds to improve soil drainage.
- Regular collection and burning of infected plant debris to reduce inoculum levels.
- Implementation of crop rotation to disrupt the pathogen's life cycle.
- Control of leaf spot diseases to minimize leaf drop and indirectly reduce nutrient availability to the pathogen.

Biological Control

- Seed treatment with *Trichoderma viride* at a rate of 4 g/kg seed.
- Soil application of *Trichoderma viride* at a rate of 2.5 kg/ha, in combination with 50 kg farmyard manure or organic amendments such as castor cake, neem cake, or mustard cake at a rate of 500 kg/ha.

Chemical Control

- Seed treatment with a combination of Thiram (3 g) and Carbendazim is recommended.
- Spot drenching with Carbendazim (1 g/L) can be applied as needed.

Dry root rot

Dry root rot in groundnut is caused by the soil-borne pathogen *Macrophomina phaseolina*. Initial symptoms manifest as a reddish-brown discoloration at the stem base, proximal to the soil line. Subsequently, leaves and branches exhibit wilting, leading to plant senescence. Mycelial growth, characterized by a white, cottony texture, is evident on lesioned areas. The root bark undergoes disintegration, accompanied by the formation of abundant sclerotia within the disintegrated tissue and on the root wood.

Favourable Conditions

Disease incidence is exacerbated by prolonged drought followed by irrigation.

Management Strategies

Biological Control

- Seed treatment with *T. viride* suspension at a concentration of 4 g/kg seed.
- Soil application of *T. viride* at a rate of 2.5 kg/ha, incorporated with 50 kg farmyard manure or in conjunction with organic amendments such as castor cake, neem cake, or mustard cake at a rate of 500 kg/ha.

Chemical Control

- Seed treatment with a fungicide formulation containing Thiram and Carbendazim at a ratio of 3 g/kg seed.
- Localized soil drenching with Carbendazim solution at a concentration of 1 g/liter.

Bud necrosis

Groundnut bud necrosis is caused by the Peanut bud necrosis virus (PBNV). Chlorotic spots appear on young leaflets and necrotic rings and streaks are developed. Terminal bud necrosis occurs when the temperature is relatively high. As the plant matures it becomes stunted with short internodes and proliferation of auxiliary shoots. The virus is mainly transmitted by thrips.

Management

Cultural

- Adopt a closer spacing of 15 x 15 cm and remove infected plants up to 6 weeks after sowing and destroy them.

Biological

- Antiviral principles from sorghum or coconut leaves.

AVP is extracted as follows: Sorghum or coconut leaves are collected, dried, cut into small bits and powdered to one kg of leaf powder two liters of water are added and heated to 60°C for one hour. It is then filtered through muslin cloth and diluted to 10 litres and sprayed. To cover one ha 500 litre of fluid will be required. Two sprays at 10 and 20 days after sowing will be needed.

Chemical

- Monocrotophos 36 WSC 500 ml/ha, 30 days after sowing either alone or in combination with antiviral principles.
- Apply Quinalphos 25%EC 1400 ml/ha

Alternaria leaf spot disease: *Alternaria arachidis* and *A. tenuissima*

Lesions produced by *A. arachidis* are brown in colour and irregular in shape surrounded by yellowish halos. Symptoms produced by *A. tenuissima* are characterized by blighting of apical portions of leaflets which turn light to dark brown colour. In the later stages of infection, blighted leaves curl inward and become brittle. Lesions produced by *A. alternata* are small, chlorotic, water-soaked, that spread over the surface of the leaf. The lesions become necrotic and brown and are round to irregular in shape. Veins and veinlets adjacent to the lesions become necrotic. Lesions increase in area and their central portions become pale, rapidly dry out, and disintegrate. Affected leaves show chlorosis and in severe attacks become prematurely senescent. Lesions can coalesce, giving the leaf a ragged and blighted appearance.

Chemical management

Apply fungicides as a preventive measure or at the onset of disease symptoms. Foliar sprays of Mancozeb (0.3%), Copper oxychloride (0.3%), or Carbendazim (0.1%) can be effective.

References

Hawaladar, S., Nandan, M., Vinaykumar, H.D., Hadimani, R.H., Hiremath, S., Venkataravanappa, V., Basha, C.J. and Reddy, C.L., 2022. Morphological and molecular characterization of *Sclerotium rolfsii* associated with stem rot disease of groundnut (*Arachis hypogaea* L.). *Indian Phytopathology*, pp.1-12.

Mondal, S., Hande, P. and Badigannavar, A.M., 2014. Identification of transposable element markers for a rust (*Puccinia arachidis* Speg.) resistance gene in cultivated peanut. *Journal of Phytopathology*, *162*(7-8), pp.548-552.

Cole, D.L., 1987. Rust disease of groundnut in southern Africa: present situation and possible interactions with other groundnut foliar diseases. In Citation: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1987. Groundnut rust disease. Proceedings of a Discussion Group Meeting, 24-28 Sep 1984, ICRISAT Center, India. Patancheru, AP 502324, India: ICRISAT. (p. 109).

Kumari, M., Jadhav, A.S., Amolic, V.L. and Latke, S.B., 2020. Screening of groundnut (*Arachis hypogaea* L.) genotypes for rust (*Puccinia arachidis* Speg.) and late leaf spot (*Phaseoisariopsis personata* (Berk & curt)) diseases in field condition. *Journal of Pharmacognosy and Phytochemistry*, *9*(1), pp.2114-2117.

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LOCUST – AN INTER-CONTINENTA PEST

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Introduction

- Locusts are those species of Acrididae (Orthoptera), which under certain favourable conditions, congregate, move together in their larval stages as bands, and the resultant swarms fly to distant areas in dense masses, destroying the natural and cultivated vegetation.
- There are three important species in India

Species of locusts: (Acriddidae: Orthoptera)

Desert locusts, *Schistocerea gregaria*

- It is the most destructive species which breeds and swarms in Eastern Arabia during winter and spring and migrate to Indo-Pakistan region during May-July.
- A very polyphagous pest but there is some preference for cereals.

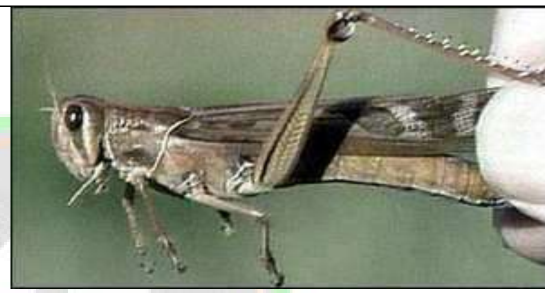
Bombay locusts, *Patanga succincta*

- It occurs in India, Sri Lanka and Malaysia.

- Noticed in Ramnad 30 years ago.
- Destroy maize and other graminaceous crops (alternative), wild grasses (Gramineae) and some herbaceous crops.

Migratory locusts, *Locusta migratoria*

- This species breeds in Baluchistan in spring and the adults migrate to the desert area in India.
- The scattered solitary forms cause negligible damage but swarms cause complete defoliation of crops.



Biology

- Females make a hole in moist sandy areas, lay the eggs in clusters (30-100) and cover them with a frothy secretion which hardens to form the egg pod that is water-proof. As many as 1000 egg pods may be seen in a square meter area.
- The egg period lasts 2-4 weeks. The nymphs congregate and move from place to place, destroying the green vegetation. They undergo 5 instars in 4-6 weeks.
- The adults swarm, migrate and destroy the crops. They can fly at a speed of 12-16 km/hr. The length and breadth of a swarm may be as wide as 2-3 km.

Phase theory

Uvarov, a Russian Scientist, proposed a theory that each species of locust can exist in two main forms or phases which differ structurally and biologically:

- Gregarious phase (phasis gregaria)
- Solitary phase (phasis solitaria)
- Intermediates (phasis transiens) which occur during the transition of a population from one extreme to the other.

In the solitary phase, the nymphs occur in different colours, green, grey or brown similar to its environment. The adults have longer and crested pronotum. The hind femur is relatively long compared with its fore wing. Biologically, it is less active and solitary**.** In the gregarious phase, the nymphs have back-coloured femur and they are yellow or orange in color of bold pattern. The adults are characterized by a short and saddle–shaped pronotum and relatively shorter hind femur. Highly active with gregarious tendencies, they march from place to place. Gregaria forms occur in dense swarms which fly over great distances, even trans-continental, physiologically assisted by the adipokinetic hormone. The swarms originate in outbreak areas. They may fly low (stratiform) or be piled high in the sky (cumuliform or towering) according to the wind speed. They invade large regions and breed to give rise to solitaria or gregaria forms according to the local conditions. Pheromones, temperature and rainfall are the factors that are responsible for the phases.

Management

- Forewarning: There is an Anti-locust Research Centre in London to monitor the activity of the locusts by remote sensing. It is called the Overseas Development Natural Resources Institute (ODNRI). Earlier it was called the Center for Overseas Pests Research. In India the Plant Protection Adviser to the Government of India with his headquarters in Faridabad, Haryana monitors the outbreaks in collaboration with Pakistan and Iran.
- The well-defined areas of egg laying may be located and the eggs destroyed on an organized scale by ploughing, digging or harrowing, which expose them to the sun and predators.
- Trenches (45 cm deep, 30 cm wide) act as a barrier to the marching nymphs which can be torched to death.
- Poison baits containing wheat or rice bran, molasses and carbaryl 50 WP may be used to kill the locusts.
- Insecticide dusts may be applied @ 25 kg per hectare.
- Neem kernel spray 5% acts as a repellent and deterrent to locusts.
- The swarms can be mechanically collected and burnt.
- The predatory birds feast on the locusts.
- Aerial sprays are resorted to as a last means.

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WASTE MANAGEMENT AND SUSTAINABILITY: TURNING TRASH INTO TREASURE

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Introduction

In a world increasingly defined by its consumption, the issue of waste management has never been more pressing. With the global population surpassing eight billion, the sheer volume of waste generated daily poses a monumental challenge to both the environment and human health. Yet, amidst this looming crisis lies an unprecedented opportunity: the chance to rethink waste not as a problem, but as a resource—a catalyst for sustainable development.

The Waste Crisis: A Global Perspective

Waste is a universal byproduct of human activity, manifesting in countless forms—solid, liquid, and gaseous. Every year, the world generates approximately 2.01 billion tons of municipal solid waste, with that figure expected to increase by 70% to 3.4 billion tons by 2050, according to the World Bank. This staggering amount of waste reflects a linear economic model—take, make, dispose—that has dominated industrialized societies for over a century.

The implications of this waste are far-reaching. Landfills, the most common method of waste disposal, contribute to significant land degradation and greenhouse gas emissions, particularly methane—a potent greenhouse gas with a global warming potential 28 times that of carbon dioxide over a 100-year period. Moreover, the leachate produced by decomposing waste poses a serious threat to groundwater and soil quality.

Oceanic waste, particularly plastic, has become another pressing issue. With an estimated 8 million tons of plastic entering the oceans annually, marine ecosystems are under severe threat.

The Great Pacific Garbage Patch, a massive accumulation of marine debris, is a stark reminder of our wasteful practices. This plastic pollution not only harms marine life but also enters the food chain, posing risks to human health.

However, the challenge of waste is not uniform across the globe. High-income countries, which comprise about 16% of the world's population, generate nearly 34% of the world's waste, while low-income countries, with 9% of the global population, generate only 5%. Despite this disparity, the consequences of waste mismanagement are felt globally, necessitating a concerted international effort to address the issue.

The Circular Economy: A Pathway to Sustainability

The concept of a circular economy offers a transformative approach to waste management. Unlike the traditional linear model, a circular economy seeks to close the loop, ensuring that products, materials, and resources are reused, remanufactured, or recycled rather than discarded. This paradigm shift not only minimizes waste but also fosters sustainable economic growth by reducing reliance on finite resources.

In a circular economy, waste becomes a valuable input rather than an unwanted output. For instance, organic waste can be composted to enrich soil health and improve agricultural yields, while industrial byproducts can be repurposed into new materials. Recycling is also a cornerstone of the circular economy, transforming discarded materials like metals, paper, and plastics into new products. However, the success of recycling depends on effective waste segregation at the source and the development of efficient recycling infrastructure.

One of the most promising areas of innovation within the circular economy is the development of bioplastics and biodegradable materials. Unlike conventional plastics, which can take hundreds of years to decompose, bioplastics are designed to break down more quickly, reducing their environmental impact. Similarly, advances in material science are leading to the creation of products that are easier to disassemble and recycle, further reducing waste.

The transition to a circular economy also requires a change in consumer behavior. The rise of the sharing economy—exemplified by platforms like Uber, Airbnb, and clothing rental services—demonstrates the potential for reducing waste by promoting access over ownership. By embracing concepts like product-as-a-service and encouraging the repair and reuse of goods, we can significantly reduce the amount of waste generated by consumer culture.

Waste-to-Energy: Harnessing the Power of Waste

Waste-to-energy (WtE) technologies present another innovative solution to the waste problem. By converting waste into electricity, heat, or fuel, WtE plants provide a dual benefit: reducing the volume of waste destined for landfills and generating clean energy.

Incineration is one of the most common WtE methods, involving the combustion of waste to produce electricity and heat. Modern incineration facilities are equipped with advanced pollution control technologies, making them a cleaner alternative to traditional landfills. However, the high capital cost of these plants and the potential for air pollution remain challenges.

Anaerobic digestion is another WtE technology that has gained popularity, particularly for managing organic waste. In this process, microorganisms break down biodegradable material in the absence of oxygen, producing biogas—a mixture of methane and carbon dioxide—that can be used to generate electricity or heat. The residual material, known as digestate, can be used as a nutrient-rich fertilizer, closing the nutrient loop in agricultural systems.

Gasification and pyrolysis are more advanced WtE technologies that decompose organic material at high temperatures in the absence of oxygen, producing syngas, a mixture of hydrogen and carbon monoxide. Syngas can be used to generate electricity or converted into biofuels, offering a sustainable alternative to fossil fuels.

While WtE technologies offer significant potential, they are not without controversy. Critics argue that they can disincentivize recycling by providing a seemingly easy way to dispose of waste. Moreover, the environmental and health impacts of emissions from WtE plants remain a concern, particularly in regions with lax regulatory standards. Therefore, the development and deployment of WtE technologies must be accompanied by stringent environmental safeguards and a commitment to prioritizing waste reduction and recycling.

Policy and Governance: Driving Change at the Global and Local Levels

Effective waste management requires robust policy frameworks at both the global and local levels. Governments play a critical role in setting regulations that incentivize waste reduction, recycling, and the adoption of sustainable technologies.

At the international level, agreements like the Basel Convention aim to control the transboundary movement of hazardous waste and promote environmentally sound management practices. The European Union’s Circular Economy Action Plan is another example of a comprehensive policy framework designed to reduce waste and promote resource efficiency.

This plan includes measures to improve product design, increase recycling rates, and reduce single-use plastics.

National and local governments also have a crucial role to play. Municipalities are often on the front lines of waste management, responsible for collecting, transporting, and disposing of waste. Innovative policies like pay-as-you-throw (PAYT) programs, which charge residents based on the amount of waste they generate, have been successful in reducing waste and encouraging recycling. Similarly, extended producer responsibility (EPR) schemes hold manufacturers accountable for the entire lifecycle of their products, incentivizing them to design for durability, repairability, and recyclability.

Public awareness and education are also vital components of effective waste management. Campaigns that promote the importance of waste reduction, proper disposal, and recycling can have a significant impact on consumer behavior. Schools, businesses, and community organizations can all play a role in fostering a culture of sustainability.

The Role of Innovation and Technology

Technological innovation is key to transforming waste management and advancing sustainability. From smart waste bins that monitor fill levels and optimize collection routes to blockchain technology that enhances transparency in waste tracking, the potential for technology to revolutionize waste management is immense.

Artificial intelligence (AI) and machine learning are also being leveraged to improve waste sorting and recycling processes. Automated sorting systems that use AI to identify and separate different types of waste can significantly increase recycling efficiency and reduce contamination. Additionally, digital platforms are emerging to connect waste producers with recycling facilities and secondary markets, facilitating the reuse and repurposing of materials.

The development of circular supply chains, where waste from one process becomes the input for another, is another area of innovation. For example, industrial symbiosis projects bring together companies from different sectors to share resources and waste streams, creating closed-loop systems that reduce overall waste and resource consumption.

A Sustainable Future: The Imperative of Collective Action

The journey towards sustainable waste management is complex and multifaceted, requiring the collaboration of governments, businesses, communities, and individuals. While technological innovations and policy frameworks are crucial, the success of these efforts ultimately depends on a collective commitment to sustainability.

As we confront the dual challenges of waste and environmental degradation, the need to rethink our relationship with waste becomes ever more urgent. By embracing the principles of the circular economy, harnessing the potential of waste-to-energy technologies, and fostering a culture of sustainability, we can transform waste from a burden into a valuable resource. In doing so, we not only mitigate the environmental impacts of waste but also pave the way for a more sustainable and equitable future.

The road ahead is not without challenges, but the rewards of sustainable waste management are immense. Cleaner cities, healthier ecosystems, and more resilient economies are within our reach if we dare to rethink, innovate, and act with purpose. Let us seize this opportunity to turn trash into treasure, for the benefit of present and future generations.

Conclution

The global waste crisis is intensifying as the world generates over 2 billion tons of waste annually, with significant environmental and health impacts. Traditional waste management methods, like landfills, contribute to pollution and greenhouse gas emissions, while plastic pollution threatens marine life and human health. To address these challenges, a shift towards a circular economy, where waste is repurposed as a resource, is essential. Innovations like waste-to-energy technologies, bioplastics, and smart waste management systems offer promising solutions. Effective policies, public awareness, and international cooperation are crucial to fostering sustainable waste management and ensuring a cleaner, more equitable future.

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CLIMATE CHANGE IMPACT ON HUMAN HEALTH IN INDIA

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Abstract

Climate change is predicted to have a wide range of health implications on developing countries with limited resources, including vector-borne and water-borne illnesses including malaria, cholera, and dengue. Human health is impacted by climate change both directly and indirectly. Climate change affects all facets of health, including food systems, livelihoods, and access to clean air, water, and soil. Decades of progress in improving global health will be undermined, health risks will rise, and our shared commitment to guaranteeing everyone's right to health will be broken if we continue to put off addressing climate change. The quality of food is expected to be impacted by climate change as well. Malnutrition is particularly common in low-income groups, women, children, elderly people, Indigenous Peoples, and small-scale food producers. India, a growing nation with a dense population, may face numerous health consequences for people as a result of climate change. To reduce the risks of climate change-related illnesses and injuries and to improve public health preparedness overall, an efficient public health response is necessary.

Keywords: Climate change, Human health, Malnutrition, health consequences, public health response

Climate change and human health

Although the biological processes of the planet may be impacted by climate change, its impacts on human health are still unclear. Climate change is predicted to have a wide range of health implications on developing countries with limited resources, including vector-borne and water-borne illnesses including malaria, cholera, and dengue.

Human health is impacted by climate change both directly and indirectly (Ebi *et al*, 2018 ,IPCC 2022) . Severe heat waves, sea level rise, altered precipitation leading to droughts and floods, and powerful hurricanes can all directly result in harm, disease, or even death (IPCC, 2021).

The infrastructure and workforce in the health sector are being impacted by climate change, which limits our ability to offer universal health coverage (UHC). More broadly, the environmental and social determinants of physical and mental health are weakened by climate shocks and increasing pressures such shifting patterns of temperature and precipitation, droughts, floods, and rising sea levels. Climate change affects all facets of health, including food systems, livelihoods, and access to clean air, water, and soil. Decades of progress in improving global health will be undermined, health risks will rise, and our shared commitment to guaranteeing everyone's right to health will be broken if we continue to put off addressing climate change.

Floods provide the ideal conditions for a wide range of negative health effects brought on by the spread of illness. For instance, the rate of faecal-oral disease transmission may rise if floodwaters are polluted with human or animal waste, which could lead to the spread of diarrhoeal disease and other bacterial and viral infections.

Disease hazards from floods are reduced in affluent nations by sanitation infrastructure, surveillance to identify and manage epidemics, and flood control measures. Particularly concerning are the rising rates of cholera, dysentery, typhoid, and diarrhea in emerging nations.

Since poor sanitation and contaminated drinking water are major causes of diarrheal illnesses, a decrease in freshwater availability is likely to make these illnesses more common. Water shortages are already a problem in India due to population increase, rapid industrialization and urbanization, and wasteful water use.

The "single biggest health threat facing humanity" is climate change, according to the World Health Organization (WHO). It states that over the years 2030 to 2050, hunger, malaria, diarrhea, and heat stress are expected to result in an additional 250,000 fatalities annually due to climate change's direct effects on the environmental and social determinants of health.

India is highly susceptible to climate-related health risks, and climate change is affecting health across the country in three principal ways:

- Climate change and variability directly impact personal health
- Food security is affected, with negative implications for nutrition levels
- Extreme weather events resulting from climate change disrupt healthcare services

Food insecurity and falling nutrition levels

Food insecurity and malnutrition are widespread in India as a result of changing agricultural yields and the natural disasters that follow, as well as reduced crop nutritional values.

Foodborne infections may arise from contaminated foods that humans are exposed to due to climate change (Lake et al., 2009).

The quality of food is expected to be impacted by climate change as well. The nutritional value of staple crops may be impacted by the rise in atmospheric carbon dioxide linked to climate change, which may worsen malnutrition by lowering the amount of protein and important minerals (Smith et al, 2018).

Although everyone is susceptible to the effects of climate change on food systems, certain populations are more so than others. Malnutrition is particularly common in low-income groups, women, children, elderly people, Indigenous Peoples, and small-scale food producers (Ziska et al., 2016 and IPCC 2022).

Heat stress and human health

The frequency of heatwaves is rapidly increasing, and by 2020, the number of Indian states affected by them had more than doubled since 2015. Heatwaves are not only making respiratory and cardiovascular disorders worse; they are also making dehydration and other ailments like heat exhaustion and heatstroke more common, especially among the elderly and young. The debilitating effects of heat can be dangerous, even fatal, for the underprivileged and outdoor laborers. The way that intense heat depletes energy and health also has an impact on the productivity of the economy. Due to the necessity for rest periods, half of India's afternoon work hours in all job categories are projected to disappear by 2050.

Furthermore, prolonged periods of excessive heat and stagnant air lead to higher levels of particulate matter and ozone pollution. In line with global trends, India is also experiencing a rise in the number of days per year with extreme heat and air pollution. The frequency of these twin phenomena is predicted to increase exponentially by 2050, and when paired with other air pollution factors, there will likely be a significant increase in disease incidence, neurological and cognitive impairments, and negative consequences on both expecting mothers and infants. Finally, a rise in vector-borne diseases (VBDs) has also been attributed to a hotter temperature, irregular and variable rainfall, and drought-like conditions in some areas of India. VBDs such as the Nipah virus, the Zika virus, chikungunya, and dengue have exhibited signs of becoming endemic. Diarrheal diseases are also regarded as a key climate-induced health challenge.

Implications for health care systems

India, a growing nation with a dense population, may face numerous health consequences for people as a result of climate change. Water-borne infections and infectious disorders like chikungunya and malaria may be among these impacts. Early warning systems, which offer advantages for both health and the economy, will be necessary to monitor the development of infectious diseases. There will be negative effects on health from an increase in extreme weather events. Among the negative effects on the populace are injury, hunger, and displacement brought on by the loss of housing.

India's climate will not have a uniform effect. Due to their limited ability to adapt, people with lower socioeconomic level are probably going to be most impacted by the health effects of climate change. An interesting predicament is presented by the expanding middle class in India as the country's economy continues to grow. Breaking free from poverty will lead to better living and sanitation circumstances, which will make people more resilient to infectious diseases. However, it will also cause consumption habits to increase, which will increase carbon pollution and cause new health issues.

In order to avert catastrophic health repercussions and millions of fatalities linked to climate change, global warming must be limited to 1.5°C. However, even 1.5°C of global warming is not thought to be safe; every additional tenth of a degree will have a negative impact on people's lives and health.

WHO’s response to these challenges centres around 3 main objectives:

- Promote actions that both reduce carbon emissions and improve health
- Build better, more climate-resilient and environmentally sustainable health systems:
- Protect health from the wide range of impacts of climate change

Conclusion

India, a growing nation with a dense population, may face numerous health consequences for people as a result of climate change To reduce the risks of climate change-related illnesses and injuries and to improve public health preparedness overall, an efficient public health response is necessary.

In order to avert catastrophic health repercussions and millions of fatalities linked to climate change, global warming must be limited to 1.5°C. A certain amount of global temperature rise has already been brought about by past emissions, making more climate change unavoidable.

References

Dhara, V. Ramana, Schramm, Paul J., Luber, George. Climate change & infectious diseases in India :Implications for health care providers. *Indian Journal of Medical Research* 138(6):p 847-852, December 2013.

Sarma A. (2023).Building climate-resilient health systems in India. OBSERVER RESEARCH FOUNDATION.

Climate change.2023. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

Ebi K.L, Balbus JM, Luber G, Bole A, Crimmins A, Glass G, Saha S, Shimamoto MM, Trtanj J, and White-Newsome JL. 2018: Human Health. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II

IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

Lake, Iain R., et al. A re-evaluation of the impact of temperature and climate change on foodborne illness. Epidemiology & Infection 137.11 (2009): 1538-1547.

Harvard C-Change Center for Climate, Health, and the Global Environment. Climate change puts at risk the food supplies of people in developing and developed nations alike. Floods, droughts, more intense hurricanes, heatwaves and wildfires can drive down crop yields, destroy livestock, and interfere with the transport of food. Rising carbon dioxide levels from human activity can make staple crops like rice and wheat less nutritious.

Smith, M. R., & Myers, S. S. (2018). Impact of anthropogenic CO2 emissions on global human nutrition. Nature Climate Change, 8(9), 834-839.

Ziska, L., A. Crimmins, A. Auclair, S. DeGrasse, J.F. Garofalo, A.S. Khan, I. Loladze, A.A. Pérez de León, A. Showler, J. Thurston, and I. Walls, 2016: Ch. 7: Food Safety, Nutrition, and Distribution. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC, 189–216.

IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

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GUAVA (*Psidium guajava* L.) LEAVES: NUTRITIONAL COMPOSITIONS AND BIOACTIVE COMPOUNDS

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Introduction

Guava, (*Psidium guajava*), a small tropical tree, belongs to the family Myrtaceae, cultivated for its edible fruits. Guava trees are native to tropical America and are grown in tropical and subtropical areas worldwide. Guava trees have been grown for its fruits, and utilized as fruit in tropical areas like India, Indonesia, Pakistan, Bangladesh and South America. Different parts of the guava tree, i.e., roots, leaves, bark, stems, and fruits, have been employed for treating various diseases like stomachache, diabetes, diarrhea, and other health ailments in many countries. Guava fruit pulp is a major ingredient, it used to prepare jams and jellies. Fresh guavas are rich in vitamins A, B, and C; they are commonly eaten raw and may be sliced and served with sugar and cream as a dessert. Fruits are oval in shape, having white or pink flesh, light green to yellow skin and contain edible seeds. Guava leaves has numerous medicinal values, it has been used along with the pulp and seeds, to treat respiratory and gastrointestinal disorders. GL is also used to increase platelets in patients suffering from dengue fever. Guava leaves are used to prepare herbal tea and they are given as an antioxidant supplement.

2. Biochemical Composition

2.1 Proteins

Guava leaves contain a considerable amount of protein (9.73%) on a dry weight basis. Proteins are large biomolecules comprising an amino acids and building blocks of cells. Proteins play several roles in the body, which act as a biocatalysts, growth and development, cell signaling and enzyme regulation. Recently, plant-based nutrients have gained potential because of the high demand for nutritionally rich food, particularly protein.16.8 mg protein/100g and 8 mg amino acids/100g in guava leaves as estimated according to Lowry's and ninhydrin methods. Guava leaves are utilized as a novel and sustainable dietary source because of its rich source of proteins, carbohydrates, dietary fibers, vitamins and antioxidant compounds.

2.2. Minerals and Vitamins

Guava leaves contain a greater amount of minerals, which include calcium, potassium, sulfur, sodium, iron, boron, magnesium, manganese, and vitamins C and B. The higher concentrations of Mg, Na, S, Mn, and B in GLs make them a highly suitable choice for human nutrition and also as an animal feed to prevent micronutrient deficiency. The concentration of minerals such as Ca, P, K, Fe, and Mg as 1660, 360, 1602, 13.50, and 440 mg per 100g of guava leaf dry weight (DW), respectively. The concentration of vitamins C and B was 103.0 and 14.80 mg per 100g DW related to diseases like hypocalcemia, hypophosphatemia, and osteoporosis. The concentration of Ca, P, Mg, Fe, and vitamin B in guava leaves was higher than that in guava fruit. The higher vitamin C content in GLs helps in improving the immune system and maintaining the health of blood vessels. Vitamin B plays an important role in improving blood circulation and cognitive function stimulation respectively. Consumption of calcium and Phosphorus rich guava leaves reduces the risk of deficiency.

2.3. Phytochemical Profiles

Guava leaves also contain essential oil, which have potential bioactive compounds. The major constituents of essential oil are 1,8-cineole and trans-caryophyllene. The major compounds are β-caryophyllene, α-pinene, and 1,8-cineole. The compounds are predominantly present which act as an antioxidant, anticancer, anti-inflammatory, and antimicrobial agent. Table 1depicts various active compounds of guava.

Table 1. Phytochemical Profile

Compounds	Approximate Composition
α-pinene	1.53%
Benzaldehyde	0.83%
β-caryophyllene	2.91%
Limonene	54.70%
α-Humulene	0.77%
α-Terpineol	1.79%
1,8-cineole	32.14%

Lee *et al*, 2012

Conclusion

The presence of antioxidant compounds, like quercetin, flavonoids, ferulic, caffeic, and gallic acids in guava leaves are considered for therapeutic applications. This review aims to discuss the various nutritional and bioactive compounds present in guava leaves. GLs are widely employed for treating diarrhea and digestive ailments, while the fruit pulp is utilized to enhance the platelet count for treating dengue fever. The flavonoids present in guava leaf extract chiefly determine their antibacterial activity, while quercetin, which is the most predominant flavonoid of guava leaves, exhibits strong antioxidant activities. Guava leaf polysaccharides (GLPs) can be utilized as an antioxidant additive in food and for diabetes treatment.

References

Shabbir, H.; Kausar, T.; Noreen, S.; Hussain, A.; Huang, Q.; Gani, A.; Su, S.; Nawaz, A. In vivo screening and antidiabetic potential of polyphenol extracts from guava pulp, seeds and leaves. Animals 2020, 10, 1714.

Lee, W.C.; Mahmud, R.; Pillai, S.; Perumal, S.; Ismail, S. Antioxidant activities of essential oil of Psidium guajava L. leaves. APCBEE Procedia 2012, 2, 86–91.

Newman, D.J.; Cragg, G.M.; Snader, K.M. Natural products as sources of new drugs over the period 1981–2002. *J. Nat. Prod.* 2003, *66*, 1022–1037.

Kumar, M.; Saurabh, V.; Tomar, M.; Hasan, M.; Changan, S.; Sasi, M.; Maheshwari, C.; Prajapati, U.; Singh, S.; Prajapat, R.K.; et al. Mango (*Mangifera indica* L.) leaves: Nutritional composition, phytochemical profile, and health-promoting bioactivities. *Antioxidants* 2021, *10*, 299.

Sharma, A.; del Carmen Flores-Vallejo, R.; Cardoso-Taketa, A.; Villarreal, M.L. Antibacterial activities of medicinal plants used in Mexican traditional medicine. *J. Ethnopharmacol.* 2017, *208*, 264–329.

Amat-ur-Rasool, H.; Symes, F.; Tooth, D.; Schaffert, L.N.; Elmorsy, E.; Ahmed, M.; Hasnain, S.; Carter, W.G. Potential nutraceutical properties of leaves from several commonly cultivated plants. *Biomolecules* 2020, *10*, 1556.

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GENOMIC IMPRINTING IN PLANTS

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Introduction

As we know genetic change results from the change in the nucleotide sequence due to various reasons. In addition to this change, there is epigenetic change which brings modification without any change in DNA sequence. This change is referred as Epigenetics. The term epigenetics was coined by C.H. Waddington in 1942. The Greek prefix, Epi - "over, outside of, around "on top of" or "in addition to" the traditional genetic basis for inheritance. It refers to external modifications of DNA that turn genes "on" or "off" without change in the sequence of DNA. It is stably heritable phenotype resulting from changes in a chromosome without alterations in the DNA sequence. One of the phenomenon under Epigenetics is Genomic Imprinting.

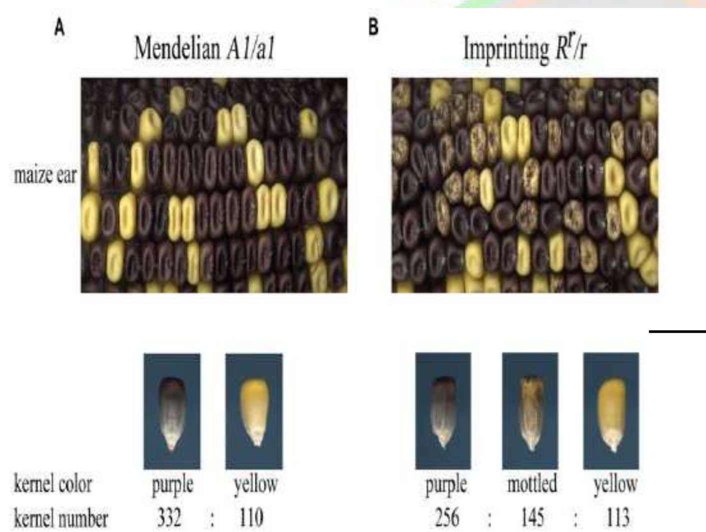
Genomic imprinting

Genomic imprinting refers to the preferential expression of a gene from one parent over the other, determined by the sex of the parent contributing that allele. This means that gene expression can be skewed even if the DNA sequences of both alleles are identical. Helen crouse coined the term "imprinting" in 1960. When a gene is mainly expressed from the allele inherited from the mother, it is called a maternally expressed gene. Conversely, if it is expressed from the allele inherited from the father, it is known as a paternally expressed gene. For both types, the key factor is that the maternal and paternal alleles are distinguished after fertilization by an existing mark, known as an imprint, which is epigenetic in nature—meaning it does not involve changes to the DNA sequence itself.

These imprints can be found on maternal or paternal chromosomes, or on both, indicating a relative difference rather than an absolute state. Imprints are established in the parent and continue through the development of the offspring. Therefore, they need to be preserved during cell division as genetic material replicates. Importantly, imprints are not permanent; they are reversible and must be reset with each new generation.

The first mammalian imprinted gene Insulin like Growth Factor (Igf2) was discovered in mice (1991). Dr.Jerry kermicle discovered the first imprinting locus in plants i.e. Kernel colour phenotype of maize – R gene.

Comparison of Mendelian inheritance and Imprinted inheritance (Bai and settles,2015)



$R^r r$ * $R^r r$

↓

$R^r R^r$- Purple coloured kernels
$R^r r$ - Purple coloured kernels } 2

rR^r - Mottled kernel 1

rr – Yellow coloured kenel 1

Mendelian ratio: 3:1

A) Self pollination of individuals containing A1/a1 locus gives mendelian rati of 3:1.

B) Individulas containing Imprinted locus R^r/r on selfing gives ratio of 2:1:1 which is distorted from normal mendelian ratio due to the imprinting of allele in the locus

Types of Imprinting

Maternally Imprinted Genes: These genes are expressed only from the allele inherited from the father. The allele inherited from the mother is silenced or less active. An example of a maternally imprinted gene is the **H19** gene in mammals, which is expressed only from the maternal allele while the paternal allele is silenced.

Paternally Imprinted Genes: These genes are expressed only from the allele inherited from the mother. The allele inherited from the father is silenced or less active. The **IGF2** (insulin-like growth factor 2) gene in mammals is a classic example of a paternally imprinted gene, where only the paternal allele is expressed.

Regulatory mechanisms of imprinting

1.DNA Methylation

DNA methylation is a key mechanism of epigenetic inheritance, primarily mediated by enzymes such as the Dnmt1 family in animals and MET1 in plants. These enzymes add methyl groups to cytosines in symmetric CG dinucleotides, preserving methylation patterns after DNA replication. DNA methylation is traditionally linked to gene silencing and the repression of transposable elements, though it can also enhance gene activity. Differential methylation between maternal and paternal alleles can lead to imprinted gene expression. In Arabidopsis, rice, and maize, parent-of-origin-specific DNA methylation differences in the endosperm result from hypomethylation of maternally inherited DNA. In Arabidopsis, this hypomethylation is facilitated by the DEMETER (DME) DNA glycosylase, which removes methyl groups from DNA in the female central cell before fertilization. DME's activity is associated with both activation and repression of maternal-specific genes. Similar patterns of maternal-specific DNA hypomethylation are observed in maize and rice, indicating conserved regulatory mechanisms across these species over approximately 150 million years of evolution (Ibarra et al. 2012; Rodrigues et al. 2013; Zhang et al. 2014)

2. RNA Directed DNA Methylation

It is proposed that small RNAs move from the central cell to the egg cell in the female gametophyte or from the endosperm to the embryo in the developing seed to direct DNA methylation.

3. Histone Modification : Polycomb Group Proteins

Parental asymmetries in DNA methylation lead to parental- specific deposition of the repressive histone mark H3K27me3 by PcG protiens. PcG proteins acts as multimeric complexes denominated Polycomb repressive complexes (PRCs)

Significance of genomic imprinting in plants

- Imprinting can affect the expression levels of certain genes, ensuring a proper balance between maternal and paternal contributions.

- Imprinting plays a crucial role in seed development. For example, in many plants, imprinted genes are involved in endosperm development, which is essential for seed nourishment and proper embryo development.
- Imprinting allows plants to regulate gene expression in response to environmental changes and evolutionary pressures. This flexibility can be advantageous for adaptation and survival.
- Imprinting can contribute to genetic diversity within plant species by affecting the expression of imprinted genes differently across individuals and populations.
- Knowledge of genomic imprinting can be used to enhance crop traits such as yield, stress resistance, and quality. For example, imprinting affects traits like seed size and nutrient content, which are important for crop productivity

Conclusion

Genomic imprinting is a critical epigenetic mechanism that regulates gene expression in a parent-of-origin-specific manner, significantly influencing plant development and adaptation. Its role in controlling seed development, nutrient allocation, and stress responses highlights its importance in plant biology and agriculture. Future research into genomic imprinting could reveal more about its regulatory mechanisms and broader impacts on plant growth and evolution.

References

Fang Bai and Settles, A. M., 2015. Imprinting in plants as a mechanism to generate seed phenotypic diversity. *Frontiers in Plant Science,* 5 : 780

Rodrigues, J. A., Ruan, R., Nishimura, T., Sharma, M. K., Sharma, R., Ronald, P. C., Fischer, R. L., & Zilberman, D., 2013. Imprinted expression of genes and small RNA is associated with localized hypomethylation of the maternal genome in rice endosperm. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(19): 7934–7939.

Zhang M, Xie S, Dong X, Zhao X, Zeng B, Chen J, Li H, Yang W, Zhao H, Wang G, et al., 2014. Genome-wide high resolution parental-specific DNA and histone methylation maps uncover patterns of imprinting regulation in maize. *Genome Res*, 24: 167–176.

Ibarra CA, Feng X, Schoft VK, Hsieh TF, Uzawa R, Rodrigues JA, Zemach A, Chumak N, Machlicova A, Nishimura T, et al., 2012. Active DNA demethylation in plant companion cells reinforces transposon methylation in gametes. *Science,* 337: 1360–1364.

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HALDINA CORDIFOLIA: A POTENTIAL AGROFORESTRY SPECIES

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Introduction

Native to Southern Asia, commonly found in India, Sri Lanka, Southern China, Nepal and Vietnam. It is a multipurpose tree species commonly found in Indian forest subtype 3B/C_{1c}, 3B/C_2, 3C/C_{3a}, 5B/C_{1b}, 5B/C_{1c}, variety 3C/$C_{1a(ii)}$ and 3C/$C_{2b(ii)}$. Especially found in the Eastern Ghats and Karnataka and levitates up to an altitude of 900 m in the sub-Himalayan stretch, except in arid regions of Rajasthan.

Habitat

Moist mixed deciduous forests. The annual temperature requirement is 25˚C-35˚C and prefers a mean annual rainfall between 1000-2000mm.

Wood

Wood is uniformly fine textured, straight grained and moderately hard. Heartwood is deep yellow when fresh, turns reddish- yellow or brownish on exposure and sapwood is pale yellowish or yellowish white. Vessels are small and angular in outline, solitary and in radial multiples of two to three, pore clusters rarely present. Parenchyma is scanty, diffuse in aggregates and indistinct to the naked eye. Fibre are non- septate and thin walled; narrowly bordered pit; no appreciable difference between early wood and latewood in wall thickness.

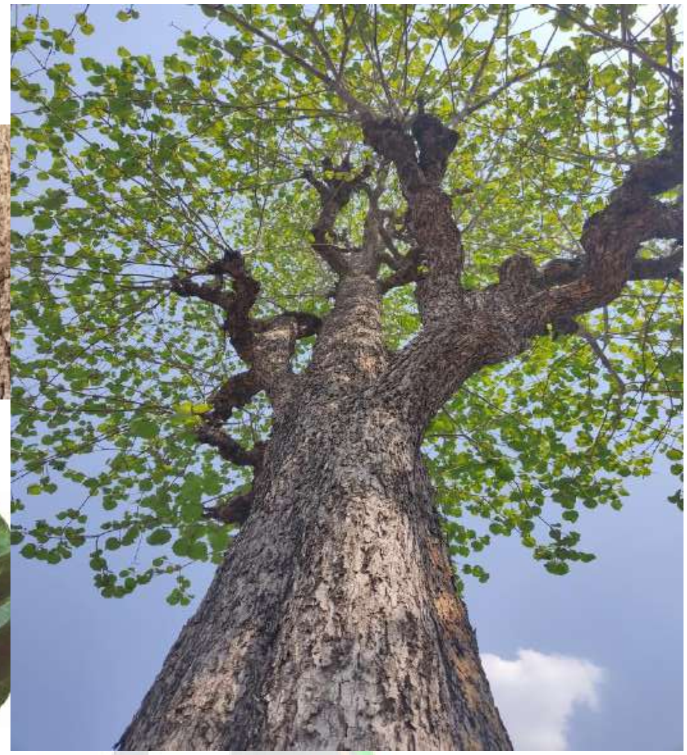
Size: Medium sized deciduous tree, Height up to 15–20 meters.

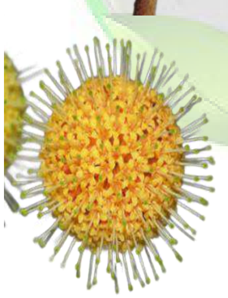
Bark: pale brown, shallowly pitted, horizontally wrinkled and cracked (10- 12 mm thick)

Leaf: orbicular – cordate; inflorescence is yellowish, solitary or in panicles (0.5-0.8 cm dia. across calyces)

Inflorescence: Yellowish, solitary or in panicles (0.5-0.8 cm dia)

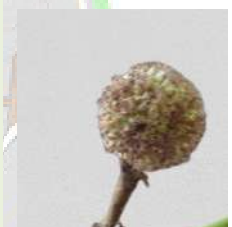
Flowers:June-July; bisexual, yellow in color in round heads with short filament, oblong anther (0.1-0.2 cm), 0.4-0.7 cm long pistil, 2 loculed ovary





Fruit: December-March; Capsule 0.4-0.6 cm long, obconical, pubescent, anemophily, maturity in April

Seeds: 0.06 to 0.12 in. long with tail at one end and bifid wings on other end (about 11 million seeds/kg)



Important Uses

Medicinal use

Root	Used as used antioxidant activity, astringent in dysentery, constipating and are useful in diarrhea
Leaves	Anti-diabetes activity, antiseptic utilized in dressing wounds, cuts, boils and to cure hemicranias. Leaf juice is used to treat boils and conjunctivitis. Leaf extract have antifertility properties and employed to kill maggots and other pests
Bud	Used as antidote to snake venom
Flower	Used in headaches
Stem	Anti-ulcer, anti-cancer activity
Bark	Fresh bark grounded with brown sugar are taken internally for stomachache and fresh stem bark juice is taken in rheumatism
Latex	Applied on aching tooth.
Wood extract	0.5 and 1.0 mg/ml, inhibits weed growth but stimulate growth in crop plants

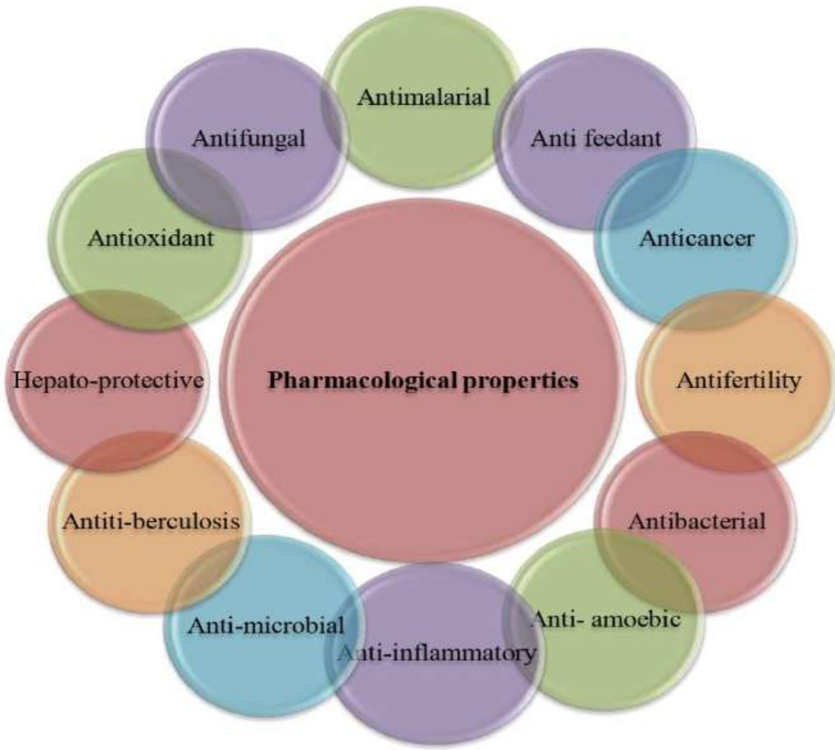
Traditional use

A. cordifolia was used by traditional healers as the remedy of chronic cough and jaundice, stomach ache, fodder, and swelling in the stomach. It is efficacious in deprave pitta conditions, wounds and ulcers, skin disease, strangury, gastropathy, fever and burning sensation. It was described having a wide range of medicinal applications and all the parts have medicinal value. In Ayurveda, the bark of this plant is employed to address liver disorders. Bark is tonic, vulnerary, diuretic, aphrodisiac, bitter, astringent, and refrigerant, helpful in pitta-vitiated disorders, burns, fever, and burning sensations.

Phytochemistry

To date, 25 chemical constituents, such as flavonoids, phenols, alkaloid, sterol, fatty acid, coumarin, triterpenoid and ester have been isolated from the heartwood, roots, leaves, wood and stem of *A. cordifolia*.

Pharmacological properties



Other uses

Food industries
Leaves have potential uses in the pharmaceutical business, as a dietary supplement, and as a conveniently accessible source of natural antioxidants.

Fuelwood
Wood hard to very hard, heavy to very heavy, average weight 945 kg/m^3 (59lb/ft^3) at 12 per cent moisture content. Basic density ranges from 503.0 kg/m3 to 663.5 kg/m3, average density at breast height of 596.7 kg/m3.

Charcoal
Charcoal derived from this wood has a calorific value ranging from 6688 to 6813 when processed using open or closed kiln methods.

Role in Agroforestry
used in different agroforestry systems like Agrihortisilvi, Agrihorti and Agrisilvi with *Mangifera indica*, Citrus limon, *Artocarpus heterophyllus, Grewia oppositifolia, Morus alba* in Gharwal region.

Ecological importance
As a native tree species, it provides habitat and food for various wildlife species. Its presence helps in soil conservation, water regulation, and maintaining biodiversity. Additionally, it can be used as a substitute for agroforestry, which would boost farmer income. Due of its widespread distribution, it may be used to fill in barren spots.

IMPORTANCE IN AGROFORESTRY

- Indigenous tree species capacity to adapt to local conditions, resilience to pests and diseases, production of valuable timber, firewood, local cultivation and cultural knowledge contributes to efficient forest management, improving the quality of forest products. Tree species like *H.*

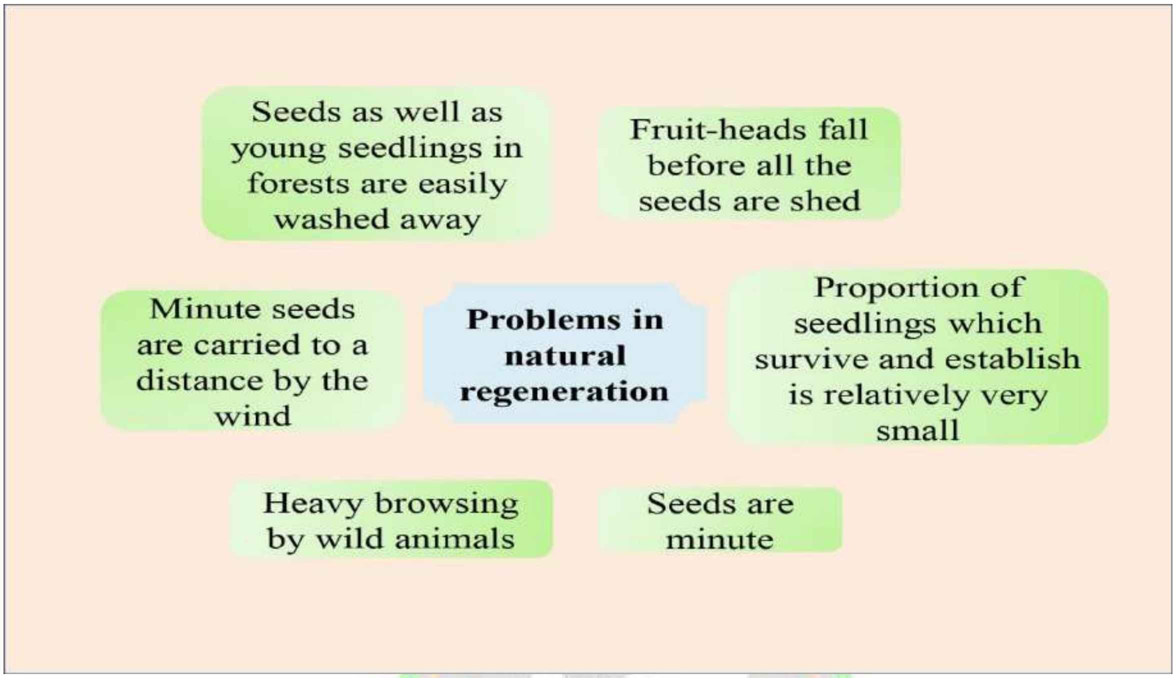
cordifolia plays an important role in indigenous agroforestry system like carbon sequestration, adaptation to climate change and reducing pressure on natural forests.

- Leaves and young twigs are used as fodder and wood useful for fuelwood and timber.
- Also used in furniture, stairs, panelling, flooring, veneer, boxes and crates, pencils, joinery, sliced veneer, cigar boxes and light carpentry.
- It is a multipurpose tree species the wood, bark, leaves, fruits, seeds and roots of trees produce fodder, shelter, medicine, fiber, timber and other goods required for sustenance by people living in rural and tribal regions.

PROPAGATION

It has germination range from 54 -97%, mainly the propagation of this species is through sexual (seed and runners) and asexual methods (cuttings, micropropagation, invitropropagation).

Parameters	Observed
Fruit colour	Changed from light green to light brown
Seed maturation	moisture content of fruit between 38 to 46% is useful indicator
Seed collection	February in West Bengal, February to May in UP and December to March in Maharashtra
Germination	maximum in seeds collected during first week of May
Germination percent	Range of 54-97% and about 90% germination from fresh seed.
Number of pure seed per Kg	11000000
Purity percent	35
Germination	Within 20-40 days
Germination percent	80
Plant percent	10



Asexual propagation

Cuttings

- For vegetative propagation, when compared to hardwood and semi-hardwood cuttings softwood cuttings are the most suitable.
- Cuttings with diameter 1 to 2 cm treated with IBA (Indole-3 Butyric Acid) at a concentration of 2000 mgl^{-1} root well than other diameter class tested.
- With the application of IBA, softwood cuttings prepared from terminal portion of the lateral branches showed 15 to 18 per cent rooting.
- With the increase in concentration of IBA from 4000ppm to 6000ppm the mono nodal leafy softwood cuttings rooting increased from 62.5% to 75%.
- For sprouting of *H. cordifolia* cuttings and their growth the application of IBA at the concentration of 20,000 ppm and use of low cost vegetative propagation chamber condition provided better environment.
- In rooting media having 50% coarse sand and 50% sphagnum peat moss with 40 minutes treatment with 500 ppm IBA, 80-90% rooting percentage and cutting survivality was achieved.

Micropropagation

April- June was found to be best period for initiating shoots buds.The culture established in MS media supplemented with IBA was more suitable than NAA where IBA 1.0mg/l was found more effective for root induction and for its micro propagation MS medium supplemented with BAP 1.0% + NAA 0.5% was found to be very effective.

In –vitro propagation

The ideal explants for in vitro propagation are apical buds or shoot tips. In presence of MS medium supplemented with 2mg/L BAP or 0.5mg/L NAA alone *H. cordifolia* established very well in in-vitro conditions and recorded the highest shoot length. Maximum survival rate of explants was observed at 1 mg/L BAP (66.67%).Multiple shoots developed in MS medium supplemented with (1.0 mg/L BAP + 0.5 mg/L NAA) and the shoots were rooted in MS medium supplemented with 1.0mg/L IBA.

Conclusion and Future prospects

After thorough examination and literature search it was observed that despite its versatile uses less work has been done on *H. cordifolia***.** Every part of this plant possesses its specific medicinal properties which highlights its significance, emphasizing the importance of its preservation for future generations.

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MARKET ACCESS AND EXPORT OPPORTUNITIES FOR INDIAN FARMERS

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Introduction

India's agricultural sector is a cornerstone of its economy, employing nearly half of its population and contributing significantly to its GDP. However, the potential of this sector extends beyond domestic boundaries. With the growing global demand for agricultural products, Indian farmers have a unique opportunity to tap into international markets. This article delves into the current export scenario for Indian farmers from 2020 to 2024, the challenges they face in accessing global markets, government initiatives to promote agricultural exports, potential export markets, and strategies for enhancing export opportunities.

Current export scenario of Indian farm products:

The agricultural export landscape in India has seen notable changes between 2020 and 2024. In the financial year 2020-21, India's agricultural exports reached a record $41.25 billion, marking a significant 17.34% increase from the previous year (Ministry of Commerce and Industry, 2021). This growth trajectory continued, with exports touching approximately $50 billion by 2023, driven by products like rice, spices, and marine items (APEDA, 2023).

Rice, particularly Basmati, has consistently been a top-performing export, contributing around 25% to total agricultural exports. The Middle East and European countries have been major importers of Indian rice. Spices such as turmeric, cumin, and black pepper also saw increased demand, especially in North America and Europe. Furthermore, the rise in organic farming in India has opened up new export avenues, as global consumers increasingly prefer organic and sustainably sourced products (Kumar et al., 2023).

Despite these positive trends, the agricultural export sector faced challenges during this period. The global supply networks were interrupted by the COVID-19 epidemic, which created logistical issues, especially for the shipping and storage of perishable items. Additionally, fluctuating international trade policies and tariffs impacted the export volumes of certain commodities. Nonetheless, strategic interventions by the Indian government helped sustain the growth momentum in agricultural exports.

Challenges faced by Indian farmers in accessing global markets:

While the potential for agricultural exports from India is immense, farmers face several significant challenges in accessing global markets.

1. **Lack of Awareness and Knowledge:** Many Indian farmers are unaware of the stringent quality standards, certifications, and market requirements necessary for entering and sustaining themselves in international markets. This knowledge gap often results in produce that fails to meet international standards, limiting the farmers' ability to export (Ramasamy & Babu, 2022).
2. **Quality Control and Certification Issues:** Meeting the stringent quality standards and obtaining the necessary certifications required by global markets can be daunting, especially for small and marginal farmers. The cost and complexity of these processes create significant barriers to market access (Singh & Sharma, 2020).
3. **Infrastructure and Logistics:** India's agricultural infrastructure, particularly in terms of cold storage and efficient transportation networks, remains underdeveloped. This inadequacy leads to high post-harvest losses, especially for perishable goods like fruits, vegetables, and dairy products, making it challenging for farmers to export their produce (National Centre for Cold-chain Development, 2021).
4. **Regulatory and Compliance Challenges:** Navigating the complex international trade regulations, tariffs, and non-tariff barriers requires expertise and resources that many Indian farmers lack. Additionally, sudden changes in trade policies, both domestically and internationally, can disrupt export activities (Kumar & Mehta, 2022).
5. **Market Volatility:** Global agricultural markets are highly volatile, with prices influenced by factors such as weather conditions, geopolitical tensions, and currency fluctuations. This volatility poses a significant risk to farmers who rely on exports for their income (Sharma et al., 2023).

Government initiatives to promote agricultural exports in recent years:

Recognizing the importance of agricultural exports for boosting farmers' incomes and the national economy, the Indian government has introduced several initiatives in recent years.

1. Agricultural Export Policy (AEP): The Agricultural Export Policy, launched in 2018, aims to double agricultural exports from $30 billion to $60 billion by 2022. The policy focuses on creating a stable and predictable export regime, promoting value-added products, and developing a robust quality infrastructure (Department of Commerce, 2018).

2. Agri-Export Zones (AEZs): Agri-Export Zones have been established to encourage cluster-based production of exportable crops. These zones provide farmers with access to necessary export facilities, including processing units, testing laboratories, and export-oriented infrastructure (APEDA, 2022).

3. **Digital Initiatives:** e-NAM is an online trading platform that connects farmers with buyers across India, facilitating better price discovery and market access. The platform has played a significant role in improving the export potential of farmers by enabling them to reach a wider audience (Ministry of Agriculture and Farmers Welfare, 2022).

4. Infrastructure Development: Investments in cold storage facilities, transportation networks, and logistics hubs are being prioritized to reduce post-harvest losses and improve supply chain efficiency. The government has recognized the need for better infrastructure to support agricultural exports.

5. Financial Assistance and Subsidies: The government provides financial assistance to farmers for obtaining international certifications and adhering to global quality standards. Subsidies are also available to support infrastructure development, including cold storage facilities and logistics (Ministry of Commerce and Industry, 2022).

Potential export markets for Indian agricultural products:

India's agricultural products are in demand worldwide, and several key markets present significant opportunities for Indian farmers.

1. Middle East and North Africa (MENA): The MENA region is a significant importer of Indian rice, particularly Basmati, as well as spices, fruits, and vegetables. The region's proximity and historical trade ties with India make it an attractive market for agricultural exports (APEDA, 2022).

2. Southeast Asia: Countries such as Indonesia, Malaysia, and Vietnam are emerging markets for Indian pulses, grains, and horticultural products. The geographical and cultural proximity of these countries to India also facilitates trade (Export Import Data Bank, 2023).

3. European Union: The European Union (EU) is a lucrative market for high-quality and organic agricultural products. Indian tea, spices, and fruits have been particularly successful in this region, driven by the increasing consumer preference for healthy and sustainable products (European Union Market Analysis, 2022).

4. United States and Canada: North America represents a major market for Indian spices, fruits, and processed foods. The large Indian diaspora in these countries also contributes to the demand for traditional Indian agricultural products (USDA Foreign Agricultural Service, 2021).

5. Africa: Africa is an emerging market for Indian agricultural exports, particularly for staples such as rice, pulses, and sugar. The growing economic ties between India and African countries provide a strong foundation for expanding agricultural trade (Export Import Data Bank, 2023).

Strategies for enhancing export opportunities:

To enhance export opportunities for Indian farmers, several strategies can be implemented:

1. Adopting International Standards: Farmers should be encouraged to adopt international standards and obtain necessary certifications, making their products more competitive in global markets (Food and Agriculture Organization, 2021).

2. Expanding Agri-Export Zones: The government should consider expanding Agri-Export Zones to more regions and crops, ensuring that a larger number of farmers can benefit from the infrastructure and support provided by these zones (APEDA, 2022).

3. Improving Infrastructure: Investments in cold chain logistics, transportation, and processing facilities are crucial to reducing post-harvest losses and enhancing the export potential of perishable goods (National Centre for Cold-chain Development, 2021).

4. Promoting Farmer Cooperatives: Encouraging the formation of farmer cooperatives can help small and marginal farmers pool resources, achieve economies of scale, and access global markets more effectively (National Bank for Agriculture and Rural Development, 2021).

5. Leveraging Digital Platforms: Farmers should be trained to effectively use digital platforms for market access, price discovery, and direct sales to international buyers. Digital literacy programs can play a crucial role in this regard (Ministry of Agriculture and Farmers Welfare, 2022).

7. Enhancing Logistics and Supply Chains: Investments in logistics infrastructure and cold chain facilities can reduce post-harvest losses and improve product quality. Streamlining supply chains can also lead to cost savings for farmers.

8. Promoting Branding and Marketing: Developing strong brands for Indian agricultural products can help in distinguishing them in international markets. Marketing campaigns that highlight the unique qualities of Indian products can attract global consumers.

Future prospects and recommendations:

The future of agricultural exports in India looks promising, with the potential for significant growth. However, for this potential to be realised, all parties involved must work together. The recommendations include:

1. Policy Reforms: Continuous evaluation and reform of agricultural policies to ensure they meet the needs of farmers and the market. Simplifying export regulations can encourage more farmers to participate in international trade.

2. Capacity Building: Ongoing training and capacity-building programs for farmers to enhance their skills in production, marketing, and export management. Empowering farmers with knowledge is crucial for their success in global markets.

3. Public-Private Partnerships: Encouraging collaborations between the government, private sector, and farmers to create a more supportive ecosystem for exports. Partnerships can facilitate knowledge sharing and resource mobilization.

4. Consumer Awareness Campaigns: Promoting awareness of Indian agricultural products, especially organic and natural, to boost demand in international markets. Educating consumers about the benefits of Indian products can drive sales.

5. Research and Development: Investing in R&D to develop new products and improve existing ones can help farmers meet changing consumer preferences. Innovation is key to staying competitive in global markets.

Conclusion

Indian agriculture is at a critical juncture, with global markets offering unprecedented opportunities for growth and prosperity. By addressing the barriers to market access and leveraging technology and innovation, Indian farmers can significantly enhance their incomes and contribute to the nation's economic growth. The concerted efforts of the government, farmers, and industry stakeholders are essential to ensuring that Indian agricultural products achieve a strong presence in the global market.

References:

APEDA (2023), Apex Update, April-June 2023.

Deepak Kumar, Helga Willer, N. Ravisankar, Chandrabhanu and Amit Kumar (2023), Book chapter on Current Scenario of Organic Farming Worldwide, Transforming Organic Agri-Produce into Processed Food Products, Apple Academic Press.

Department of Commerce (2018), Agricultural Export Policy.

Kumar, R., & Mehta, A. (2022), 'Trade Policies and Agricultural Exports: A Study of Indian Scenario, Journal of International Trade & Economic Development.

Ministry of Agriculture and Farmers Welfare (2022), Annual Report.

National Centre for Cold-chain Development (2021), 'Infrastructure and Post-Harvest Management'.

Ramasamy, S., & Babu, M. (2022), Challenges in Indian Agricultural Exports: A Farmer's Perspective, Agricultural Economics Research Review.

Sharma, S. Rohatgi, D. Jasuja, 2023, Scientific mapping of gravity model of international trade literature: a bibliometric analysis, Journal of Scientometric Research, 11: 447-457.

Singh, P., & Sharma, K. (2020), Quality Standards and Certification: Barriers to Export for Indian Farmers, Indian Journal of Agricultural Economics.

USDA Foreign Agricultural Service (2021), Report on 'India Agricultural Export Opportunities'.

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NANO DELIVERY SYSTEMS FOR FOOD BIO ACTIVES

Article ID: AG-VO4-I08-99

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Introduction

The Tiny world that's changing everything. Nanoscience and Nanotechnology are interdisciplinary fields focused on the study and manipulation of matter at the nanoscale, typically ranging from 1 to 100 nanometers. A nanometer is an incredibly small unit of measurement, equivalent to one billionth of a meter. At this scale, materials exhibit distinct physical, chemical, and biological properties compared to bulk materials. They exhibit a unique property of high surface to low volume ratio at nano scale. Nanoscience probes the understanding of these properties and behaviors applies this knowledge to create novel materials, devices, and systems with revolutionary applications across various sectors.

The ideology of exploring materials at nano regime was introduced by a American physicist and Nobel Prize laureate Richard Feynman in his lecture entitled **"There's Plenty of Room at the Bottom"** in the annual meeting of the American Physical Society in 1959, where he described the vision of fabricating smaller machines down to the molecular level to carry out the tasks.

Nanotechnology and Food

Nanotechnology is revolutionizing the food industry. Food materials are often considered not only a source of nutrients but also as having to contribute to the health. By manipulating matter at the nanoscale, scientists are developing innovative solutions for food production, processing, and packaging. Majority of traditionally employed nanoparticles are classified as colloids, encompassing structures such as emulsions, micelles, and lipid bilayers. The increased surface area-to-mass ratio of nanoparticles renders them inherently more biologically reactive compared to larger particles. Nanotechnology improves food safety through rapid contaminant detection, enhances taste and texture, and extends shelf life. Nano-coated packaging protects food from spoilage and provides smart features like freshness indicators.

Food Bioactives

Food bioactives are the unsung heroes of our diet. These functional compounds can be found naturally in certain foods having physiological and health benefits beyond basic nutrition. In other words, bioactives are compounds having specific biological activity that remains active inside a biological system. Foods rich in bioactives can potentially reduce the risk of chronic diseases like heart disease, cancer, and diabetes.

Bioactives	**Source**
Curcumin	Turmeric
Betalain	Beetroot
Limonene	Citrus
Omega-3 fatty acids	fish, flaxseed, and chia seeds.
Carotenoids	Carrot

Benefits of Bioactives

These natural compounds act as powerful antioxidants, shielding our cells from damage. They also contribute to robust immune function, aiding our body in fighting off infections. Furthermore, many bioactives possess anti-inflammatory properties, helping to reduce chronic inflammation linked to various diseases. They protect cells from damage caused by free radicals. By incorporating a diverse range of plant-based foods into our meals, we can harness the full potential of these natural health-promoting compounds.

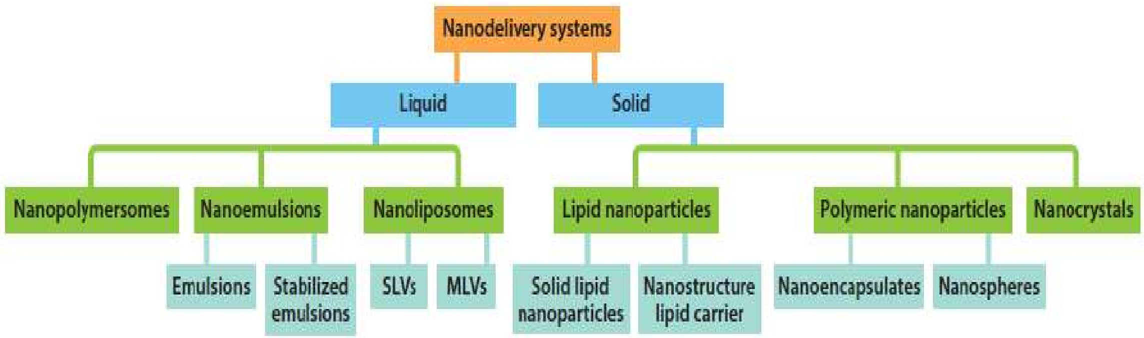
Delivery of Bioactives by Nanotechnology

Nanotechnology has emerged as a powerful tool for enhancing the delivery of bioactive compounds. By incorporating bioactives within tiny particles, nanotechnology overcomes several challenges associated with traditional delivery methods. Nano delivery protects degradation of food bio actives from internal and external environmental conditions such as stomach pH and light.

It ensures bioavailability, targeted and sustained release of compounds.

Nano Delivery Systems for Bio Actives

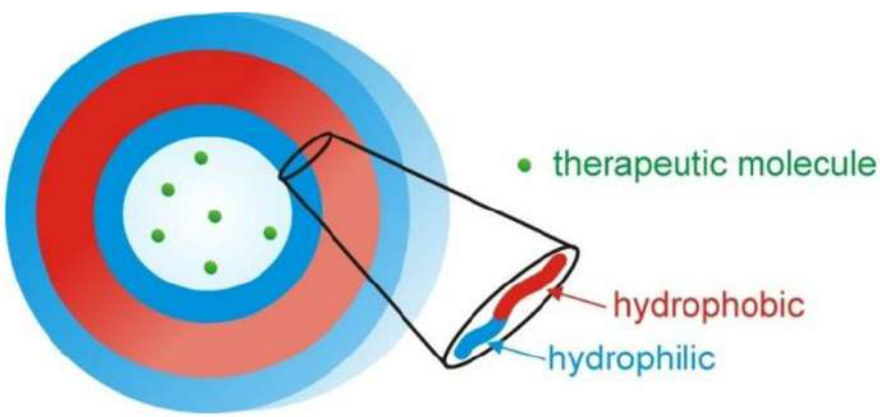
Nano-delivery systems are engineered structures at the nanoscale designed to transport and deliver bioactive compounds or drugs to specific targets within the body. Delivery systems are broadly classified into solid and liquid based delivery systems.



Liquid Based Delivery System

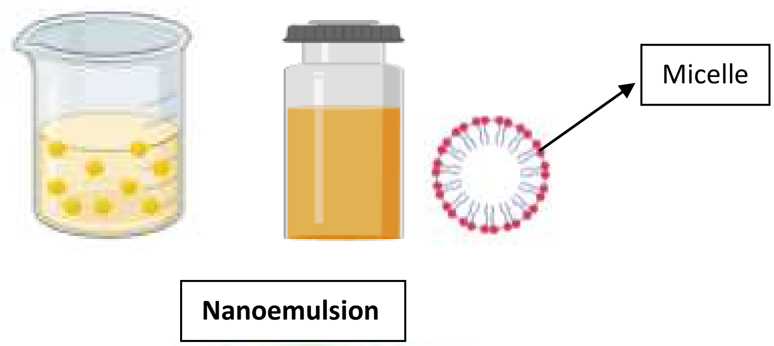
Liquid-based nano delivery systems are structures composed of liquid components that operate at the nanoscale. They are designed to encapsulate and deliver bioactive substances within the body. They are classified into Nanopolymerosomes, Nanoemulsions and Nanoliposomes.

Nanopolymerosomes: Nanopolymerosomes are a type of vesicle formed from amphiphilic copolymers have both hydrophilic (water-loving) and hydrophobic (water-repelling) segments. The amphiphilic polymers self-assemble into a bilayer structure, creating a vesicle with an aqueous core surrounded by polymeric membrane.



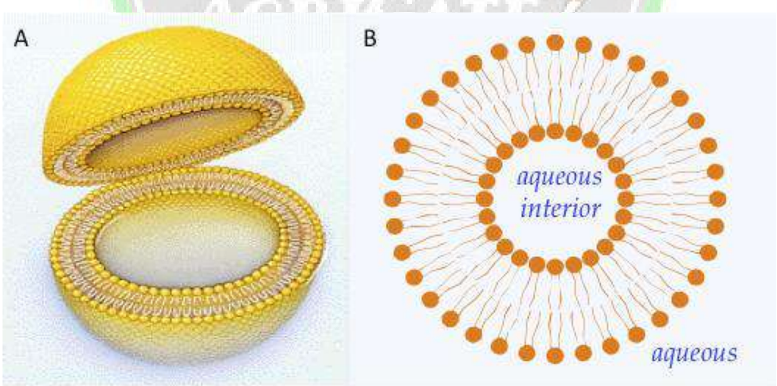
Nanopolymerosome

Nanoemulsion: A nanoemulsion is a mixture of two or more immiscible liquids that don't normally mix, stabilized by an emulsifier result in the formation of micelle It's called "nano" because the droplets of one liquid are extremely small, typically between 10-100 nanometers (nm) in size. Nanoemulsions are made by using special techniques, like high-pressure homogenization or ultrasonication, to break down the droplets into small sizes which creates a stable mixture that can be used in a variety of applications, such as a carrier for bioactives.



Nanoliposomes:

Nanoliposomes are a type of vesicle formed from amphiphilic copolymers have both hydrophilic (water-loving) and hydrophobic (water-repelling) segments. The amphiphilic polymers self-assemble into a lipid bilayer (Phospholipids) structure, creating a vesicle with an aqueous core. They are more similar to Nanopolymerosomes.



Solid Based Delivery System

Solid Based Delivery System involves encapsulating bioactive compounds within a solid matrix at the nanoscale, providing protection against degradation and improving their solubility and absorption. These delivery systems further classified into lipid nanoparticles, Polymeric nanoparticles and Nano crystals.

Lipid Nanoparticles (LNPs):

Lipid nanoparticles are tiny, spherical particles composed of lipids. They serve as a powerful tool for delivering a bioactives and other therapeutic agents. The unique properties make them highly effective in protecting and transporting these molecules to target cells.

How LNPs Work

Food bioactives are encapsulated at the core of LNPs. Once administered, they interact with cells in the biological system and are taken up through endocytosis. The acidic environment within the biological system triggers the release of the encapsulated cargo, allowing it to exert its therapeutic effect. The lipid nanoparticles are further divided into Solid Lipid Nanoparticle (SLN) and Nano structured Lipid Carrier (NLC).

Solid Lipid Nanoparticles (Brick Wall Matrix)

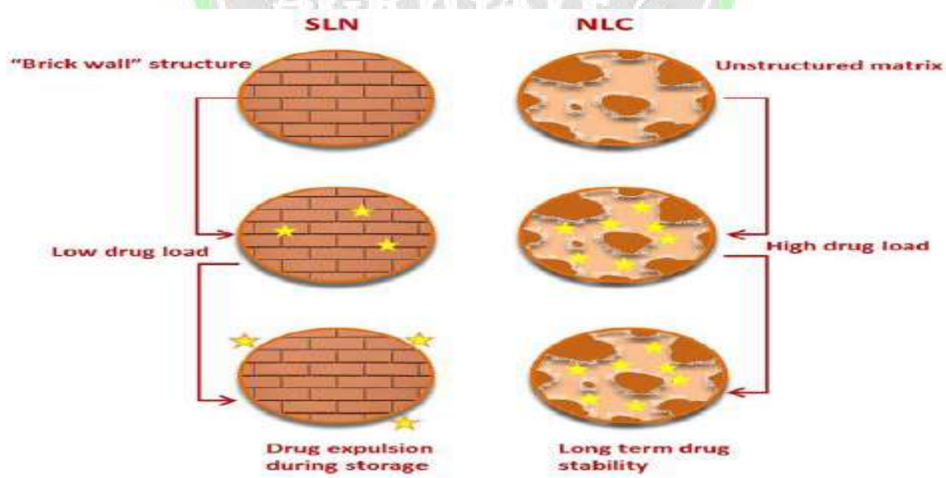
- Composed of solid lipids as the matrix. It can encapsulate both hydrophilic and lipophilic bioactives offering high biocompatibility and stability.
- Widely used for delivering vitamins, carotenoids, and omega-3 fatty acids.

Disadvantages of SLN

- Low drug load efficiency and Drug expulsion during storage

Nano Structured Lipid Carrier (Unstructured Matrix)

- Combination of solid lipids and liquid lipids. It has a increased drug loading capacity compared to SLNs.

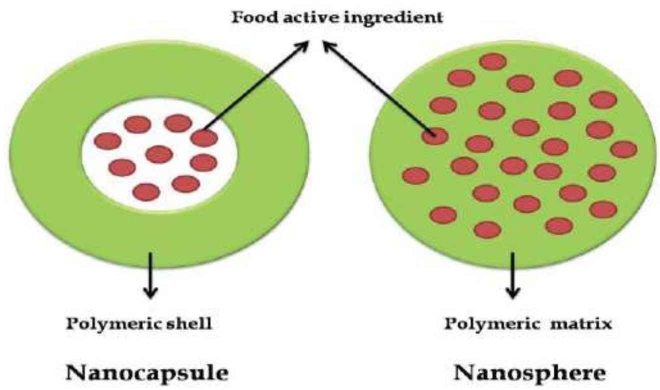


Polymeric Nanoparticles

Polymeric nanoparticles are nanoscale particles composed of polymers. They are classified into Nanoencapsulates and Nanospheres.

Nanoencapsulates: Nanoencapsulates are core shell structure in which the food active components are loaded in core surrounded by a polymeric shell.

Nanospheres: In case of nanospheres the food bioactive compounds are dispersed all over the polymer matrix.



Nanocrystals

Nanocrystals are formed by the integration of bioactives with a surfactant.

Conclusion

Nano delivery systems offer a promising avenue for enhancing the efficacy and bioavailability of food bioactives. By encapsulating these compounds within nanoscale structures, it's possible to overcome challenges associated with their inherent properties, such as poor solubility, instability, and low bioavailability. In conclusion, Nano delivery systems represent a valuable tool for optimizing the delivery of food bioactives, with the potential to revolutionize the food industry and improve human health.

Reference

Subramanian, K. S., Janavi, G. J., Marimuthu, S., Kannan, M., Raja, K., Haripriya, S., & Moorthy, P. S. (2022). *A textbook on fundamentals and applications of nanotechnology*. ASTRAL INTERNATIONAL PVT.

Rashidi, L. (2021). Different nano-delivery systems for delivery of nutraceuticals. *Food Bioscience*, *43*, 101258.

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NOVEL TECHNIQUE OF GENOME EDITING: TRANSPOSASE ASSISTED TARGET SITE INTEGRATION

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Introduction

Transposase Assisted Target Site Integration (TATI) represents an innovative approach in genome editing that utilizes the natural functions of transposases for precise DNA integration. Transposases are enzymes that facilitate the movement of transposable elements, often called "jumping genes," within the genome. Unlike conventional genome editing tools like CRISPR-Cas9, which create double-strand breaks in DNA to stimulate repair processes, TATI enables the insertion of specific DNA sequences into designated genomic sites without causing significant genomic damage. This technique uses engineered or naturally occurring transposases that can identify specific DNA sequences and integrate genetic material accurately. TATI technology offers a potentially safer and more efficient alternative for targeted gene insertion, with promising applications in areas such as gene therapy, functional genomics, and the creation of genetically modified organisms (GMOs). As research in this field progresses, TATI may become a fundamental tool for precise and dependable genome editing.

Steps involved in Transposase Assisted Target Site Integration (TATI)

Transposase Assisted Target Site Integration (TATI) involves a range of techniques designed to harness the natural capabilities of transposases for precise DNA insertion into specific genomic locations. The primary methods used in TATI can be broadly categorized into several key steps:

1. **Selection and Engineering of Transposases**

The first step in TATI is identifying a suitable transposase enzyme. Researchers may choose natural transposases based on their ability to recognize specific DNA sequences or motifs within the genome. Alternatively, transposases can be engineered to enhance their specificity and efficiency. This engineering may involve modifying the enzyme's DNA-binding domain to increase its affinity for target sequences or altering the catalytic domain to optimize the integration process (Ivics & Izsvak, 2010).

2. Design of Donor DNA Constructs

Designing the donor DNA is crucial in TATI. The donor DNA, which is the DNA segment intended for integration, typically includes the desired gene or genetic element flanked by sequences recognized by the transposase. These flanking sequences, often referred to as inverted repeats or transposon ends, are vital for directing the transposase to the correct genomic location for integration (Liu *et al*., 2020).

3. Delivery of Transposase and Donor DNA

For TATI to be successful, both the transposase enzyme and the donor DNA must be efficiently delivered into the target cells. Common delivery methods include viral vectors, plasmid transfection, or direct injection into cells or tissues. The choice of delivery method depends on several factors, including the type of target organism, the specific cells being modified, and the intended application (Huang *et al*., 2010).

4. **Target Site Selection and Integration**:

Selecting the appropriate target site within the genome is a key aspect of TATI. The transposase identifies specific DNA sequences or motifs that serve as integration sites. Once it binds to the target site, the transposase facilitates the integration of the donor DNA into the host genome. The specificity and efficiency of this integration depend on the properties of both the transposase and the compatibility between the target site and the flanking sequences of the donor DNA (Yusa, 2015).

5. **Screening and Validation**:

After the integration process, it is essential to verify that the donor DNA has been successfully inserted at the desired location. This verification typically involves molecular biology techniques such as PCR, Southern blotting, or next-generation sequencing (NGS) to confirm the presence and integrity of the integrated sequence. Additionally, functional assays may be conducted to assess the expression and activity of the inserted gene or genetic element (Liu *et al*., 2020).

6. **Optimization and Iteration**

The TATI process often requires optimization to improve efficiency and minimize off-target effects. This may involve iterative rounds of modifying the transposase, adjusting the donor DNA construct, or refining the delivery method. By systematically optimizing these factors, researchers can enhance the precision and reliability of the integration process (Ivics & Izsvak, 2010).

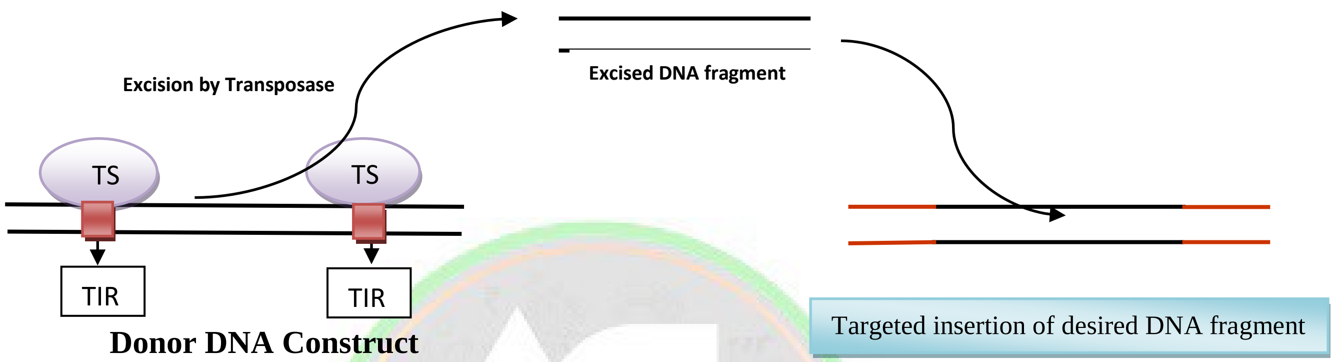

Fig. Diagramatic Representation of Transposase Assisted Target Site Integration

(TS-Transposase, TIR: Terminal Inverted Repeats)

Advantages:

- **Precision in DNA Integration:** TATI allows for highly specific integration of DNA sequences into targeted sites within the genome. By leveraging the natural ability of transposases to recognize particular DNA motifs, TATI can minimize off-target effects, making it a precise tool for genome editing.
- **Minimal Genome Damage:** Unlike traditional genome editing methods such as CRISPR-Cas9, which induce double-strand breaks (DSBs) in the DNA, TATI can insert genetic material without causing extensive damage to the genome. This reduces the risk of unintended mutations and genomic instability, which can be a significant concern in therapeutic applications.
- **Versatility Across Different Organisms:** TATI can be adapted for use in a wide range of organisms, including plants, animals, and microorganisms. This versatility is due to the broad compatibility of transposases with various genomic contexts, making TATI a valuable tool in agricultural biotechnology, environmental engineering, and medical research.
- **Potential for Large DNA Insertions:** Transposase systems like PiggyBac can efficiently integrate large DNA fragments, which is advantageous for applications requiring the insertion of

multiple genes or large regulatory elements. This capability is particularly beneficial in gene therapy and synthetic biology, where complex genetic constructs are often needed.

- **Reusability of Target Sites:** Some transposon systems, such as Sleeping Beauty, allow for the excision and re-integration of transposable elements, enabling multiple rounds of gene insertion or modification. This reusability provides flexibility in iterative genetic engineering applications, allowing for more refined control over genetic modifications.

Disadavantages

- Limited Target Site Specificity
- Variable Efficiency Across Cell Types
- Dependence on Delivery Methods

Conclusion

Transposon-assisted target site integration (TASI) offers a precise and efficient method for targeted genetic modifications, enhancing its appeal for various applications in functional genomics, gene therapy, and the development of genetically modified organisms (GMOs). As our understanding of transposon biology and host genome interactions deepens, the accuracy and safety of TASI are expected to improve, expanding its potential in gene editing. Future advancements could involve the refinement of transposase enzymes for even greater specificity and the integration of TASI with other genome editing technologies, such as CRISPR-Cas, to create more versatile and powerful tools for genetic engineering and therapeutic applications.

References

Huang, X., Guo, H., Tammana, S., Jung, Y. C., Mellgren, E., Bachelot, T., ... & Kohn, D. B. (2010). "Gene transfer efficiency and genome-wide integration specificity of linear and circular sleeping beauty transposons in human primary T cells." *Molecular Therapy*, 18(10), 1803-1813.

Ivics, Z., & Izsvák, Z. (2010). "The Sleeping Beauty transposon system for human therapeutic gene insertion." *Molecular Therapy*, 18(9), 1590-1599.

Liu, D., Li, Z., Ma, W., & Xie, X. (2020). "Transposon-based genetic engineering and genome editing for precision medicine." *Current Gene Therapy*, 20(4), 222-233.

Yusa, K. (2015). "PiggyBac transposon." *Microbiology Spectrum*, 3(2), 1-6.

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FROM FIELD TO FEED: CUTTING-EDGE PRACTICES IN SILAGE MAKING

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Introduction

Livestock farming involves numerous requirements essential for its successful operation and sustainability, with primary emphasis placed on feed and nutrition. Among the different feeding sources for dairy animals, green fodders represent an economical source of nutrients. Green fodders serve as abundant and cost-effective sources of carbohydrates, protein, vitamins, and minerals essential for dairy animals. Typically, forages contain carbohydrates and protein (8 – 10% in non-legumes and 18 – 22% in legumes), along with vitamins (such as Vitamin A carotene) and minerals (calcium content ranging from 1.5% to 3% in legumes and 0.3% to 1.3% in non-legumes). These nutrients play a crucial role in the growth, maintenance, reproduction, and productivity of dairy animals. Green forages are appetizing and preferred by animals to satisfy their hunger and fill their stomachs. Forage contributes over 75% to animal feed and is acknowledged as a cost-effective nutrient source (Kumar *et al.*, 2014).

Presently, a key obstacle in livestock production is the inadequate availability of forage derived from feed crops, grasses, crop residues, and cereals across various countries (Cai *et al.*, 2021). With a rising global population and declining per capita arable land, conventional forage production methods struggle to meet the nutritional needs of livestock, leading to feed shortages that affect sustainable livestock product output worldwide (Du *et al.*, 2021). As a result, there is an immediate need to explore new feed resources, including nutrient-rich natural woody plant materials, to tackle the challenges arising from the rapid expansion of the livestock sector

(Vandermeulen *et al.*, 2017). Preserving green fodder serves as a solution to address scarcity, especially amid increasing costs of concentrate feed.

Silage

Preserving grasses for fodder has been a traditional practice since ancient times. This technique was initially confined to Europe but expanded globally during the 19th century. It is a method in which fresh green fodder is harvested, chopped, and stored in sealed containers or structures known as silos, creating anaerobic conditions to facilitate fermentation. Silage, a specialized method of preserving fodder, showcases the innovation of agricultural practices, having evolved over centuries to meet the critical demand for a dependable and nutrient-rich feed source for animals, especially ruminants such as cattle, sheep, and goats (Edwards *et al.*, 1988). The process of silage production commences with carefully compacting these crops into sealed storage containers, initiating a fermentation process (Kolli *et al.*, 2023). Silage plays a crucial role in securing a consistent food source for livestock, particularly in times of scarcity, thereby safeguarding the health and productivity of the animals it feeds (Provenza *et al.*, 2015). This distinctive preservation technique not only prolongs the storage life of the fodder but also enriches its nutritional content, offering animals a flavorful and high-quality feed (Tavakoli *et al.*, 2022).

Principle

In forage or fodder crops, the water-soluble sugars are fermented under anaerobic conditions until the acidity produced by naturally occurring sugar-fermenting bacteria (epiphytic bacteria) is sufficient to prevent rotting. These epiphytic bacteria, primarily lactic acid bacteria, convert the water-soluble sugars in the plant material into lactic acid, which has a pleasant smell and inhibits spoilage by other bacteria or molds.

Crops and Harvesting

Selecting the right crops and timing their harvest are initial stages in silage preparation. The quality and nutritional value of the final silage product hinge directly on these critical decisions, encompassing crop selection, maturity evaluation, harvesting techniques, and equipment utilization (Bernardes *et al.*, 2018). Common silage crops include corn, sorghum, grasses such as ryegrass, cumbu napier, and clover, legumes like alfalfa and clover, cowpea and minor grains such as oats, barley, and wheat. Maize and sorghum are preferred for silage production because of their high sugar content. The nutritional composition and fermentation characteristics of silage are significantly influenced by the maturity stage of the crop at harvest. Key indicators of maturity include plant height, seed head development, and moisture content. Harvesting too late can lead to decreased digestibility and higher lignin content, while harvesting too early may result in lower yields and nutrient content (Frydendal-Nielsen *et al.*, 2016). The choice of harvesting equipment (forage harvester, mower-conditioner, or chopper) depends on the crop type and operational scale. Precision in cutting, chopping, and processing ensures uniform particle size, which promotes effective compaction and fermentation (Mathanker & Hansen, 2014). Harvesting within the optimal timeframe reduces the risk of over-maturity, which can diminish energy content, fiber digestibility, and overall feed intake (Yirdaw *et al.*, 2017).

Fermentation

Fermentation is fundamental to silage preservation. During ensiling, the absence of oxygen creates anaerobic conditions that promote beneficial microbial activity while inhibiting spoilage organisms. This process reduces the pH of the silage by converting sugars in the plant material into organic acids, predominantly lactic acid, which aids in its preservation (Jiang *et al.*, 2020). The quality of the fermentation process is affected by factors such as moisture content, chop length, packing density, and sealing. Silage additives, including inoculants, are vital for improving the fermentation process and enhancing the quality of silage. Inoculants typically contain carefully chosen strains of lactic acid bacteria (LAB), enzymes, and other compounds that expedite and optimize fermentation. These inoculants quickly lower the pH, inhibiting the growth of spoilage organisms, preserving the nutrients in the crop, improving the aerobic stability of silage, and reducing the risk of spoilage when exposed to air during feed out.

Additives/ Preservatives: Inoculants and their role

Silage additives are essential for enhancing the fermentation process and improving the quality of silage. Inoculants, which include specific strains of lactic acid bacteria, enzymes, and other compounds, help to accelerate and optimize fermentation. Preservatives such as sugar supplements (e.g., molasses), bacterial inoculants, enzymes, and acids (such as diluted sulfuric acid, phosphoric acid, hydrochloric acid, and sodium metabisulfite) are added to reduce the pH of the silage. This helps prevent spoilage by inhibiting mold growth and mycotoxin production, while also preserving the nutrients in the crop, thereby increasing the feed value of the silage.

Storage structures

Different storage structures offer various benefits and considerations. These include bunker silos, tower silos, silage piles, as well as small plastic bags and steel drums for storage.

1. **Bunker Silos**: These ground-level structures provide flexibility in size and shape, making them ideal for easy packing and compaction.

2. **Tower Silos**: These vertical towers utilize space efficiently and allow for controlled filling and extraction. Proper packing and sealing are essential to prevent spoilage in tower silos.

3. **Silage Piles**: These are cost-effective and suitable for large-scale operations. They should be constructed on well-drained surfaces and require meticulous packing and compaction.

Procedure

- Build a silage storage facility. A silo with a one cubic meter capacity can hold 500 to 600 kg of green fodder.
- Forage crops intended for silage should be harvested when succulent and at the optimal stage of maturity, with moisture content of approximately 60-70%, and free from pests and diseases.

- After harvesting, the forages are chopped into small pieces of size 2 to 3 cm to increase their surface area, facilitating the fermentation process.
- These chopped forages are then spread over the silos (pit or cement tower) in layers of 30 to 45 cm. Ensure that the silo is filled quickly.
- After filling, seal the silos by covering them with a 12-inch thick layer of earth followed by mud plastering.
- This airtight sealing prevents the entry of oxygen, creating the anaerobic conditions necessary for fermentation.
- During fermentation, lactic acid bacteria convert sugars into lactic acid, preserving the nutrients and preventing spoilage due to the acidic environment.
- Properly prepared silage is typically ready for use in approximately 90 days. Open the silo for feeding only after a minimum of 45 days, as needed.

Quality

- High-quality silage is yellowish-brown, has a pleasant aroma, and is eagerly consumed by cattle.
- The texture of the silage should be firm but with some softer material.
- Moisture content should be between 65 and 70 percent.

- Lactic acid content should range from 3 to 14 percent, while butyric acid should be below 0.2 percent, with a pH level between 4 and 4.2.
- The silage should have a lactic acid smell and should be free of butyric acid and ammonia odors.

Feeding

- The silo can be opened from one side as needed, but only after 45 days.

- To feed livestock, the pit can be opened in sections down to the bottom. The silage can be used immediately or stored in a feed bunk for later use.
- Start by feeding 5 kg of silage per animal to help them adjust to this feed.
- Silage serves as an alternative to green fodder and can be fed in the same manner as green fodder.

Conclusion

As the demand for livestock products rises alongside growing economies and increasing per capita consumption, ensuring a sustainable and abundant forage supply becomes crucial. To address this urgent issue, it is essential to explore new feed resources, with a focus on nutrient-rich natural woody plants proving to be a promising solution. These plants provide high biomass yields and fresh branches and leaves rich in nutrients, including high crude protein levels, bioactive components, amino acids, vitamins, and macro minerals. Although the high moisture content in fresh branches and leaves presents challenges for traditional hay production, silage, fermented feed made from fresh forage, emerges as a vital technology for producing clean feed from woody plants.

References

Bernardes TF, Daniel JL, Adesogan AT, McAllister TA, Drouin P, Nussio LG, et al. Silage review: Unique challenges of silages made in hot and cold regions. Journal of dairy science. 2018;101(5):4001-19.

Cai Y, Du Z, Jethro DB, Nignan M, Yamasaki S (2021). Analysis of main factors affecting silage fermentation of sorghum prepared with whole crop and stover in semiarid West Africa. African Journal of Range and Forage Science. 38(2):169-178.

Du Z, Sun L, Chen C, Lin J, Yang F, Cai Y. (2021b). Exploring microbial community structure and metabolic gene clusters during silage fermentation of paper mulberry, a high-protein woody plant. Animal Feed Science and Technology. 275.

Edwards P, Pullin RS, Gartner JA. (1988). Research and education for the development of integrated crop-livestock-fish farming systems in the tropics. World Fish.

Frydendal-Nielsen S, Hjorth M, Baby S, Felby C, Jørgensen U, Gislum R. (2016). The effect of harvest time, dry matter content and mechanical pretreatments on anaerobic digestion and enzymatic hydrolysis of miscanthus. Bio-resource technology.218:1008-15.

Jiang FG, Cheng HJ, Liu D, Wei C, An WJ, Wang YF, et al. (2020). Treatment of whole-plant corn silage with lactic acid bacteria and organic acid enhances quality by elevating acid content, reducing pH, and inhibiting undesirable microorganisms. Frontiers in microbiology.11:593088.

Kolli VS, Garg S, Shirkole SS. (2023). Silos and bins. In Transporting Operations of Food Materials Within Food Factories. Wood Head Publishing. p. 61-93.

Kumar B, Lamba JS, Dhaliwal SS, Sarlach RS and Ram H (2014). Exogenous application of bio-regulators improves grain yield and nutritional quality of forage cowpea (Vigna unguiculata). International Journal of Agriculture and Biology. 16: 759-765.

Mathanker SK, Hansen AC. (2014). Harvesting system design and performance. Engineering and science of biomass feedstock production and provision. 18:85-139.

Provenza FD, Meuret M, Gregorini P. (2015). Our landscapes, our livestock, ourselves: Restoring broken linkages among plants, herbivores and humans with diets that nourish and satiate. Appetite. 95:500-19.

Tavakoli S, Regenstein JM, Daneshvar E, Bhatnagar A, Luo Y, Hong H. (2022). Recent advances in the application of microalgae and its derivatives for preservation, quality improvement, and shelf-life extension of seafood. Critical Reviews in Food Science and Nutrition. 62(22):6055-68.

Vandermeulen S, Ramirez-Restrepo CA, Beckers Y, Claessens H, Bindelle J. (2017). Agroforestry for nutrients: A review of trees and shrubs as fodder in silvopastoral temperate and tropical production systems. Animal Production Science. 58(5):767-777.

Yirdaw M, Mengistu A, Tamir B, Berhane G. (2017). Replacing cotton seed cake by dried Acacia saligna, Sesbania sesbana and Cowpea on productivity of Begait sheep in North Ethiopia. American Eurasian Journal of Scientific Research.12(1):29-36.

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BHAC CYCLE: TURBOCHARGING C3 PLANTS WITH A C4 SHUTTLE

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Abstract

In C3 plants, photosynthetic efficiency is hampered by the generation of toxic compounds, such as glyoxylate, during photorespiration, leading to reduced crop yields. To address this, one of the most recent breakthroughs in the areas of metabolic engineering to bypass photorespiration, is the discovery of the β-hydroxyaspartate cycle (BHAC) in marine proteobacteria. This pathway offers a novel approach to mitigating the effects of photorespiration by converting glyoxylate, a key photorespiratory intermediate, into oxaloacetate—a C4 compound—through four enzymatic steps. Remarkably, this conversion occurs with minimal loss of carbon and nitrogen, making the BHAC pathway a promising strategy for improving photosynthetic efficiency and increasing crop yields.

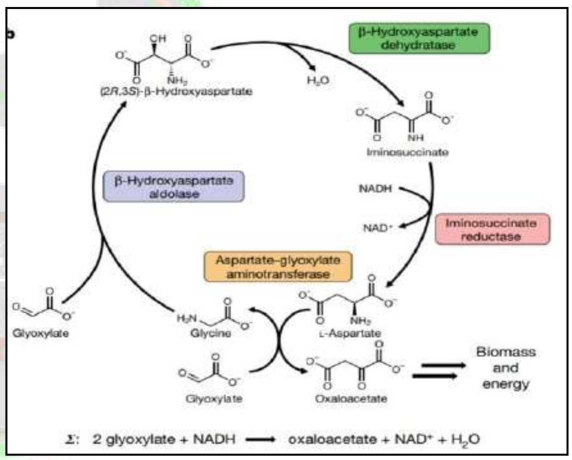
Key words: Photorespiration, BHAC, C4, Oxaloacetate

Introduction

Due to the rapid growth of the human population, the demand for food production is rising at an unprecedented rate. To ensure sustainable food production, it is estimated that global food output must double by 2050 (Tilman *et al*., 2011; Jones *et al*., 2013). One approach to addressing this challenge has been the development of high-yielding crop varieties. Additionally, recent advancements in synthetic biology hold promise for enhancing the carbon efficiency of plants, which could further boost crop yields. A significant barrier to achieving higher yields, however, is photorespiration, a process that reduces the efficiency of photosynthesis. Addressing this constraint is crucial for meeting the future food demands. Photorespiration begins with the oxygenation reaction of ribulose 1,5-bisphosphate carboxylase/oxygenase (Rubisco), leading to the production of 2-phosphoglycolate, a toxic byproduct that must be recycled (Weber and Bar-Even, 2019). In C3 plants, this process reduces photosynthetic efficiency, ultimately lowering crop yields. To counteract this, several strategies are being explored to enhance growth and productivity. These include natural carbon-concentrating mechanisms such as C4 photosynthesis, single-cell C4 photosynthesis, and the application of metabolic engineering to modify photorespiration. One promising recent discovery is the β-hydroxyaspartate cycle (BHAC) found in marine proteobacteria (Schada et al., 2019). This pathway converts glyoxylate, a key photorespiratory intermediate, into oxaloacetate (OAA), a C4 compound, through four enzymatic steps in plant peroxisome, which is used to integrate a synthetic C4 cycle in plant, thereby minimizing carbon and nitrogen loss.

What is BHAC cycle?

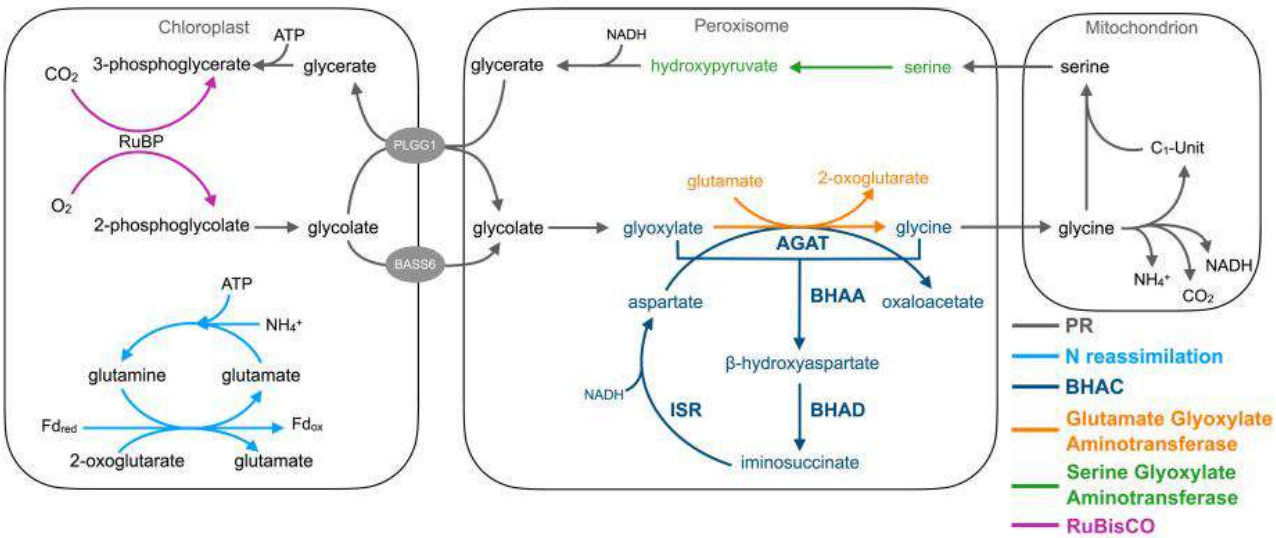
The BHAC gene cluster consists of four genes: BhcA, BhcB, BhcC, and BhcD. BhcA encodes a pyridoxal phosphate (PLP)-dependent aminotransferase that utilizes aspartate to donate an amino group, facilitating the transamination of glyoxylate into glycine (via aspartate aminotransferase, AGAT). BhcB encodes β-hydroxyaspartate dehydratase (BHAD), while BhcC encodes β-hydroxyaspartate aldolase (BHAA), which is responsible for the condensation of glyoxylate and glycine to produce β-hydroxyaspartate. BhcD is a putative ornithine cyclodeaminase, and together with BhcB, it functions as an immuno-succinate reductase (ISR). This enzyme complex processes the imino-succinate intermediate, which is generated by ISR, contributing to the overall conversion pathway (Schada *et al*., 2019).



(Schada *et al*., 2019)

Significance of BHAC cycle

The BHAC pathway offers significant advantages by reducing the loss of carbon and nitrogen, as well as preventing the accumulation of toxic photorespiratory intermediates. Unlike other engineered bypasses, BHAC directly forms a C4 compound without incurring additional energy costs, making it a more efficient and sustainable solution. If a plant utilizes the BHAC pathway instead of traditional photorespiration, there is no release of NH_4^+ or CO_2 in the mitochondrion, and no ATP is consumed in the chloroplast. The oxaloacetate (OAA) produced through this pathway can be converted into aspartate, which is then used in the synthesis of aspartate-derived amino acids such as lysine, methionine, and threonine within the chloroplast (Schonherr, 2022). Additionally, OAA plays a crucial role as a metabolite that could facilitate



the integration of a synthetic C4 cycle into the plant, as it is a key component of the initial CO_2 fixation process in mesophyll cells during the C4 cycle.

Engineering a C4 shuttle via BHAC cycle in C3 plant Arabidopsis:

In the *Arabidopsis ggt1-1* mutant background, which lacks peroxisomal glutamate glyoxylate aminotransferase, glycine production from glyoxylate is significantly reduced. As a result, the metabolic flux is redirected through the BHAC pathway. One of the key intermediates in the BHAC cycle is β-hydroxyaspartate (BHA), which only appears in plants that have implemented the BHAC pathway under photorespiratory or ambient air conditions, or when shifted from photorespiratory to non-photorespiratory (ambient air) conditions, but not in strictly non-photorespiratory environments (Roell *et al*., 2021)

Plants grown in ambient air that utilize the BHAC pathway accumulate soluble amino acids such as glutamate and ornithine, which are involved in the urea cycle, as well as lysine and methionine, which rely on OAA-derived carbon skeletons (Blume C *et al*., 2019). BHAC-specific metabolites, including glycine, aspartate, and malate, are particularly formed and accumulated under photorespiratory conditions, Roell *et al*., 2021 confirming that

BHAC indeed functions as an effective bypass. Additionally, it has been observed that BHAC plants grown in ambient air reduce ammonia release and enhance nitrogen conservation. The aspartate produced from BHAC-derived OAA is utilized in the de novo biosynthesis of amino acids such as lysine, threonine, and methionine, demonstrating that the BHAC pathway operates in a nitrogen-conserving manner (Kirma *et al*., 2012; Ravanel *et al*., 2004).

Conclusion

By incorporating bacterial genes responsible for the BHAC cycle into plants, researchers aim to create a more efficient pathway for processing glycolate. This engineered pathway bypasses the energy-intensive steps of photorespiration, allowing plants to recycle carbon more effectively, potentially leading to increased growth and higher yields. If successfully integrated and optimized, the BHAC cycle could lead to crops with higher photosynthetic efficiency and resilience, paving the way of addressing global food security challenges.

Reference

Blume, C., Ost, J., Mühlenbruch, M., Peterhänsel, C., & Laxa, M. (2019). Low CO2 induces urea cycle intermediate accumulation in Arabidopsis thaliana. *PLoS One*, *14*(1), e0210342.

Jones, C. A., & Sands, R. D. (2013). Impact of agricultural productivity gains on greenhouse gas emissions: A global analysis. *American journal of agricultural economics*, *95*(5), 1309-1316.

Kirma, M., Araujo, W. L., Fernie, A. R., & Galili, G. (2012). The multifaceted role of aspartate-family amino acids in plant metabolism. *Journal of Experimental Botany*, *63*(14), 4995-5001.

Ravanel, S., Block, M. A., Rippert, P., Jabrin, S., Curien, G., Rébeillé, F., & Douce, R. (2004). Methionine metabolism in plants: chloroplasts are autonomous for de novo methionine synthesis and can import S-adenosylmethionine from the cytosol. *Journal of Biological Chemistry*, *279*(21), 22548-22557.

Roell, M. S., Schada von Borzyskowski, L., Westhoff, P., Plett, A., Paczia, N., Claus, P., ... & Weber, A. P. (2021). A synthetic C4 shuttle via the β-hydroxyaspartate cycle in C3 plants. *Proceedings of the National Academy of Sciences*, *118*(21), e2022307118.

Schada von Borzyskowski, L., Severi, F., Krüger, K., Hermann, L., Gilardet, A., Sippel, F., ... & Erb, T. J. (2019). Marine Proteobacteria metabolize glycolate via the β-hydroxyaspartate cycle. *Nature*, *575*(7783), 500-504.

Schönherr, L. (2022). *Computational modelling of a photorespiratory bypass in C3 metabolism to establish a synthetic C4 cycle* (Bachelor's thesis).

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the national academy of sciences*, *108*(50), 20260-20264.

Weber, A. P., & Bar-Even, A. (2019). Update: improving the efficiency of photosynthetic carbon reactions. *Plant Physiology*, *179*(3), 803-812.

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SAFFRON,"THE RED GOLD"

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Abstract

(Crocus sativus L.) Botanical name of Saffron commonly known as kesar or Red Gold. It is one of expensive spice in the world and contains a lot of medicinal benefits such as indigestion, insomnia, inflammation and more. Saffron in mostly utilized by Arabic and South Asian countries. In India the stigmas of the Saffron Flower are used in traditional dessert preparation and are part of its rich heritage but nowadays due to ecological and climate changes the production of saffron is significantly reduced. The Saffron bowl of India i.e. Jammu & Kashmir has observed a 8% decline of total saffron production compared to previous year. To solve the issue indoor cultivation of saffron form various entrepreneurs are growing rapidly providing people with employment opportunities to sustain their livelihood.

Key Word: Kesar, Safranal, Antispasmodic, Corms, Indoor cultivation, Sanitization

Introduction

Saffron (Crocus sativus L.) is a perennial herb from the Iris family, Iridaceae. Crocus sativus L., known as saffron, golden spice, red gold, or 'Kesar,' It is one of the costliest spices in the world. The unique qualities of saffron—its color, flavor, and aroma—are attributed to the compounds crocin, picrocrocin, and safranal, respectively.[1] Saffron contains around 150 phytochemical compounds, both volatile and non-volatile. The volatile compounds are primarily terpenoids and terpene alcohols, while the non-volatile compounds include picrocrocin, crocetin, and crocins. The bright yellow color of saffron is attributed to crocin derivatives, its bitterness comes from picrocrocin, and its characteristic aroma is due to safranal.[2]

Fig1.1: showing a collection of stigmas bulb and flower of saffron

Fig1.2: Saffron flowers sprouting from the doing traditional farming

Saffron is mainly cultivated in Jammu & Kashmir and Himachal Pradesh in India. It requires well-drained loamy, sandy, or calcareous soils with an ideal pH of 5.5 to 8.5. Grown at altitudes between 1500-2500 meters, saffron thrives in climates with hot summers and cold winters, along with a necessary 12-hour photoperiod, though this can delay flowering.[3] Cultivation uses corms, typically planted from June to July or August to September, with flowering starting in October. Common saffron varieties in Kashmir include Aquilla, Crème, and Lacha. Flowers are harvested before sunrise, and the stigma strands are dried for 5-6 days under the sun or 7-8 hours in solar Driers.[4]

Benefits of Saffron

It is valued for its numerous medicinal properties, including aphrodisiac, antispasmodic, antimicrobial, antibacterial, antifungal, antiseptic, anti-inflammatory, and anticancer effects, which contribute to its high price. The dried stigmas of saffron are widely utilized in various industries such as food, pharmaceuticals, cosmetics, perfumery, and textile dyeing.[5] There are other significant advantage of saffron related to Indian heritage and Indian Economy.

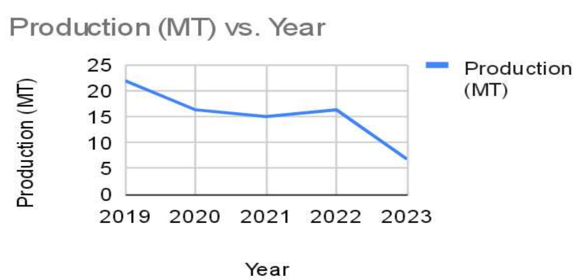
- Economic Growth: As one of the most expensive spices, saffron offers significant economic benefits to the regions that produce it, helping to stimulate local economies and generate employment opportunities.[6]
- Health Benefits: Saffron is known for its various health advantages, such as aiding

digestion and enhancing immune function, contributing to better overall health for the population.[7]

- Enhanced Quality of Life: Growing saffron can boost the quality of life in the area by providing a new source of income and employment, which helps alleviate poverty and improve living conditions.
- Cultural Heritage: The cultivation of saffron is often intertwined with local traditions and can play a role in preserving the cultural heritage of the region.
- Environmental Advantages: Saffron farming contributes to improving soil fertility and reducing reliance on chemical fertilizers and pesticides, thereby protecting the environment and decreasing pollution.

Trend analysis of Saffron Production in India

Saffron is cultivated in countries like Iran, Greece, Morocco, Spain, Italy, Turkey, France, Switzerland, Pakistan, China, Japan, and Australia. India produces 5% of the global supply, with 90% coming from Jammu and Kashmir, which produces 3.83 tonnes annually, though the national demand is around 100 tonnes. India has seen a declining trend in production of saffron from 1990 to 2023-24. A rapid decrease of 7% has been shown. In 2023 only 2.6 metric tonnes was produced from the highest saffron producing state in India i.e. Jammu &



Kashmir. Annually only 6-7% MT is produced in the country. Globally India come 2nd the export of saffron. Fig1.3 showcase the decline of saffron production from 2019 to 2023.

Fig1.3: Graphical representation of year-wise production of Saffron in India.

Factor Affecting the decline of Saffron Production

In recent years there is a decline trend in the production of saffron in India. The mother corm's energy was largely used up during the growth of roots and leaves. Afterward, new corms developed, relying on photosynthesis, with only 10% of their biomass coming from the mother corm. Photosynthesis stayed high (26 µmol m−2 s−1) but was lower in larger corms.

Saffron plants grown in greenhouses showed characteristics of low-light plants, which limited corm growth even after being transferred to the field. Although water stress reduced photosynthesis, corms and roots still maintained a relatively high rate (12 μmol m−2s−1) in dry conditions.[12] There are various factors contributing such change such as usage of substandard quality corms or bulb for cultivation resulting in poor yield and deteriorating soil health and nutrient quality because of continuous saffron cultivation. Saffron cultivation requires adequate rainfall but due to draught conditions and less annual rainfall production is affected. Proper drying of stigma is also effected greatly and harvesting loss occurs causing farmers to lose profit. Saffron marketing is heavily influenced by brokers leading to exploitation. Lack of national institute for training and quality assessment also contribute in the reduction in saffron production and productivity.

Indoor Saffron production and technology

Saffron cultivation with controlled Environment conditions can generate huge returns up to 1 lakh from 350 grams of saffron (Mogra variety) some of the things which should be kept in mind are listed below

- Controlled Environment conditions maintained with the help of air conditioners and humidifiers. Apt temperature for sprouting of bulbs is 15-20 °C and 5-7°C during flowering.
- Procurement of high quality bulbs with different treatment including Neem oil and other organic products to prevent fungal attack on bulbs, use of plastic trays over wooden to reduce moisture content and proper care during transportation.
- Maintaining proper sanitization in the workspace and ensuring proper humidity ranging from 60-70% in a unit. Do not allow unnecessary visit for the risk of contamination.
- Harvesting of Stigma from saffron flower each flower will contain 3 stigma after the flowering cycle of saffron flower multiplication stage happen in which the corms divide into two and can be stored for next season of saffron cultivation

Conclusion

Saffron is an integral part of rich culture and heritage and also providing sustaining income sources for livelihood especially in extreme winter conditions. Saffron is expensive spice due to care it requires at each stage of cultivation from sowing of corms to flowering, from stigma collection to drying and transporting, quality control and marketing but saffron is worth all those efforts as 350 gm of saffron can fetch up to 1 lakh of rupees. Iran and Spain have a monopoly on the saffron export which sometimes results in cheap quality of saffron being imported by various countries around the world. Young entrepreneurs and technological advances people can grow saffron in controlled environment in any climate region and with dedication and determination India can become the largest producer of saffron of highest quality across the world.

References

https://iiim.res.in/saffron-production/

Samira Eghbali, Faegheh Farhadi, Vahid Reza Askari, An overview of analytical methods employed for quality assessment of Crocus sativus (saffron),Food Chemistry: X, Volume 20,n2023, 100992,ISSN 2590-1575,

https://krishijagran.com/agripedia/saffron-cultivation-a-complete-information/

Aabid M. Rather, Sufiya Rashid, Rubaya Sultan, Irshad A. Nawchoo, Ishfaq Ahmad Wani, Azra N. Kamili, Hurdles and clarifications for the cultivation of saffron in Jammu and Kashmir, Journal of Agriculture and Food Research,Volume 10, 2022, 100344, ISSN 2666-1543,

Kumar, A., Devi, M., Kumar, R. et al. Introduction of high-value Crocus sativus (saffron) cultivation in non-traditional regions of India through ecological modelling. Sci Rep 12, 11925 (2022).

Moghaddasi, M. S., & Koocheki, A. (2020). “Saffron and its importance in economic development: A case study of Iran.” Agricultural Economics and Development, 24(93), 45-58.

Hosseinzadeh, H., & Nassiri-Asl, M. (2013). “Avicenna’s (Ibn Sina) the Canon of Medicine and Saffron (Crocus sativus): A review.” Phytotherapy Research, 27(4), 475-483.

Moradi, M., & Tehrani, S. (2018). "The impact of saffron cultivation on improving living standards in rural areas of Iran." *Journal of Rural Development Studies*, 35(4), 115-127.

Salgueiro, R., & Amaral, E. (2017). “Saffron: Cultivation and its cultural heritage in Iran.” International Journal of Heritage Studies, 23(5), 412-425.

Koocheki, A., & Seyyedi, S. M. (2015). "Saffron and sustainable agriculture: Low water requirement and environmental compatibility." *Agricultural Water Management*, 148, 57-67.

Kumar, A., Devi, M., Kumar, R. et al. Introduction of high-value Crocus sativus (saffron) cultivation in non-traditional regions of India through ecological modelling. Sci Rep 12, 11925 (2022).

B. Renau-Morata, S.G. Nebauer, M. SÃ¡nchez, R.V. Molina,Effect of corm size, water stress and cultivation conditions on photosynthesis and biomass partitioning during the vegetative growth of saffron (Crocus sativus L.), Industrial Crops and Products,Volume 39,2012,Pages 40-46,ISSN 0926-6690,

Mukhter, Irtifa, Ganie, Aasim Ur Rehman, Ahad, Bisma, Ahmad, Sarafraz, Chowdhary, Richa, and Seerat, Syed. (2020), Qualitative Analysis of Factors Influencing the Decline of Saffron (Crocus sativus) Cultivation in the Valley of Kashmir, India: Need of Regaining its Legacy. In: Journal of Social and Political Sciences, Vol.3, No.3, 584-596

Sarita parihar, Subash Kumar, an declining trend in production and productivity of Saffron in Jammu & Kashmir, International Journal of Creative Research thoughts, volume 10, issue 5, 2022, ISSN 2320-2882

https://thebetterindia.com/355809/grow-saffron-indoors-aeroponics-steps-guide-harsh-patil-nandurbar-maharashtra-earn-lakhs/

https://india.mongabay.com/2024/04/indoor-saffron-farming-offers-hope-amidst-declining-saffr7on-production/?amp=1

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MYCOTIC INFECTIONS IN POULTRY

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Introduction

Mycotic infections are relatively common in avian species. Medically important fungi are opportunistic rather than obligate parasites. They belong to the Fungi kingdom (Eumycota) which includes a diversity of organisms including filamentous microscopic structures, yeast-like, and macroscopic forms. Characteristically, fungi are heterotrophic eukaryotes with unicellular or multicellular structures surrounded by a rigid cell wall. Mycotic diseases are often devastating in the infected host. Most clinically important fungi, other than yeasts, produce large amounts of airborne spores for dissemination. Except for the dermatophytoses, which affect the integument, animals are dead-end hosts for fungal infections, because they are not contagious. Histoplasmosis and cryptococcosis are rare fungal infections of poultry but are notable as public health hazards.

Aspergillosis

Aspergillosis is the most important fungal respiratory infection in birds and a major cause of mortality in free-living, captive, and domestic birds worldwide (15). In young poultry, the disease is referred to as “brooder pneumonia” because it is most commonly diagnosed in neonatal poultry associated with infection at around hatching. *A. fumigatus* is the principal agent causing aspergillosis in poultry because the spores are very small and easily inhaled. Toxins produced by pathogenic species of *Aspergillus*, particularly *A. flavus* and *A. fumigatus*, may be involved in the pathogenesis of *Aspergillus* infections in poultry. One more toxin produced by these species is Gliotoxin.

Acute aspergillosis usually affects young birds and is characterized by high morbidity andmortality. Brooder pneumonia in broiler chicks as a result of hatchery contamination can be a significant problem, especially with *in ovo* vaccination. Chronic aspergillosis occurs in adult birds, especially turkey breeders, or occasionally in captive birds in aviaries. Aspergillosis is primarily an infection of the respiratory tract. Infection of the lungs and the air sacs is the most common form of the disease in avian species (Fig.1). Systemic aspergillosis includes dermatitis, omphalitis, mycotic osteomyelitis and arthritis, opthalmitis and encephalitis.

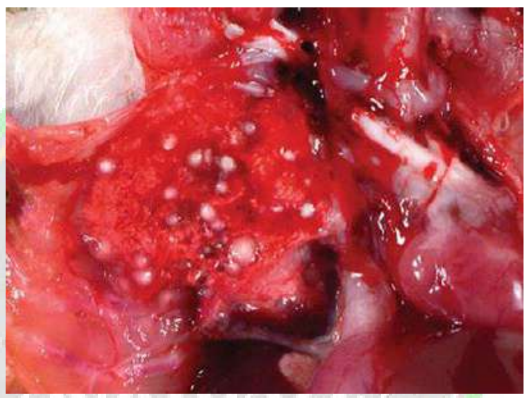

Fig.1. Caseous nodules in the lung of a turkey poult

Candidiasis (Crop Mycosis)

Candidiasis is a mycosis caused by infection with the mycelial yeasts of the genus *Candida*, principally *C. albicans*. Birds are particularly susceptible to oral and crop candidiasis, which resembles thrush in humans. Candidiasis affects chickens, turkeys, geese, pigeons, guinea fowl, pheasants, quail, and other avian species. Candidiasis is an opportunistic endogenous mycosis that results from a disturbance of the microflora or other debilitation of the host, rather than dissemination of a pathogenic strain. Affected chicks show poor growth, stunting, listlessness, and roughness of feathers. Young birds are more susceptible than older birds to mycosis of the digestive tract. Lesions occur most frequently in the crop and consist of thickening of the mucosa with white to off-white, raised circular or rugose lesions. Often, curd-like pseudomembranous patches that are peeled easily from the eroded mucosal surface are seen (Fig.2). The mouth and oesophagus may be diphtheritic and eroded.

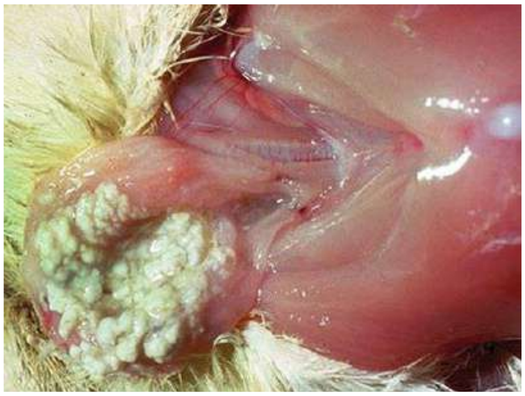

Fig.2. Crop mycosis in a broiler bird

Dermatophytosis (Favus)

Dermatophytosis, dermatomycosis, ringworm, and favus are terms applied to fungal infections of skin. The primary etiologic agent of favus, *Microsporum gallinae*. It typically produces white scaly or crusty lesions on the comb and skin of the head and neck with loss of feathers. Other than skin lesions, affected birds are typically healthy and will spread gradually through a flock. It can produce ringworm lesions in people in contact with the birds. Birds with favus need to be segregated to prevent transmission of the disease. Topical application of miconazole ointment on affected areas can be efficacious.

Ochroconosis (Dactylariosis)

Ochroconosis is a sporadic fungal encephalitis of birds caused by the dematiaceous, thermophilic fungus *Ochroconis gallopava.* Clinical signs are those of central nervous system disease and include incoordination, loss of equilibrium, tremors, torticollis, paralysis, and death. Gross lesions are frequently confined to the brain with involvement of both cerebellum and cerebrum, but pulmonary granulomas may also be seen. Lesions have been described as focally extensive, circumscribed, firm, and gray or red. Ochroconosis in poultry has been associated with contaminated litter and egg incubators.

Zygomycosis (Mucormycosis)

Zygomycosis is caused primarily by fungi belonging to the genera Mucor, Rhizopus, Absidia, Rhizomucor, and Mortierella. Clinical syndromes associated with zygomycosis depend on the organ or system infected. Multifocal white nodules in the lungs have been reported in a chicken with pulmonary zygomycosis. Disseminated zygomycosis with concurrent pulmonary aspergillosis in a flock of layer cockerels showed granulomas in lung, air sac, peritoneum, liver, spleen, and kidney. Zygomycosis is characterized by heterophilic granulomatous or granulomatous inflammation, usually with numerous multinucleated giant cells. Necrosis and angioinvasion occur frequently. Granulomas typically have a necrotic centre.

Macrorhabdosis (Megabacteriosis)

Macrorhabdosis results from heavy infections with *Macrorhabdus ornithogaster*, an opportunistic yeast that colonizes the proventriculus and ventriculus in birds. Among domesticated birds, *Macrorhabdus* infection has been identified in chickens, turkeys, guinea fowls, quails, partridges, ducks, geese, pigeons, and ostriches. Macrorhabdosis is a chronic progressively debilitating, gastrointestinal disease characterized by emaciation, prostration, anorexia, cachexia, and death.

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UNRAVELING THE MOLECULAR GENETICS OF MAJOR BACTERIAL BLIGHT RESISTANCE GENES

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Introduction

Bacterial blight, caused by the bacterium *Xanthomonas oryzae* pv. *oryzae*, is one of the most devastating diseases affecting various crops, particularly rice. This disease can cause significant yield losses, leading to severe economic consequences for farmers and impacting global food security. Understanding the molecular genetics of bacterial blight resistance is crucial for developing resistant crop varieties and ensuring sustainable agricultural practices. These genes encode proteins that recognize specific pathogen effectors, triggering a series of molecular responses that limit pathogen proliferation. Unraveling the molecular genetics of these major resistance genes involves dissecting their structure, function, and the signaling pathways they activate. This knowledge is essential for breeding programs aimed at developing crops with durable resistance to bacterial blight (Mew *et al*., 1993; Khush, 2005). A total of 46 Resistant genes conferring resistance to bacterial leaf blight have been identified till date (Chen *et al*., 2020). The details regarding molecular genetics of some of the major R genes are given below:

Molecular genetics of *Xa4* gene

Dominant gene *Xa4* was identified in TKM6 cultivar of rice and it confers resistance to Philippine race 1 of *Xoo* pathogen. *Xa4* locus was mapped between the two RFLP markers, RZ536 and L457. RM224, a PCR based SSR marker is found to distinguish susceptible and resistant genotypes. The *Xa4* gene contributes to the plant's defense mechanism by recognizing specific components produced by the *Xoo* bacterium, triggering a series of responses that collectively hinder the bacterial infection. One of the hallmarks of the response induced by the

Xa4 gene is the hypersensitive response (HR), a localized programmed cell death at the site of infection (Hu *et al*., 2017).

Molecular genetics of *xa5* gene

The *xa5*, a recessive resistant gene encodes a receptor-like kinase (RLK) protein that recognizes specific avirulence (*Avr*) proteins produced by *Xoo*. This recognition triggers a defense response, leading to resistance against *Xoo* infection. The *xa5* gene is located on the long arm of chromosome 4 in rice. It confers resistance to certain strains of *Xoo* that carry the corresponding *Avr* gene, called *AvrXa5***.** The molecular interaction between the *xa5* gene product and *AvrXa5* involves direct binding and activation of the *xa5* protein by *AvrXa5*. This recognition event initiates a signaling cascade that triggers various defense responses, including the hypersensitive response (HR), cell wall reinforcement, and the production of antimicrobial compounds

Molecular genetics of *Xa7* gene

Xa7, the dominant gene for resistance to BB of rice, was derived from three varieties DV85, DV86, and DZ78 from Bangladesh. It is located on chromosome 6. It was resistant to PXO61, PXO86, PXO79 and SCB4-1 and was the dominant gene for resistance at booting stage. The gene was located between markers GDSSR02 and RM20593 and the genetic distances from markers were 0.07 and 0.14 cM, respectively. The gene was further locked in a range of 28 kb through map cloning and radiation mutagenesis (Chen *et al*., 2021).

Molecular genetics of *xa13* gene

xa13, a recessive resistance gene was first identified in the cultivar BJ1 by Ogawa *et al.*, in 1987. It has specific resistance to Race 6 of Philippines and for many isolates of India. It is found on Chromosome No. 8 and flanked by two RFLP markers namely RG136 and R2027 (Sanchez *et al*., 1999). RG136 was extensively used in various breeding programmes. Another PCR based codominant marker, *xa13* prom, was developed by Sundaram *et al*. (2011). This marker amplifies 500 bp fragment in resistant cultivars and 250 bp fragment in susceptible cultivars.

Only two putative genes that appeared to be intact according to sequence analysis of the 14.8 kb segment containing the *xa13* gene were an extensin-like gene and a homologue of nodulin (MtN3), as well as the 5′ end of a projected hypothetical protein (Chu *et al*., 2006). Following infection by the *Xoo* strain PXO99A, the expression of the rice gene *Os8N3*, a member of the MtN3 gene family found in both plants and animals, increased and was dependent on the type III effector gene PbXo-1. *Os8N3* lives close to *xa13* and was unable to be induced in rice lines containing *xa13*. Plants with PX099A resistance were generated through *Os8N3* inhibitory RNA silencing (Yang *et al*., 2006).

Molecular genetics of *Xa21* gene

Xa21, a dominant gene resistant to rice BB, was derived from *Oryza longstaminata*, confers resistance to many isolates of *Xoo* in India. *Xa21* gene was located in the 8.5 cM interval on chromosome 11 and the physical size of the region containing this gene is around 800 kb (Ronald *et al*., 1992). *Xa21* gene was co-segregated with molecular markers such as RG103, RAPD818, and RAPD248 (Ronald *et al*., 1992). This was the first cloned R gene in rice (Song *et al*., 1995). They reported that *Xa21* gene encodes a receptor like kinase protein with serine-threonine specificity. It was found that RG1O3 was tightly linked to the *Xa21* with the map distance of 1.2 cM. Another PCR based STS marker, pTA248 was developed which was very closely linked to the gene at the distance of 0.1 cM. Later it was clarified that pTA248 is a functional marker i.e. the marker is within a gene (Rao *et al*., 2002). At the initial stages of Crop growth *Xa21* gene activity was observed to be very minimal and gradually increases with crop growth. It was reported that the pathogen confers complete resistance at the adult stage (Century *et al*., 1999). The *Xa21* gene encodes a receptor-like kinase (RLK) protein located on the surface of rice cells. This RLK has a specialized extracellular domain that binds to a specific molecule called a "ligand" produced by *Xoo*. This ligand, known as Ax21, is released by *Xoo* during its interaction with the rice plant. Upon binding of Ax21 to the *Xa21* RLK, a series of intracellular signaling events are triggered. This initiates a complex signaling cascade involving various enzymes and molecules. These pathways lead to the activation of defense-related genes, production of antimicrobial compounds, and reinforcement of cell walls (Antolín-Llovera *et al*., 2012). With the advent of molecular marker pTA248, *Xa21* gene has been widely used in breeding programmes singly or in combination with other genes to give broad spectrum resistance. It amplifies 950-1000 bp band in resistant cultivars and 650 bp in susceptible cultivars in codominant manner (Ronald *et al*., 1992).

Significance of Resistance genes against Bacterial blight

- R genes are integral components of the plant immune system, providing the first line of defense against pathogenic bacteria such as *Xanthomonas oryzae* pv. *oryzae*, which causes bacterial blight in rice.

- R genes encode proteins that act as molecular sensors, recognizing specific effectors produced by pathogens.
- R genes activates various responses include the production of reactive oxygen species (ROS), strengthening of cell walls, activation of defense-related genes, and programmed cell death at the infection site, known as the hypersensitive response (HR).
- R genes often confer durable resistance, which remains effective over multiple cropping seasons and across different environmental conditions.
- The identification and characterization of R genes have significant implications for crop improvement and sustainable agriculture
- The strategic deployment of R genes is crucial for enhancing crop resilience to bacterial blight and safeguarding food security, particularly in regions where rice and other staple crops are heavily impacted by this disease.

Conclusion

The study of resistance genes (R genes) against bacterial blight, such as *Xa4*, *xa5*, *Xa7*, *xa13*, and *Xa21*, provides valuable insights into the molecular mechanisms of plant immunity. These genes play crucial roles in recognizing pathogen effectors and triggering defense responses, enhancing resistance against *Xanthomonas oryzae pv. oryzae* in rice. Utilizing these R genes in breeding programs has proven effective in developing resistant rice varieties, thereby improving crop resilience and ensuring sustainable agriculture. Future prospects include the exploration of novel R genes and their combinations to create broad-spectrum and durable resistance. Advances in genetic engineering and molecular breeding could further facilitate the development of rice varieties with enhanced resistance to bacterial blight, contributing to global food security. Integrating R genes with emerging technologies such as CRISPR/Cas9 could also provide new opportunities for precision breeding and sustainable crop improvement.

References

Antolín-Llovera, M., Ried, M. K., Binder, A. and Parniske, M., 2012. Receptor kinase signaling pathways in plant-microbe interactions. *Annual review of phytopathology*, 50: 451-473.

Century, K. S., Lagman, R. A., Adkisson, M., Morlan, J., Tobias, R., Schwartz, K. *et al*., 1999. Developmental control of *Xa21*-mediated disease resistance in rice. *The Plant Journal*, 20(2): 231-236.

Chen, S., Wang, C., Yang, J., Chen, B., Wang, W., Su, J. *et al*., 2020. Identification of the novel bacterial blight resistance gene *Xa46* (t) by mapping and expression analysis of the rice mutant H120. *Scientific reports*, 10(1): 12642.

Chen, X., Liu, P., Mei, L., He, X., Chen, L., Liu, H. *et al*., 2021. *Xa7*, a new executor R gene that confers durable and broad-spectrum resistance to bacterial blight disease in rice. *Plant communications*, 2(3).

Chu, Z., Yuan, M., Yao, J., Ge, X., Yuan, B., Xu, C. *et al*., 2006. Promoter mutations of an essential gene for pollen development result in disease resistance in rice. *Genes and development*, 20(10): 1250-1255.

Hu, K., Cao, J., Zhang, J., Xia, F., Ke, Y., Zhang, H. *et al*., 2017. Improvement of multiple agronomic traits by a disease resistance gene via cell wall reinforcement. *Nature plants*, 3(3): 1- 9.

Mew, T. W., Alvarez, A. M., Leach, J. E. and Swings, J., 1993. Focus on bacterial blight of rice. *Plant Disease*, 77(1): 5-12.

Ogawa, T., Lin, L., Tabien, R. E. and Khush, G. S., 1987. A new recessive gene for resistance to bacterial blight of rice. *Rice Genetics Newsletter*, 4(98): 100.

Rao, K. K., Lakshminarasu, M. and Jena, K. K., 2002. DNA markers and marker-assisted breeding for durable resistance to bacterial blight disease in rice. *Biotechnology Advances*, 20(1): 33-47.

Ronald, P. C., Albano, B., Tabien, R., Abenes, L., Wu, K. S., McCouch, S. and Tanksley, S. D., 1992. Genetic and physical analysis of the rice bacterial blight disease resistance locus, *Xa21*. *Molecular and General Genetics*, 236: 113-120

Sanchez, A. C., Ilag, L. L., Yang, D., Brar, D. S., Ausubel, F., Khush, G. S. *et al*., 1999. Genetic and physical mapping of *xa13*, a recessive bacterial blight resistance gene in rice. *Theoretical and applied genetics*, 98: 1022-1028.

Song, W. Y., Wang, G. L., Chen, L. L., Kim, H. S., Pi, L. Y., Holsten, T. *et al*., 1995. A receptor kinase-like protein encoded by the rice disease resistance gene, *Xa21*. *Science*, 270(5243): 1804-1806.

Sundaram, R. M., Laha, G. S., Viraktamath, B. C., Sujatha, K., Natarajkumar, P., Hari, Y. *et al*., 2011. Marker assisted breeding for development of bacterial blight resistant rice. *Genomics and Crop Improvement: Relevance and Reservations, Institute of*

Biotechnology, Acharya N G Ranga Agricultural University, Hyderabad, 154-182.

Yang, B., Sugio, A. and White, F. F., 2006. *Os8N3* is a host disease-susceptibility gene for bacterial blight of rice. *Proceedings of the National Academy of Sciences*, 103(27): 10503-10508

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Volume: 04 Issue No: 08

MICROBIOME IN WATER AS PROMISING PROBIOTIC IN AQUACULTURE(FROM MOLLY FISH) FOR GROWTH PROMOTING RHIZOBACTERIA (PGPR)FOR SUSTAINABILITY

Article ID: AG-VO4-I08-106

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Introduction

Climate change is the biggest challenge planet Earth facing in this century. Organic aquaculture seems to play a promising role to mitigate clean and sustainable Environment. Organic aquaponics is gaining importance for its healthy method of growing fish and plants Like leafy vegetables, medicinal plants and even cereal crops for their mutual benefits. Aquaculture fisheries seem to have an important role in increasing food productivity in an eco-friendly manner for sustainability to cover-up land cultivation problems to some extent.

This study is basis for assessing the general health of fish and plant with identification of water microbiome by metagenomics which colonize plant roots with Plant Growth Promoting Rhizobacteria.

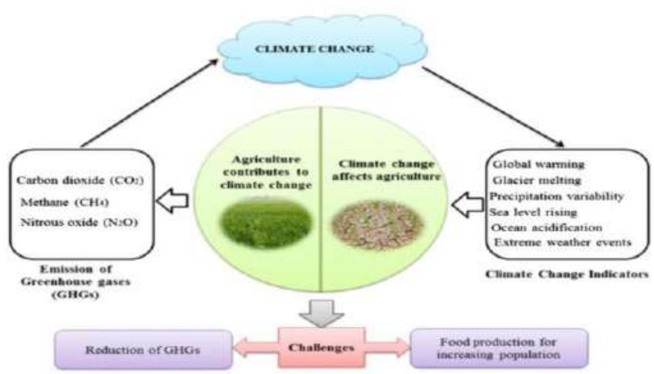
The present study has established evidence by experimental tank system in which required sustainable ecosystem is created with fish culture. In that it was observed for keratin and chitin solubilisation and the luxuriant plants growth. Plactomycetes isolation , was carried out when its source soil from fish tank is enriched with marine soil (sand). The mixed sample was boiled (Vegetative forms get killed for viable spores) cooled and streaked on starch casein agar for culture isolation and characterisation of Actinomycetes for phyto pathogenic effect. This establishes evidence that the fish gut bacteria played vital role for luxurious growth of plants by aquaculture fisheries.

Key words : climatic change , Mitigation measures, Aquaponics, *plants and molly fish* and metagenomics.report.

Introduction

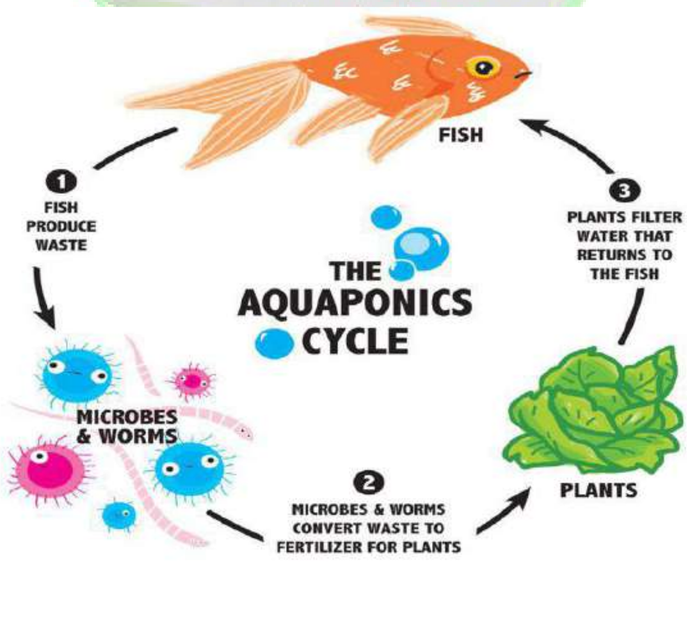
Climate change is the biggest challenge planet Earth is facing this century. It takes place either due to natural phenomenon or human activities. The changes are attributable to human activities-mainly burning of fossil fuels. Continues to rise due to increased release of Green House Gases in the atmosphere. Some of the gases in the earth's atmosphere can trap heat and maintain the earth's temperature acting as thermal blanket. These gases are mainly carbon dioxide($CO2$),methane ($CH4$) and nitrous oxide($N2O$).The concentration of the naturally present GHGs in the atmosphere is increasing and new gases are being added , which lead to more heat being retained in the atmosphere. The result is the warming of our atmosphere.This is known as Green House Effect, which is causing the global temperature to rise.

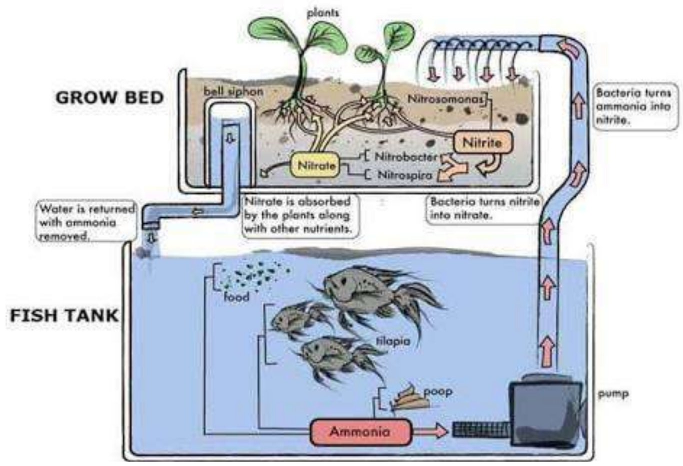
The earth's climate had been changing due to natural causes since ages. However the present change is man-made. Since industrial revolution the concentration of greenhouse gases in the atmosphere has increased due to various human activities such as burning of fossil fuel for energy generation ,industrial processes and transportation, deforestation and agriculture practices etc. Moreover, new gases like HFCs (hydroFlourocarbon),)PFCs (perforate chemicals) and SF6 (SulphurHexachloride) used in refrigeration and air conditioning have been added. With urbanisation population growth and fancier lifestyles green house gas emissions have reached unprecedented levels.



The impacts of climate change are already visible. The average surface temperature increase is causing the polar caps to melt with subsequent increase in the sea level. However there are primary and direct impacts and their onset is slow. The immediate direct impacts are the increase in extreme weather conditions and irregularity in precipitation which has indirect impacts on health, agriculture and water resources. At other levels are the indirect impacts like migration, economic losses and increase in various conflicts. In other words impacts of climate change are cascading in nature -change as a trigger in one of the systems will alter and impact all the associated ecosystems and earth's elements as well as socio-economic systems.

Climatic change impacts in India, high health risk due to increase in heat waves, vector borne diseases and epidemics. Increase in the number of heat wave days from about 5 to between 30 to 40 every year. Change in the spatial and temporal pattern with increased frequency of vector borne diseases. Loss of ecosystem and biodiversity and increased frequency of forest fire is leading to ecological degradation, coastal inundation, sea wateringress and loss of life due to sea level rise. Loss due to extreme weather events, decreased agriculture production due to variability in precipitation and temperature rise- results into shrinkage in rice, wheat, maize production. Loss of soil fertility even with increased level of fertiliser application, besides more fertility in some cultivable, less chance of natural soil fertility build up by microbes due to continuous cultivation, frequent drought conditions and predictability of climatic weather pattern, decline in ground water etc, are threatening food production industry by soil based agriculture . Under such circumstances in near future it will be impossible to feed the entire population using open field of agriculture production only.[1]





Naturally soil less culture is becoming more relevant in the present scenario to cope with these challenges. Soil less culture has shown promising results all over the world due to poor waste management, river pollution and water management. Organic aquaculture plays an important role in increasing soil fertility, minimising input costs and producing an eco-friendly and safe products. Organic aquaculture is breeding of fish, shellfish , algae, seaweed and other organisms in all types of water environments is promising as mitigation measures to cope-up with impacts of climate change.

Materials and Method.

Soil sample from sea shores to isolate Actinomycetes, Soil from fish tank, plants growing in the fish pond and mangrove for its soil (*Asparagus* racemosus root).

Isolation of Actinomycetes

0.5 grams of soil sample (mixture of fish tank soil and sea shore sand was air dried then boiled) was suspended in 9.5 ml sterile water and was 10 fold diluted. 1ml of dilution was spread on various culture medias such as Bennet agar, L glycine glycerol agar,, L -arginine glycerol agar, Starch casein agar, humus agar with pH 7.8 and anti-fungal agents fluconazole &streptomycin. The plates were incubated at 300 C for 2weeks

Observations

Colonies were opaque and variously pigmented. The colony surface was waxy white, chalky orange, red purple grey. Pink pigment is seen with smooth band granular margins. Colonies were velvety depending on the abundance of growth. Biochemical tests carried out include catalase, amylase, cellulase and lipase for the secondary screening. Amylase test positive caesin hydrolysis isolated colony on glyscerol arginine agar isolated colonies on starch agar methyl red positive showing glucose fermentation. Vogus- prosker negetive in glucose broth indole test in tryptone broth.Bacteria from fish gut for bioactive compounds released into Fish tank are showing keratin degradation and chitin degradation (bird feathers ,insects and worms) are seen growing on plate count agar with glucose at 37’c with pH 7.8 to +2, upon incubation produced isolated grey colonies . On Gram staining it is Gram -positive, rod shaped. Facultative anaerobic, motile, spore forming bacteria in soil has growth promoting factors (PGPR) seen by the growth of marine Actinomycetes . The sample gave well isolated chalk like colonies of marine Actinomycetes producing novel enzymes and antibiotics. Isolated colonies of *Bacillus* and Actinomycetes were-seen. Starch casein agar, cellulose casein agar, and arginine glycerol agar showed respective enzyme activity.

Sample Name	Aqua Culture Water Sample		
Test Required	16S rRNA Metagenomics		
Lab provided details			
Sample Registered On	2021/02/08	Sample Received	2021/02/08
Sampling Details	Sample analyzed as received		
Analysis Start Date	2021/02/09	Analysis Complete Date	2021/04/20
Received Quantity	Aqua Culture Water Sample – 500 mL		
Mode of Testing	16S Metagenomic Sequencing Library Preparation		

QC REPORT

S. No.	Test Required	UOM	Method	Results
1	16S rRNA Metagenomics	--	Illumina MiSeq System	Microbiome Characterized.

Amylase production was observed by iodine test and Di nitro salicylic method, casein degradation in starch casein agar, cellulase release in cellulose agar plate is observed. *Bacillus* species showed anti-fungal and antibacterial effect by its growth in chitin and keratin media for its proteases. [2] A .Isolated colonies from fish gut. B. Isolated colonies from *Asparagus* root. racemes racemes C. Feather media showing its lysisThis *Bacillus* species from fish gut was confirmed by its rRNA analysis and is identified by 16s sequence as *Bacillus cereus*

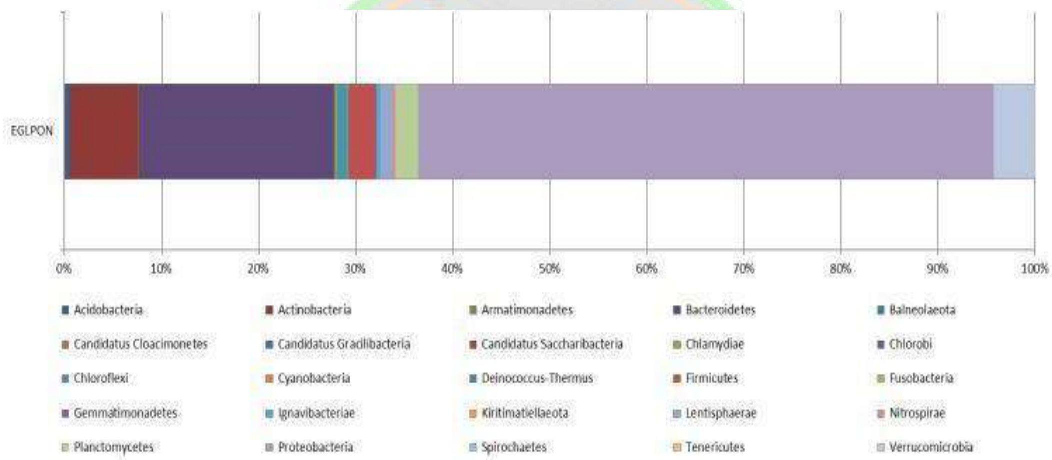
Micro scopic view *Bacillus cereus*

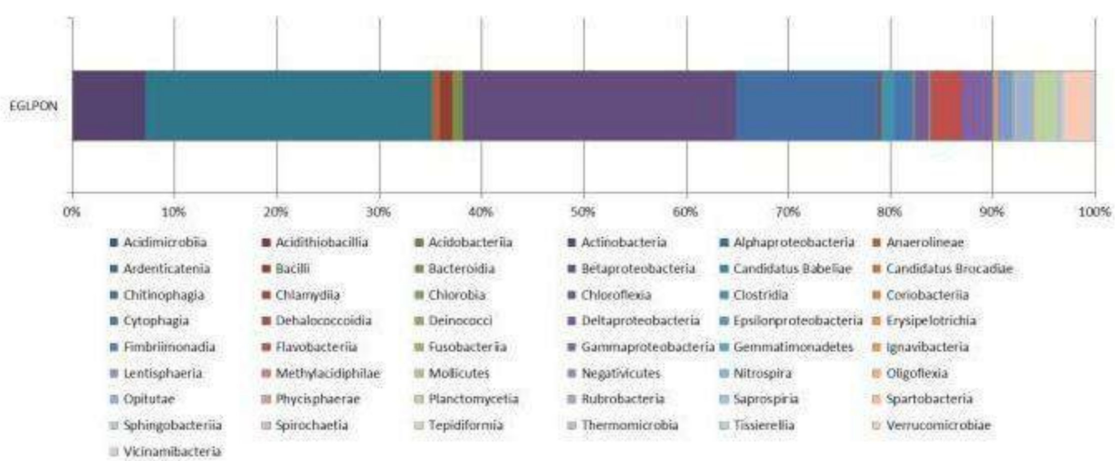
A: *Bacillus cereus* is Gram -positive rod shaped, facultatively anaerobic bacterium, soil saprophyte, spores are widely spread ,commonly found in soil and food. Some strains are harmful to humans and cause food borne illness while other strains can be beneficial as probiotics for animals.

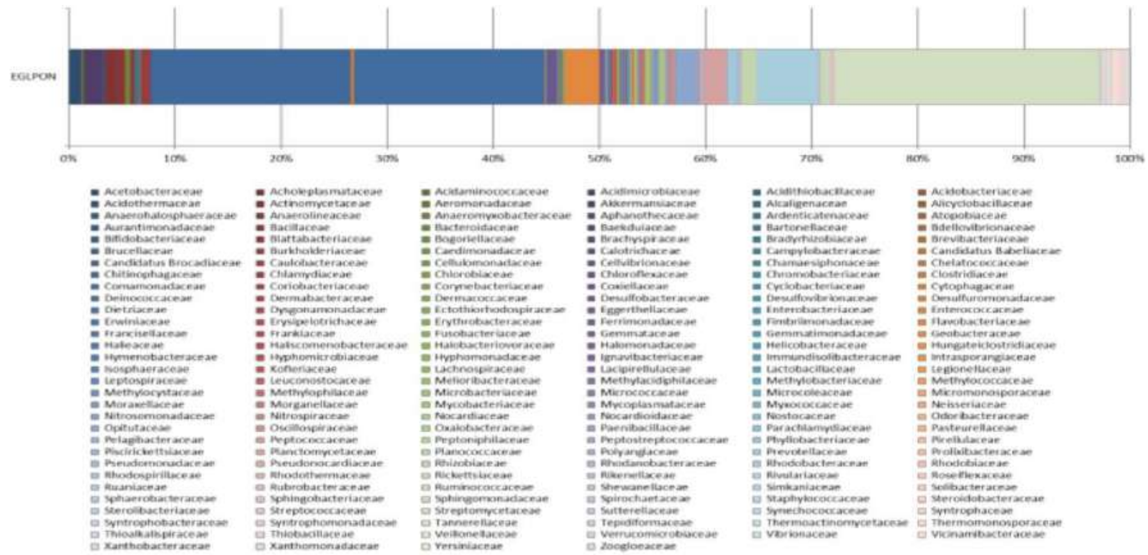
B: *Bacillus paramycoides*from rhizosphere of *Asparagus racemeouses*

*Bacillus paramycoides*is a spore -forming bacterium of the genus Bacillus they are usually larger then 3micrometers, flat , relatively rough with silken threads around the colony .Form chains of cells , gram positive, spores can form acid from glucose , and this form is non motile . , Vogue's -Proskaur test positive test .hydrolysis starch , cellulose and inulin which is reserve food in the root.

Metagenomic analysis of water microbiome for water purification called **Anammox**



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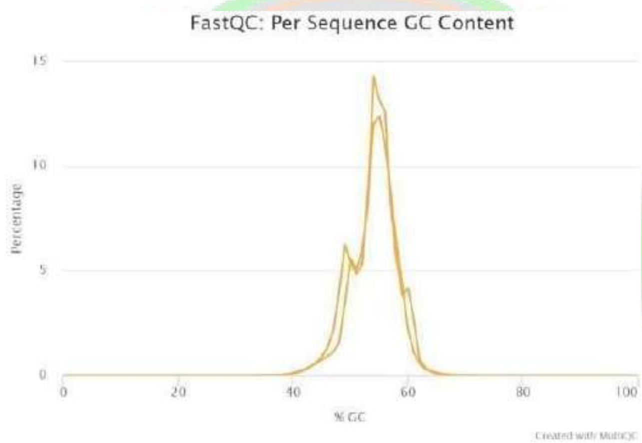
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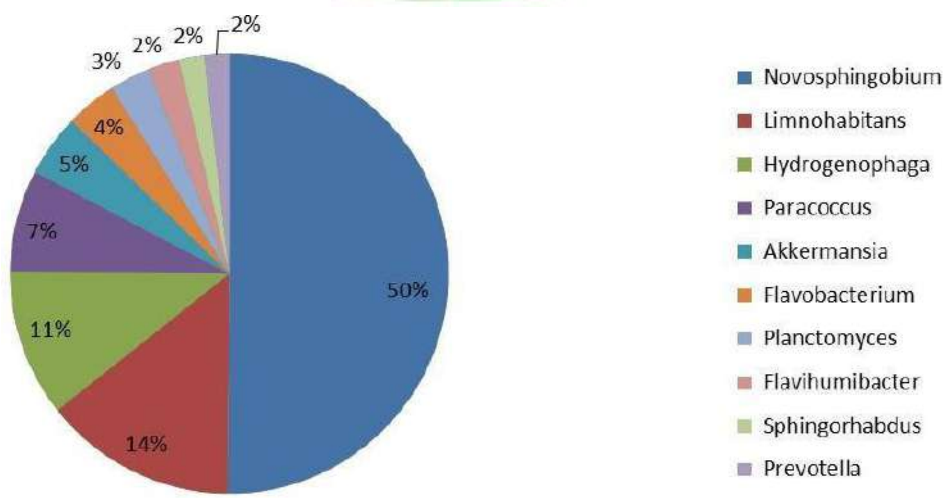
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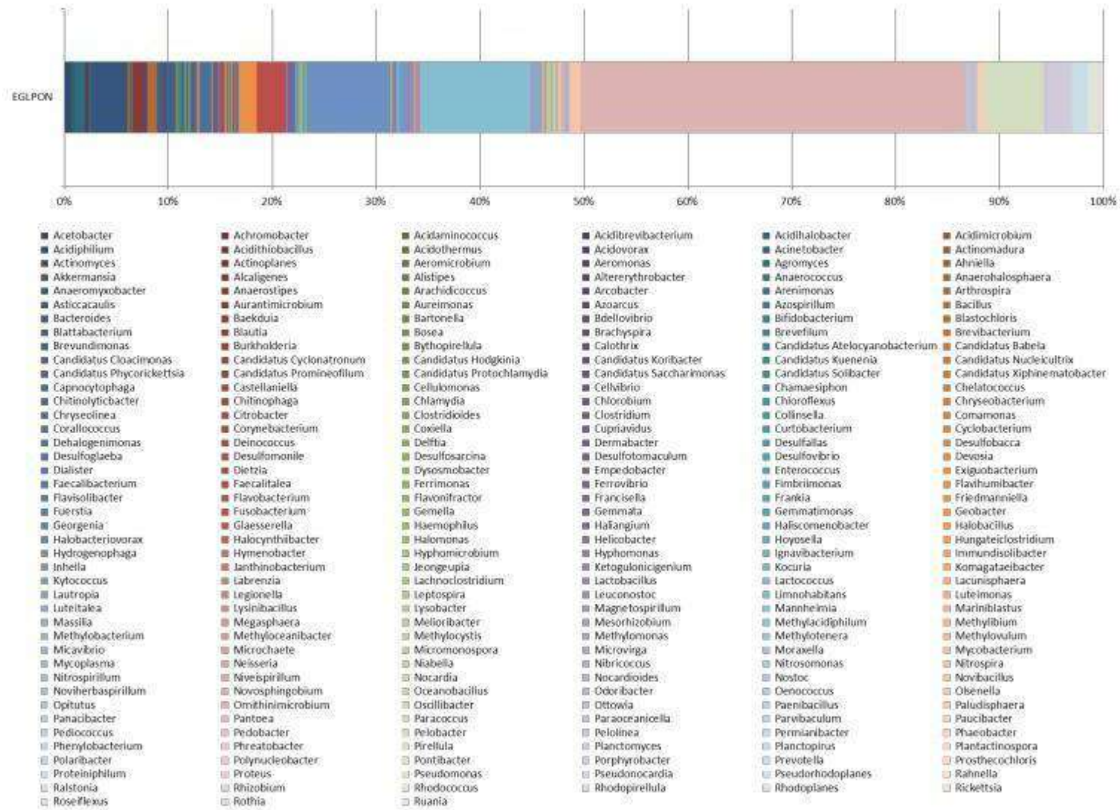


Bacterial Characteristics

1. *Novosphingobium* is a genus of Gram-negative bacteria that is capable of degrading aromatic compounds such as phenol, aniline, nitrobenzene andphenanthrene.

The species *N. aromativorans*, which was first found in Ulsan Bay, similarly degrades aromatic molecules of two to five rings.

2. *Limnohabitans* is a genus of proteobacteria that contains four species, which all represent planktonic bacteria dwelling in the water column of freshwater lakes, reservoirs, and streams.

Planktonic bacteria are involved in carbon cycle.

3. *Hydrogenophaga* is a genus of comamonad bacteria, several of which were formerly classified in the genus Pseudomonas.

4. *Paracoccus* is a genus of bacteria in the family rhodobacteraceae, known for its nitrate reducing properties, its ability to replicate under conditions of hypergravity and for being a relative of the eukaryotic mitochondrion (endosymbiotictheory).

5. *Akkermansia* is a genus in the phylum Verrucomicrobia. They are more closely related to

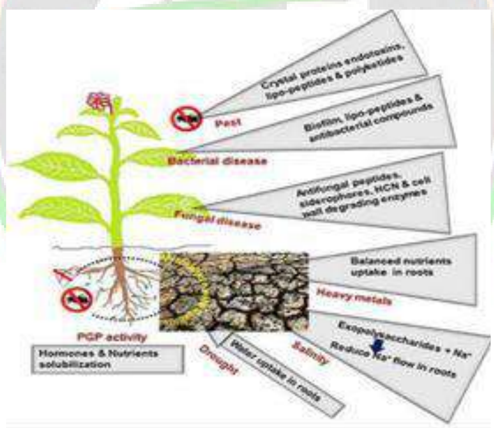
Planctomycetesfamily.

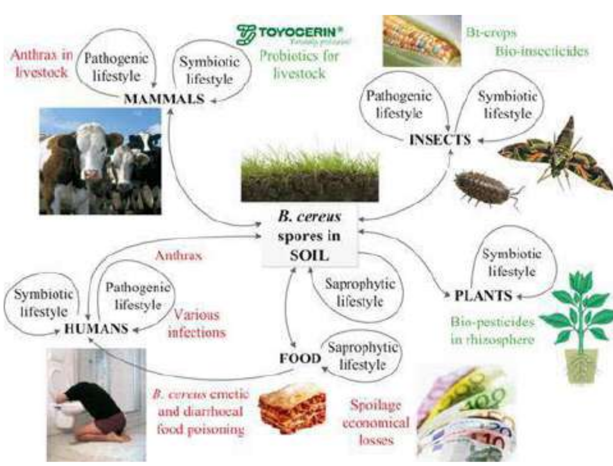
Planctomycetes phylum is a widely distributed bacteria, occurring in both aquatic and terrestrial habitats. They play a considerable role in global carbon and nitrogen cycles, with many species of this phylum capable of anaerobic ammonium oxidation, also known as anammox.

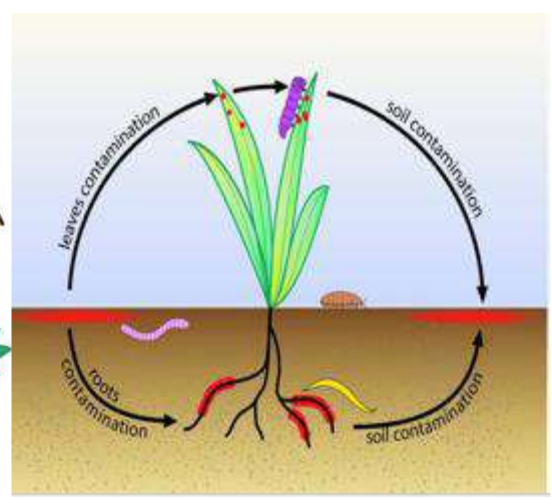
6. Flavobacterium is a genus of Gram-negative, nonmotile and motile, rod-shaped bacteria that consists of 130 recognized species. Flavobacteria are found in soil and fresh water in a variety of environments. Several species are known to cause disease in freshwaterfish.

7. Planctomycetes are a phylum of widely distributed bacteria, occurring in both aquatic and terrestrial habitats. They play a considerable role in global carbon and nitrogen cycles, with many species of this phylum capable of anaerobic ammonium oxidation, also known as anammox. Many planctomycetes occur in relatively high abundance as biofilms, often associating with other organisms such as macroalgae and marinesponges.

8. *Chitinophagaceae* is an aerobic or facultatively anaerobic and rod-shaped family of bacteria in the order ofChitinophagales.







Field setup

Experimental fish tank

Live fish in fish tank Based on its reviews, it is Plant growth promoting bacteria (PGPR) as well as harmful bacteria found in soil and food .*Bacillus* sps is spore forming that is resistant to aggressive physical and chemical methods. Name *cereus* means waxy in latin. It normally grows at room in rice soups and milk leading to spoilage. [3,4] *Bacillus cereus* being source of nitrogen fertiliser and bio pesticide (with its chitinase activity against pests and worms) proved by the growth of Actinomycetes on culture plates and plants in the tank. The fish tank shows luxuriant growth of plants such lotus, mint, *Alternantheria sessilis* and ornamental creeper as well as fish . Aquaculture is closed system for the continuous food production where in fish provided nitrogenous wastes to plants and in turn plants provide fresh oxygen by trapping solar energy which can also be supplied by LED lamps with solar battery for indoor plants.

Conclusion

The objective of the review paper is on *Bacillus cereus* as a probiotic in aquaculture. Bioactive compounds for bioremediation, efficacy in fish.

Scope

This case study has scope for food industry, Diary industry, Textile industry, Cosmetic industry, Leather industry, Probiotic in Fish & Prawn culture ,Agriculture for Bio-pesticide & Bio-fertilizer, Bioremediation of heavy metals and plastics.

Acknowledgments

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References

.Marine-bacteria Actinomycetes:A case study for their potential in bioremediation pratibhaKulkarni, HameedaBEE .biotech ResJ2015 Vol 1(3)171-174 elSSN 2395-6763

Genus Bacillus promising Probiotics in aquaculture, Aquatic animal origin, bio-active components, bioremediation and efficiency in fish https://www.tandfonline.com

Evaluation of Probiotic potential of Bacillus spp.isolated from the digestive track of freshwater fishesLabeocalbasu (Hamilton ,1822) Calgary MathiaganKavithaPachiappanPerumal

Identification of Bacillus species: implication on the quality of probiotic formulations

https:// journals.plos.org

Evaluation of Bacillus strains for Plant Growth Promotion and Predictability of Efficacy by in vitro Physiological Traits

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THE KING OF FRUITS: WHY MANGO REIGNS SUPREME

Article ID: AG-VO4-I08-107

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Introduction

Mango, often referred to as the "King of Fruits," is more than just a delicious tropical treat. This golden, juicy fruit holds a special place in the hearts of millions across the globe, not only for its unique flavor but also for its rich history, cultural significance, and economic importance.


A Fruit with a Storied Past

The mango's origins trace back thousands of years to the Indo-Burma region, where it was first domesticated and cherished by ancient civilizations. It quickly spread across Asia, carried by traders, travelers, and conquerors who recognized its value. From the lush groves of India to the far-flung corners of Southeast Asia, the mango became a symbol of prosperity and abundance.

Its journey didn't stop there. Over the centuries, the mango made its way to Africa, the Middle East, and eventually the Americas, where it found new homes in the fertile soils of Brazil, Mexico, and the Caribbean. Today, the mango is grown in over 140 countries, with its cultivation continuing to expand as more people discover the fruit's irresistible appeal.

A Nutritional Powerhouse

Beyond its delightful taste, the mango is a nutritional powerhouse packed with essential vitamins and minerals. Rich in vitamin A, which is crucial for vision and immune function, and vitamin C, known for its antioxidant properties, mangoes offer a healthful boost in every bite. They are also an excellent source of dietary fiber, which supports digestive health, and contain a variety of bioactive compounds that contribute to overall well-being.

Mango's Global Economic Impact

Mangoes are not just a treat for the taste buds—they are also a vital economic crop for many countries. In traditional mango-growing regions like India, Pakistan, and the Philippines, the fruit is an integral part of the agricultural landscape, providing livelihoods for millions of farmers and their families. These countries have even declared mangoes as their national fruit, a testament to the fruit's deep-rooted significance.

In the global market, mangoes have gained popularity as a high-value export commodity. Countries like Mexico, Peru, and Brazil have become major exporters, supplying the world with this prized fruit. The growing demand for mangoes in international markets has led to the development of new cultivation techniques and the introduction of superior varieties that cater to diverse consumer preferences.

The Changing Face of Mango Cultivation

As the mango continues to gain popularity, its cultivation is evolving. Traditional yellow and green varieties, cherished in Asian markets for their rich flavors, are now being joined by red-peel varieties that appeal to consumers in Western markets. This shift is opening up new opportunities for mango growers and expanding the fruit's reach to new regions.

In the United States, for example, the yellow-skinned "Ataulfo" mango has become increasingly popular, breaking the dominance of red-peel varieties like "Tommy Atkins." This trend may pave the way for the introduction of other premium mango varieties, such as India's beloved "Alphonso," known for its unmatched sweetness and aroma.

A Cultural Icon

Mangoes are more than just a fruit; they are a cultural icon. In India, the mango is deeply embedded in the nation's mythology, art, and traditions. The fruit is associated with prosperity, love, and immortality, and is often used in religious ceremonies and festivals. The mango tree itself is revered as a symbol of life and fertility.

The mango's influence extends beyond India, with many countries in Asia, Africa, and the Americas embracing the fruit as a symbol of their heritage. From postage stamps to literature, the mango's image is celebrated worldwide.

Why Yellow and Green Mangoes Deserve a Place on Your Plate

While red-peel mango varieties like "Tommy Atkins" dominate the Western market, there is a growing interest in the more traditional yellow and green varieties, particularly in Asian communities. These mangoes are often smaller, more aromatic, and possess a sweetness that is unparalleled by their red-skinned counterparts.

Yellow and green mangoes are also less fibrous, making them perfect for juicing, blending into smoothies, or simply enjoying fresh. Their thinner skin and delicate flesh require careful handling, but the reward is a fruit experience that is both luxurious and refreshing.

In fact, some of the world's most prized mango varieties, such as India's "Alphonso" and the Philippines' "Carabao," fall into this category. These mangoes are celebrated for their intense flavor, creamy texture, and vibrant color. They are often enjoyed at the peak of ripeness, when their rich aroma and sweetness are most pronounced.

Despite their growing popularity, these varieties are still underrepresented in many Western markets. However, as consumers become more adventurous and seek out new taste experiences, yellow and green mangoes are poised to make a significant impact.

Conclusion

Whether enjoyed fresh, blended into smoothies, or added to savory dishes, mangoes offer a unique combination of taste, nutrition, and cultural significance. As the world continues to embrace this extraordinary fruit, the mango's legacy as the "King of Fruits" remains as strong as ever. Its journey from ancient groves to modern markets is a testament to its enduring appeal and its ability to bring people together across cultures and continents. As awareness grows about the diverse varieties of mangoes, including the underappreciated yellow and green types, the future of this fruit looks even brighter. So next time you're at the market, reach for a yellow or green mango and discover a world of flavor that has been cherished for centuries.

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ROLE OF GROWTH RETARDANTS IN COTTON

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Introduction

Soil fertility and crop management are the two most important factors of modern agricultural activity. Managing the balance of vegetative and reproductive growth is the essence of managing a cotton crop. It is well known from numerous fertilizer experiments that the yield of agricultural crops has been strongly dependent on the supply of mineral nutrients, which have been used in crop cultivation to exploit the full genetic potential of the plant. Supplying optimal quantities of mineral nutrients to growing crop plants is one way to improve crop yields. In recent years, several approaches have been tried to break this yield plateau, and among them is application of plant growth regulators (PGRs). In maximizing the quantity and quality of a crop it is necessary to identify the constraints that may affect it and to devise methods of overcoming them through the use of inputs or changes in management practices.

Growth retardents

The term growth retarding or growth retardant is that the chemical slows cell division and cell elongation of shoot tissue and regulate plant height physiologically without formative. Eg. AMO 1618, phosphon-D. Cotton is a plant sensitive to chill and is adversely affected by the low temperature at the early stages of the growth. Because cotton is sensitive to chilling injury during germination, compounds that lead to improved seed germination and seedling vigor could contribute significantly to increased yield.

Chilling temperature during the initial hydration of cotton seed can be extremely damaging. Chilling for as little as four hours at the on set of hydration can kill all seeds are cause high incidence of aborted root tips, little injury occurs, however if seed are hydrated to 12-13% moisture.Prevailing temperatures limit cotton production particularly in cooler seasons, at different sowing dates and in different locations. Although soils and other environmental factors influence production of reliable yields, temperature is the dominant environmental factor affecting crop development and yield..

The correlated speed of cotton emergence and productivity; thus, rapid plant emergence and crop vigor are important factors in predicting crop yield. Not only it is important to generate adequate above ground growth, but establishment of a healthy root system for nutrient and water uptake is equally important.

Plant growth regulators have been successfully used to reduce height, resulting in more desirable height-to-node ratios, to reduce excessive leaf area, and to alter partitioning of assimilates. Cotton plants increase in height by 2 simultaneous mechanisms, the addition of new blocks to the top of the plant and elongation of these blocks. Nodes and in- ternodes are the physiological terms for the building blocks that add height to cotton plants. Most commonly used growth retardants are (1) onium compounds such as chlormequat chloride (Cycocel, CCC) and meliquat chloride, (2) pyrimidines such as ancymidol and flurprimidol, and (3) triazoles, including paclobutrazol, uniconazole, BAS III, triadimefon, and triapenthanol.

The effect of row spacing and mepiquat chloride treatment on earliness of eight cultivars was inconsistent. Earliness of Deltapine 20 was unaffected by row spacing without mepiquat chloride, maturity was earlier at the 30 inch row spacing versus the 40 inch row spacing. When treated with mepiquat chloride it was earlier maturing in 40 inch rows than in 30 inch rows.

Mepiquat chloride and mepiquat pentaborate both contain mepiquat, which is an anti-gibberellin growth retardant that reduces plant cell enlargement to help balance vegetative and reproductive growth. When applied to cotton, mepiquat can help control rank growth by reducing stem elongation at newly formed internodes. Mepiquat chloride is a growth regulator that controls plant growth and aids in the management of cotton height, resulting in a compact canopy, greater fruit retention, reduced boll rot, enhanced foliar spray coverage, and enhanced mechanical harvest.

Mepiquat specifically targets gibberellic acid synthesis and, thereby, inhibits cell expansion. The inhibition of cell elongation limits expansion of leaf and stem tissues, resulting in reduced leaf area and shorter stem lengths. Mepiquat is thus a tool to manage cotton canopy growth and size. Studies with mepiquat chloride and date of planting suggest mepiquat chloride mitigates the adverse effects caused by delayed planting. Mepiquat chloride by planting date interactions occurred for plant height, flower production, lint yield and seed index. For three planting dates (mid-April, early May and mid-May), mepiquat chloride reduce the lint yield by 4.5% in the early plantings, and increased yield by 5.4 and 12.7% in the optimum and late plantings, respectively.

Boll weight was increased by mepiquat chloride treatment at all plantings, but flower production was increased only in the late plantings; seed index was increased and lint percentage was reduced in all mepiquat chloride – treated plots from the three dates of planting.

Temperature stress can adversely affected the physiology and subsequent productivity of cotton. Chilling of cotton plants caused reduced growth at later favourable temperatures which was directly proportional to the duration of chilling at 10°C. Mepiquat chloride reportedly increases heat and cold tolerance of cotton.

The major use of mepiquat chloride application in cotton is only delayed cotton leaf abscission in the early stage of defoliation. MC application increased auxin and cytokinin concentration in cotton leaf. Applying MC accelerated cotton maturation and achieved a higher boll-opening percentage.

Cytokinin and PGRs

Several cytokinin and cytokinin like compounds (Burst, Cytozyme, Cytokin, Trigger) have been tested for PGR activity in cotton. Specific modes of action have not been elucidated, but these compounds theoretically promote fruit set and retention, and increase the ability of the plant to fill existing fruits (sinks). Cytokinins promote cell division and growth in plants. In cotton, cytokinins stimulate the growth of the main plant stem and branches.

Cytokinins are essential plant hormones. By stimulating cell division, they regulate shoot meristem size, leaf primordia number, and leaf and shoot growth. They can stimulate both the differentiation and the outgrowth of axillary buds. The cytokinins can mediate axillary bud release from apical dominance.

Boron deficiency in cotton: symptoms

Because boron is vital to flower formation and seed production during the boll development stage, a decrease in boron supply during this critical stage can result in decreased yields. New flowers are distorted and there may be excessive shedding of squares.

Plant growth regulators may be effective in reducing pest population by altering the morphological and biochemical characteristics of cotton. As discussed earlier, PGRs have been used both early and late in the season for chemical termination of cotton to remove vegetative and reproductive parts thus denying the insect food and shelter. The application of PGRs may also alter the biosynthesis of compounds such as secondary plant constituents that are detrimental to pests. Mepiquat chloride applied at rates used for control of excessive vegetative growth increased resistance to bollworm damage in cotton. The increased resistance was attributed, in part, to increased tanin and terpinoid production from the mepiquat chloride treatment. Mepiquat chloride does not enhance cotton's resistance to second stage tobacco budworm, but may actually increase larval growth and decreases natural resistance in an ideal growing season. Growth rates of second and third stage tobacco budworm larvae increased slightly when grown on leaves treated with mepiquat chloride at either the recommended or twice the recommended rate.

Conclusion

In conclusion, plant growth regulators are a group of chemicals for controlling and enhancing the natural plant growth processes to better meet the requirements of food supply in general.

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REVOLUTIONIZING AGRICULTURE WITH LIDAR: PRECISION AND EFFICIENCY IN MODERN FARMING

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Abstract

The agricultural sector is undergoing a profound transformation, guided by the adoption of advanced technologies that enhance precision and efficiency. Among these innovations, LiDAR (Light Detection and Ranging) stands out as a powerful tool that offers unprecedented capabilities in mapping, monitoring, and managing agricultural landscapes. This chapter explores the application of LiDAR technology in modern farming, highlighting its role in precision agriculture, crop monitoring, soil analysis, irrigation management, and biomass estimation. By providing high-resolution, three-dimensional data, LiDAR enables farmers to make informed decisions, optimize resource use, and improve crop yields. Despite the significant advantages, the chapter also addresses the limitations and challenges associated with the adoption of LiDAR in agriculture, including cost, data complexity, and accessibility. The future prospects of LiDAR technology are discussed, emphasizing its potential to revolutionize agricultural practices and contribute to global food security and sustainability. Through continued research and integration with other technologies, LiDAR is poised to become a cornerstone of modern farming.

Keywords: LiDAR, Precision agriculture, Crop monitoring, Soil analysis, Irrigation management, Biomass estimation, Remote sensing, 3D mapping, Agricultural technology, Sustainable farming.

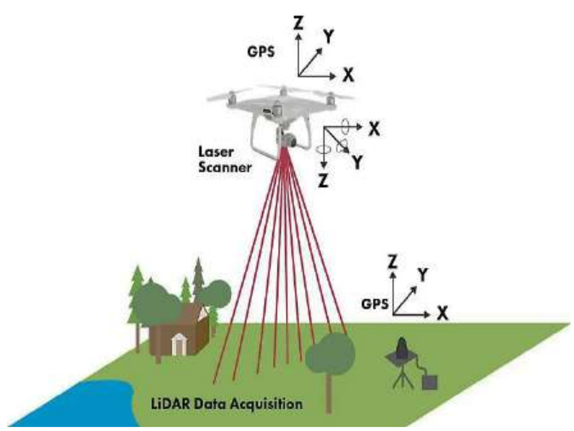
Introduction

The agricultural sector has witnessed a significant transformation in recent years, driven by the rapid adoption of advanced technologies. From automated machinery to sophisticated data analytics, technology is reshaping how we cultivate, manage, and harvest crops. Among these innovations, LiDAR (Light Detection and Ranging) has emerged as a powerful tool, offering new dimensions of precision and efficiency in farming practices. LiDAR is a remote sensing technology that uses laser light to measure distances and create highly accurate 3D models of the environment. By emitting laser pulses and measuring the time it takes for the light to return after hitting an object, LiDAR systems can map out landscapes with incredible detail. Originally developed for applications in aerospace and autonomous vehicles, LiDAR is now being increasingly utilized in agriculture to monitor crops, analyse soil, and optimize farming operations. In modern precision agriculture, where every inch of land can be analysed and managed for maximum productivity, LiDAR plays a crucial role. It allows farmers to gain insights into crop health, soil composition, and topographical variations that were previously impossible to measure with such accuracy. As a result, LiDAR is helping to usher in a new era of farming where resources are used more efficiently, yields are maximized, and environmental impact is minimized.

What is LiDAR?

LiDAR (Light Detection and Ranging) is a technology that uses laser light to measure distances and create detailed 3D maps of the environment. It works by emitting laser pulses from a sensor and measuring the time it takes for the pulses to bounce back after hitting an object. This time measurement allows the system to calculate the distance to the object and generate precise models of the area being scanned.

How LiDAR Works:



A typical LiDAR system includes:

1. **Laser**: Emits rapid pulses of light to measure distances.
2. **Scanner**: Directs the laser across the target area to capture data over a wide surface.
3. **GPS Receiver**: Provides accurate location data, ensuring precise geographic reference for the measurements.

Brief History and Evolution of LiDAR:

LiDAR technology originated in the 1960s, initially used in military and aerospace applications. Over the decades, it evolved into a valuable tool for topographic mapping, environmental monitoring, and urban planning. In recent years, its use has expanded into fields like autonomous vehicles and agriculture. In farming, LiDAR's high-resolution data on crop structure and soil has made it essential for precision agriculture, enhancing productivity and sustainability.

Applications of LiDAR in Agriculture

Crop Monitoring and Management:

LiDAR technology has been increasingly utilized in precision agriculture for crop monitoring and management, offering detailed spatial information and structural data about crops. This technology enables the measurement of various crop-related metrics, such as biomass estimation and growth patterns, which are essential for effective agricultural management (Debnath et al., 2023). Additionally, LiDAR systems facilitate high-throughput phenotyping, which is crucial for informed decision-making regarding fertilization, irrigation, and pest management (Sharma & Shivandu, 2024).

However, despite the potential benefits, the full adoption of LiDAR in agriculture faces challenges, including the need for specialized knowledge to interpret the data and the economic feasibility for farmers (Kumawat et al., 2023). Moreover, while LiDAR can provide valuable data for crop management, integrating this technology with other remote sensing tools and spectral vegetation indices could enhance its utility in precision agriculture (Kumawat et al., 2023).

Topography and Soil Analysis:

LiDAR technology, through its ability to generate accurate 3D representations of the Earth's surface, can be instrumental in analyzing soil properties, identifying soil erosion, and aiding in soil conservation efforts. By creating high-resolution Digital Elevation Models (DEMs) and Digital Surface Models (DSMs), LiDAR provides detailed information on terrain and surface characteristics, which are essential for understanding soil composition, structure, and potential erosion patterns (Awange & Kiema, 2018).

Interestingly, while LiDAR is primarily known for its surface mapping capabilities, its potential in soil analysis extends to the detection of changes in topography that indicate soil erosion. For instance, by comparing temporally separated LiDAR datasets, one can detect subtle changes in the landscape, such as those caused by erosion processes. Furthermore, LiDAR's ability to penetrate vegetation canopies with certain wavelengths allows for the assessment of soil surface characteristics even in forested areas, which is crucial for comprehensive soil conservation planning (Reutebuch et al., 2005).

Precision Farming:

LiDAR technology has become a pivotal tool in precision farming, offering detailed structural and topographical data that can be used to enhance agricultural practices. Precision agriculture leverages such data to optimize crop growth, manage resources efficiently, and increase overall production (Pandey et al., 2021). LiDAR's ability to generate accurate 3D representations of the environment is particularly useful for crop-related metric estimation, tree and plant digitization, and planning and decision support systems (Rivera et al., 2023).

The continued development of standards and the combination of LiDAR with complementary technologies will likely drive further advancements in precision agriculture. The methodologies and results across these studies show some discrepancies. For instance, (Tian et al., 2019) introduces a novel canopy height layering biomass estimation model (CHL-BEM) using full-waveform spaceborne LiDAR, which achieved higher accuracy compared to other models.

Plant Height and Biomass Estimation:

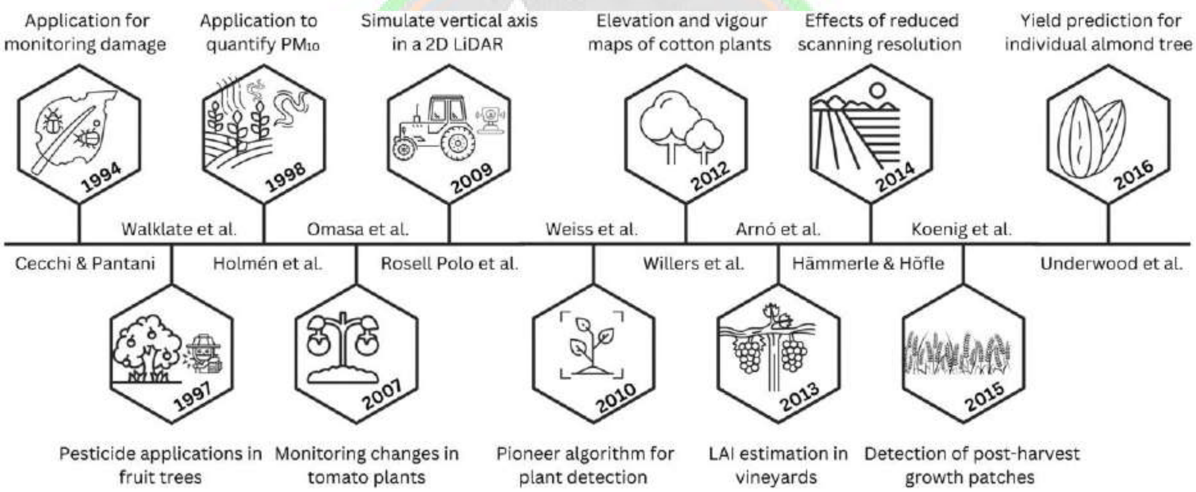
LiDAR technology has been extensively applied for plant height and biomass estimation, the use of LiDAR in various ecosystems, including forests and agricultural fields, to estimate aboveground biomass (AGB) and plant height with varying degrees of accuracy. In contrast, (Edson & Wing, 2011) reports underestimation and overestimation of forest total aboveground biomass (TAGB) using different LiDAR-based software programs.

(Rizal et al., 2021) highlights the successful application of LiDAR in peat swamp forests for biomass estimation using a quadratic regression model. The use of terrestrial laser scanning (TLS) for non-destructive estimation of plant height as a proxy for biomass in agricultural settings, demonstrating high correlations between TLS-derived plant height and actual biomass.

Irrigation Management:

LiDAR technology has diverse applications, one of which includes irrigation management. LiDAR's ability to generate accurate topographic maps and Digital Elevation Models (DEMs) can be instrumental in designing efficient irrigation systems by providing detailed information on field topography and slope, which are critical for water distribution and drainage planning (Awange & Kiema, 2018).

The precision and accuracy of LiDAR data in capturing the 3D structure of environments suggest that it could be used to optimize the layout of irrigation systems, assess crop health through canopy measurements, and monitor water distribution across agricultural fields. The technology's ability to create detailed 3D representations of the environment indicates that it could play a significant role in the planning and monitoring of irrigation systems. By leveraging LiDAR's high-resolution topographic data, stakeholders in agriculture could design irrigation schemes that maximize water efficiency and contribute to sustainable water resource management (Awange & Kiema, 2018). Further research and development in this specific application of LiDAR could yield innovative solutions for irrigation challenges.



Advancement of LiDAR technology in agriculture

Advantages and Limitations of LiDAR in Agriculture

Advantages:

1. **High Precision and Accuracy:** LiDAR provides highly accurate, three-dimensional data that is essential for precision agriculture. It precisely maps topography, crop heights, and vegetation density, enabling more informed decision-making.
2. **Efficient Land Management**: LiDAR allows for the creation of detailed elevation models, which aid in effective land management. This is useful for irrigation planning, drainage design, and identifying areas prone to erosion.

3. **Real-Time Data Collection:** LiDAR systems mounted on drones or aircraft can collect real-time data over large areas. This rapid data acquisition is beneficial for monitoring crop health, growth patterns, and identifying areas requiring immediate attention.
4. **Enhanced Crop Yield Prediction:** By analyzing the structure and density of crops, LiDAR helps in predicting crop yields more accurately. This allows farmers to plan their harvests and manage resources more efficiently.
5. **Improved Soil Analysis:** LiDAR can assess soil properties such as texture, moisture levels, and compaction. This information is critical for determining the suitability of land for specific crops and optimizing soil management practices.
6. **Environmental Monitoring:** LiDAR helps monitor environmental factors such as deforestation, water bodies, and soil erosion. This contributes to sustainable agricultural practices and environmental conservation.

Limitations:

1. **Costly Equipment:** LiDAR systems require a significant initial investment, which can be a barrier for smaller farms and operations with limited budgets.
2. **Complex Data Analysis:** The data collected by LiDAR is extensive and detailed, necessitating advanced software and expertise for proper analysis. This complexity may pose challenges for farmers without access to such resources.
3. **Weather Sensitivity:** LiDAR's performance can be compromised by adverse weather conditions, such as heavy rain, fog, or dust, which can interfere with the accuracy and reliability of the data collected.

Future Prospects of LiDAR in Agriculture

Emerging Trends and Future Possibilities:

LiDAR technology has demonstrated significant potential for advancing agricultural practices through its ability to provide detailed and accurate measurements of various parameters. The future prospects of LiDAR in agriculture are promising, given its non-destructive data capture method and the breadth of applications it supports, such as landscape and topography measurement, crop biomass estimation, and yield prediction (Debnath et al., 2023). The integration of LiDAR with other technologies could further enhance its utility in precision agriculture, potentially leading to more efficient resource use and improved crop management.

LiDAR has been a part of technological advancements since the 1960s, its applications in agriculture are still evolving, with ongoing research likely to uncover new uses and methods for data analysis (D et al., 2023; Lopac et al., 2022). The versatility of LiDAR, as evidenced by its use in various fields, suggests that agricultural applications could benefit from cross-disciplinary research and the adaptation of techniques from other sectors (Bogue, 2022; Contarino et al., 1995).

LiDAR technology is poised to become an increasingly valuable tool in the agricultural sector. Its ability to accurately measure and monitor agricultural environments supports a range of applications that can contribute to the sustainability and productivity of farming practices. Continued research and development are expected to expand its capabilities and applications, further solidifying its role in modern agriculture.

Integration with Other Technologies:

The future of LiDAR in agriculture lies in its seamless integration with other advanced technologies such as drones, artificial intelligence (AI), and the Internet of Things (IoT). When combined with drones, LiDAR can be used for rapid, large-scale data collection, offering farmers a flexible and efficient way to monitor crops and assess land conditions from above.

AI can further enhance the value of LiDAR by analyzing the collected data in real-time, identifying patterns, predicting outcomes, and automating decision-making processes. For example, AI algorithms can detect early signs of crop stress or disease from LiDAR data, allowing for prompt intervention. Additionally, IoT devices can leverage LiDAR data to optimize farming operations, such as adjusting irrigation systems based on precise topographical and soil moisture information. This integration not only maximizes resource efficiency but also supports the development of smart farming systems that can operate autonomously, improving productivity and sustainability across the agricultural landscape.

Conclusion

The integration of LiDAR technology in agriculture marks a pivotal step towards the future of precision farming. As farming practices evolve to meet the demands of a growing global population, the need for accurate, real-time data has never been more crucial. LiDAR, with its ability to generate high-resolution, three-dimensional maps and analyze various environmental parameters, offers a transformative tool for modern agriculture. Through applications in crop monitoring, soil analysis, irrigation management, and biomass estimation, LiDAR provides insights that were previously unattainable, enabling farmers to make informed decisions that enhance productivity and sustainability.

The technology's potential to automate farming processes further reduces labor costs and increases efficiency, making it an indispensable asset in the agricultural sector. However, while the benefits of LiDAR are significant, the challenges associated with its adoption, such as cost, data complexity, and accessibility, cannot be overlooked. The successful integration of LiDAR in agriculture will depend on overcoming these barriers through ongoing research, technological advancements, and the development of cost-effective solutions.

As we look to the future, the role of LiDAR in agriculture will likely expand, driven by innovations that enhance its precision, affordability, and integration with other technologies. By embracing LiDAR, the agricultural sector can achieve greater efficiency, sustainability, and resilience, ultimately contributing to global food security and environmental stewardship. The journey towards widespread adoption of LiDAR in agriculture is just beginning, but its potential to revolutionize the way we farm is undeniable.

Call to Action: Farmers, researchers, and technology developers should actively pursue the adoption and further research of LiDAR technology. By investing in LiDAR systems and collaborating on innovative applications, we can drive the future of agriculture towards more precise, efficient, and sustainable practices.

References

Awange, J., & Kiema, J. (2018). Light Detection And Ranging (LiDAR) (pp. 291–306). springer nature.

Bogue, R. (2022). The growing importance of lidar technology. In Industrial Robot: An International Journal (Vol. 49, Issue 6, pp. 1025–1031). emerald.

Contarino, V. M., Mullen, L., & Herczfeld, P. R. (1995). Ocean LIDAR technology and applications (Vol. 2).

D, P. K., R, T., S, J., & M, S. (2023). LIDAR REMOTE SENSING – ITS APPLICATIONS IN AGRICULTURE AND FORESTRY (pp. 192–200). Iterative International Publishers Selfypage Developers Pvt Ltd.

Debnath S, Paul M, Debnath T. Applications of LiDAR in Agriculture and Future Research Directions. Journal of Imaging. 2023; 9(3):57.

Edson, C., & Wing, M. G. (2011). Airborne Light Detection and Ranging (LiDAR) for Individual Tree Stem Location, Height, and Biomass Measurements. Remote Sensing, 3(11), 2494–2528.

Gilberto Rivera, Raúl Porras, Rogelio Florencia, and J. Patricia Sánchez-Solís. 2023. LiDAR applications in precision agriculture for cultivating crops: A review of recent advances. Computer. Electron. Agric. 207, C (Apr 2023).

Kim, I., Martins, R. J., Rho, J., Kim, H., Jang, J., Jung, H.-Y., Genevet, P., Badloe, T., Kim, J., & Khadir, S. (2021). Nanophotonics for light detection and ranging technology. Nature Nanotechnology, 16(5), 508–524.

Kumawat, R. K., Ramakrishnan, R. S., Debnath, S., Bhayal, L., Tiwari, G., Thakur, S., & Bhayal, D. (2023). Remote Sensing Related Tools and their Spectral Indices Applications for Crop Management in Precision Agriculture. International Journal of Environment and Climate Change, 171–188.

Reutebuch, S. E., Andersen, H.-E., & Mcgaughey, R. J. (2005). Light Detection and Ranging (LIDAR): An Emerging Tool for Multiple Resource Inventory. Journal of Forestry, 103(6), 286–292.

Rizal, M., Prasetyo, L. B., & Saleh, M. B. (2021). Biomass estimation model for peat swamp forest ecosystem using light detection and ranging. TELKOMNIKA (Telecommunication, Computing, Electronics and Control), 19(3), 770.

Sharma, K., & Shivandu, S. K. (2024). Integrating artificial intelligence and Internet of Things (IoT) for enhanced crop monitoring and management in precision agriculture. Sensors International, 5, 100292.

Takhtkeshha, N., Takhtkeshha, N., Mandlburger, G., Remondino, F., & Hyyppä, J. (2024). Multispectral Light Detection and Ranging Technology and Applications: A Review. Sensors (Basel, Switzerland), 24(5), 1669.

Tian, J., Wang, L., Zhong, R., Gong, H., Liu, X., Li, X., Shi, C., Yin, D., Nie, S., & Xu, R. (2019). Canopy Height Layering Biomass Estimation Model (CHL-BEM) with Full-Waveform LiDAR. Remote Sensing, 11(12), 1446.

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ROLE OF *THIOBACILLUS* IN HEAVY METAL REMOVAL

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Abstract

The involvement *Thiobacillus* species in the removal of heavy metals has been extensively studied, primarily due to their significant role in bioleaching. This review examines the mechanisms of Thiobacillus spp to remediate environments contaminated with heavy metals. By digesting sulphide minerals, these bacteria can neutralize metal ions, making bioleaching a very effective method for extracting metals such as copper, zinc and nickel from ores and deposits. This review also examines the biochemical and environmental approaches that enhance the biological efficiency of *Thiobacillus* species and demonstrates their flexibility and robustness In different ecological environments. In addition, this review highlights the environmental and economic benefits of bioleaching in comparison to traditional physical methods for heavy metal removal. Incorporating *Thiobacillus*-mediated bioremediation into sustainable waste management practices is an effective strategy to reduce heavy metal pollution and recover valuable metals from waste.

Introduction

Heavy metals are usually defined as metals having density more than 5 g/cm^3 . They are classified as essential and non-essential metals. The metals which are need for normal cellular growth are essential metals e.g. zinc, nickel, copper, etc. Such metals are required in low concentrations (nM), but at higher concentrations (µM to mM) all heavy metals have detrimental effects to organisms. The presence of heavy metals in soil and water from residential, agricultural and industrial activities poses significant health and environmental risks. To solve this problem, it is essential to remove these hazardous metals from the affected environment. Heavy metals are particularly difficult to remove because they cannot be chemically or biologically degraded like other contaminants. These metals have been extracted using a variety of physicochemical methods, although they frequently have shortcomings including poor efficiency and excessive cost. Biosorption is a process that involves the passive uptake and binding of metals to biomass (e.g., dead cells, cell walls) without altering the metal's chemical state. *Thiobacillus* does not primarily use this method for metal removal. *Thiobacillus* primarily follows the **bioleaching** principle rather than biosorption. Biotechnological methods for removing heavy metals, like phytoremediation and bioremediation, have gained popularity recently and are demonstrating potential in both industry and research. *Thiobacillus* and other sulfur-oxidizing bacteria are essential in the transformation of poisonous metal ions into less dangerous forms; this process has long been employed as a natural method of environmental rehabilitation. Of all these biotechnological approaches, bioleaching has proven to be one of the most successful in eliminating heavy metals.

Bioleaching

Bioleaching is a process to easily extract metals by dissolving (leaching) sulfide minerals and directly releasing bacteria to enhance the production of less toxic metals. Microorganisms widely used in bioleaching process belong to the genus Thiobacillus. Bioleaching process using acidophilic sulfur-oxidizing bacteria (*Acidithiobacillus ferrooxydans, Acidithiobacillus thiosidans*) and neutrophilic microorganism (*Aspergillus niger*) has been intensively studied for successful metal removal from sediments, municipal waste, and sludge. Sulfur-oxidizing bacteria oxidize and produce acids to solubilize heavy metals by obtaining energy from the utilization of elemental sulfur and thiosulfate in bioleaching process. A method to remove toxic metals contaminated soil and water using the biological cycle of sulfur. Biooxidation reactions based on the principle of direct or indirect oxidation often run in parallel with the bioleaching process. This solubilization process during bioleaching therefore requires favorable conditions for the growth of widespread sulfur-oxidizing bacteria.

Microorganism

Thiobacillus: The most important effective bacteria in the bioleaching process are from the *Thiobacillus* group. These are colorless, rod-shaped, fully aerobic bacteria. They are chemoautotrophic bacteria, meaning that they use inorganic chemicals such as sulfur as an energy source. These bacteria oxidize reduced sulfur compounds such as sulfide, elemental sulfur, and thiosulfate to sulfate. *Thiobacillus ferrooxidants* are responsible for the bacterial leaching process. This process occurs in an acidic environment where the pH is kept between 1.5 and 3 and other metal compounds remain in solution. Various *Thiobacillus* bacteria are able to oxidize sulfur and sulfides to sulfates at higher pH. Under these conditions, other metal ions do not remain in solution.

At lower pH, acidophilic *Thiobacillus ferrooxidants* and T.*thiooxidants* can grow. The price range for bioleaching technology using *Thiobacillus ferrooxidants* is very high and it more gently oxidizes sulfur compounds to sulfates compared to T.*thiooxidants*. *Thiobacillus cuprinus* is an acidophilic and chemolithoautotrophic bacterium. This bacterium can oxidize metal sulfides but not ferrous ions. This was isolated from a copper mine and selectively mobilizes copper from chalcopyrite under aerobic conditions.

Bioleaching Mechanisms:

Direct Bioleaching: In direct bioleaching, bacteria directly oxidize minerals and solubilize metals. $MS + H_2SO_4 + 1/2\ O_2 = MSO_4 + S + H_2O$ $S + 1\ ½\ O_2 + H_2O = H_2SO_4$

Physical contacts are present between bacterial cells and mineral sulphide surfaces in direct bioleaching mechanism. Oxidation of sulfate undergoes several chemical processes.

In this mechanism, Iron sulfate is the final oxidation product generated through some reaction steps. $4FeS_2 + 14O_2 + 4\ H_2O \rightarrow 4\ FeSO_4 + 4\ H_2SO_4$

In direct bioleaching process, minerals undergo direct enzymatic attack by the microorganisms. Disadvantage of direct bioleaching is sulfur is completely converted to sulfuric acid in the bioleach, resulting in increased oxygen and neutralizing agent consumptions.

Indirect Bioleaching

The bacteria oxidizes ferrous ion to produce ferric ion during indirect bioleaching. The final oxidizing agent is ferric iron. In actual bioleaching systems, both direct and indirect mechanisms may take place concurrently with other physicochemical reactions. There are many dissolved sulfide minerals. Because it can only occur in the absence of oxygen and living bacteria, ferric sulfate is the primary source of indirect bioleaching. Through an indirect bioleaching process, hazardous mineral compounds are converted to less toxic sulfide minerals.

$$CuFeS_2 + 2Fe_2(SO_4)_3 \rightarrow CuSO_4 + 5FeSO_4 + 2S^0$$

Zinc, silver, and copper are indirectly leached through bio-regeneration of ferric sulphate solutions. After leaching, ferric sulphate and zinc are dissolved using electrowinning. Sulphur-oxidizing bacteria continue to treat leaching residue. In indirect bioleaching, lead sulphide is converted to lead sulphate. The reaction is given in the following:

$$PbS + Fe_2(SO_4)_3 = PbSO_4 + 2FeSO_4 + S^0$$

Silver has a similar route. Silver transforms into Silver Jarosite (AgFe3 (SO4)2(OH)6). Silver Jarosite synthesis requires high temperature, low acidity, and a high concentration of ferric ions. The reaction is given in the following:

$$AgS\ (Ag_2SO_4) + Fe_2\ (SO_4)_3 = AgSO_4 + 2FeSO_4 + S^0$$

Bioleaching of Heavy Metals:

Acidithiobacillus ferrooxidant and *Acidithiobacillus thiooxidant* can oxidize sulfides to sulfates by releasing metals, which become soluble chemicals. Scientists have already studied the use of *Acidithiobacillus ferrooxidant* in monocultures and mixed cultures of mesophilic bacteria. The use of intercrops is more efficient for the oxidation of the main sulfide minerals arsenopyrite, pyrite and pyrrhotite. Elemental sulfur is released by the oxidation of sulfide concentrates. The bacterial oxidation of pyrrhotite-pyrite-arsenite concentrate produces the largest amount of elemental sulfur. The biooxidation process of elemental sulfur does not terminate with complete oxidation of pyrrhotite, arsenopyrite, and some pyrite. Elemental sulfur has a adverse effect on the gold mining process. The first commercially available was produced for gold mining at the Olympiada gold deposit in Russia in 1944. Microorganisms are suitable for bioleaching or biooxidation on a commercial scale for several minerals, but currently only two metals have been successfully recovered using this technology: gold and copper.

FeS2 and FeS are frequently utilized to explore whether metal sulfides are oxidized beneath anaerobic conditions at unbiased pH. In chemical tests, MnO2 oxidizes FeS2 and FeS. With MnO2 as the oxidizing specialist, essential sulfur and sulfate are the as it were components within the oxidation of FeS, whereas FeS2 is oxidized to different sulfur compounds, primarily sulfate, as well as intermediates such as thiosulfate, trithionate, tetrathionate, and pentathionate. MnO2 oxidizes thiosulfate to tetrathionate, whereas other intermediates are oxidized to sulfate. The response items show that the thiosulfate instrument is the most source of oxidation of FeS2 and the polysulfide instrument is the source of oxidation of FeS beneath anaerobic conditions, which was already found for oxygen consuming metal sulfide oxidation.

Apart from all these, bioleaching is influenced by a number of parameters. There are various physicochemical and biological factors. The factors are

i. Nutrients,

ii.Supply of oxygen and carbon dioxide

iii.The temperature of the leaching element,

iv.pH value- Some studies have shown that the adaptation of the acidophilic A. *ferrooxidans* to the heavy metals and their subsequent recovery is maximum at a pH range of 1.4-1.5.

v.pre-incubation period,

vi.liquid to solid ratio,

vii.physico-chemical state of the solid residue,

viii.microbial binding towards metal ions and

ix.duration of bioleaching.

Once these parameters are optimized, up to bioleaching techniques can be achieved. The success rate of microbial bioleaching depends on these physicochemical and biological parameters.

Advantages of *Thiobacillus* over other organisms

While other microorganisms, such as fungi or algae, are also used in heavy metal removal (e.g., biosorption), *Thiobacillus* has distinct advantages due to its metabolic processes and ability to operate in acidic conditions. Other microbes might excel in different aspects, such as biosorption efficiency or ability to handle different environmental conditions, but *Thiobacillus*' specific capabilities make it particularly suited for certain types of heavy metal remediation tasks.

Efficient Metal Solubilization Capability

Thiobacillus species are well-known for their ability to oxidize sulfur compounds and metal sulfides, converting them into more soluble forms. This leads to efficient solubilization of metals like iron, copper, and zinc, which can be particularly challenging to remove with other microbes. For instance, *Thiobacillus ferrooxidans* oxidizes ferrous iron to ferric iron, which can further oxidize metal sulfides, enhancing metal leaching.

Adaptability to Acidic Environments

Thiobacillus species, especially *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans*, thrive in highly acidic environments (low pH conditions). This is advantageous because many metal-contaminated sites, particularly in mining operations, are acidic due to the presence of sulfuric acid produced by the bacteria. Their ability to function and remain active in acidic conditions makes them highly effective in environments where other microbes might struggle.

Low-Grade Ore Processing:

Thiobacillus species are particularly useful for processing low-grade ores, where traditional methods might be inefficient or economically unviable. The ability of these microbes to extract metals from ores with low metal content is a significant advantage in the mining industry.

Reduced Processing Costs:

Bioleaching with *Thiobacillus* can be more cost-effective compared to conventional chemical leaching methods. It often requires less energy and fewer chemical reagents, leading to reduced operational costs. The natural metabolic processes of *Thiobacillus* reduce the need for expensive and environmentally harmful chemicals.

Sustainable and Eco-Friendly:

Using *Thiobacillus* for heavy metal removal aligns with sustainable and eco-friendly practices. The process minimizes the environmental footprint compared to traditional methods that may involve hazardous chemicals. The reduction in chemical use and the ability to treat large volumes of contaminated material with minimal environmental impact is a notable benefit.

Versatility and Scalability

Thiobacillus species can be effective in removing various heavy metals, including copper, gold, zinc, and others. This versatility makes them suitable for different types of contaminated environments. The process can be scaled up from laboratory to industrial applications, making *Thiobacillus*-based bioleaching adaptable to various operational sizes.

Natural Bioacidification:

The oxidation of sulfur compounds by *Thiobacillus* generates sulfuric acid, which further enhances metal solubilization. This creates a self-sustaining process where the microbial activity contributes to maintaining the acidic environment needed for efficient metal extraction.

Proven Track Record

Thiobacillus has a long history of use in the mining industry for bioleaching, demonstrating its effectiveness and reliability. The well-established protocols for using these microbes provide confidence in their application for heavy metal removal.

Conclusion

Bioleaching is a new method to extract harmful heavy metals from soil and water. Bioleaching is now recognized as a cost-effective process as well as a valuable method to recover soil contaminated with metals, a process that is highly beneficial for the environment. Additional research needs to be conducted to develop these technologies. Destruction of industrial wastes causes environmental pollution. Waste can be recycled through heterotrophic leaching. This produces a large number of less toxic compounds that are not harmful to the environment. The rate of bioleaching using microorganisms increases over time. Many microorganisms are resistant to toxic heavy metals. Genetic improvement of microorganisms like mutation, selection like genetic engineering methods may be beneficial as opposed to traditional methods like screening and adaptation.

References

Celaya, R. J., Noriega, J. A., Yeomans, J. H., Ortega, L. J., & Ruiz-Manriquez, A. (2000). Biosorption of Zn (II) by Thiobacillus ferrooxidans. *Bioprocess Engineering*, *22*, 539-542.

Dutrizak J.E, Raymond J.C. and MacDonald Lamarshe R.E., Solubility of Silver Sulfate in Acidified Ferric Sulfate Solutions, Extraction Metallurgy Division, Mines Branch, Department of Energy and Resources, Ottava, Ont., Canada K1A OG1., (2011)

H Tributsch., Direct vs. indirect bioleaching, Hydrometallurgy, 59, 177–185 (2001)

Kamizela, T., Grobelak, A., & Worwag, M. (2021). Use of Acidithiobacillus thiooxidans and Acidithiobacillus ferrooxidans in the Recovery of Heavy Metals from Landfill Leachates. *Energies*, *14*(11), 3336.

Mohapatra S, Bohidar S, Pradhan N, Kar RN, Sukla LB (2006). Microbial extraction of nickel from Sukinda chromite overburden by Acidithiobacillus ferrooxidans and Aspergillus strains. J Hydrometal. 85: 1-8.

Natarajan Preston and Devasia KA, Bacterial Leaching Biotechnology in the Mining Industry, Resonance, 27-34 (2004)

Roy, S., & Roy, M. (2015). Bioleaching of heavy metals by sulfur oxidizing bacteria: a review. *Int Res J Environ Sci*, *4*(9), 75-79.

Rulkens W.H., Grotenhuis J.T.C. and Tichy, R., Methods of cleaning contaminated soils and sediments. In: Salomons W., F€orstner, U., Mader, P. (Eds.), Heavy Metals, Springer Verlag, Berlin, 151–191

Shamim, S. (2018). Biosorption of Heavy Metals. InTech. doi: 10.5772/intechopen.72099.

Waksman S.S.A. and Joffe I., Micro-organism concernced with the oxidation of sulphur in soil. II. Thiobacillus thiooxidants, a new sulphur oxidizing organism isolated from soil, J. Bacteriol, 239-256 (1922)

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SEEDS OF TOMORROW - RECONSTITUTED RICE SEED LONGEVITY WITH CUTTING-EDGE TECHNOLOGY

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Introduction

Seeds are the cornerstone of agriculture, carrying the promise of new life and vital genetic information into future generations. As the global population surges toward 9.8 billion by 2050 (UN, 2017), the role of seeds - especially rice seeds, which feed more than half the world's population - becomes increasingly critical. Quality seed, which encompasses genetic potential, physical purity, germination, vigour and other key traits, is essential for ensuring high crop yields and efficient resource use. But to maintain their viability and productivity, seeds must be grown, processed, and stored with precision.

The Challenge of Seed Longevity

Rice, a staple food for billions, is predominantly grown in India, which contributes 20% of global production. To meet the escalating demand, India must produce 130 million tons of rice by 2030 (Gujja and Thiyagarajan, 2009). However, increasing productivity amidst declining resources requires a focus on seed quality and longevity. Seed longevity - the capacity of seeds to remain cable of germinating into a seedling subsequently a plant - is a crucial factor influenced by initial quality, genetic makeup, storage conditions, and environmental factors.

Orthodox seeds like rice, known for their resilience to desiccation, can remain viable even at very low moisture levels. Yet, improper storage can lead to deterioration, impacting germination and crop yield.

Innovative Techniques for Assessing Seed Longevity

Traditional methods for assessing seed viability, such as germination tests and induced aging methods like accelerated aging treatments, are often time-consuming and destructive. New advancements are now on the horizon, offering non-destructive and rapid solutions (Fahlgren et al., 2015). Innovations like RGB, multispectral, thermal imaging, hyperspectral imaging and non-imaging, and metabolomics are revolutionizing seed science.

- *RGB, Multispectral, and Thermal Imaging:* RGB imaging captures detailed color information, revealing visible traits of seeds and their physical condition. Multispectral imaging extends this by analyzing reflectance across specific wavelength bands, offering insights into seed health and stress responses. Thermal imaging detects temperature variations, indicating internal seed conditions and potential longevity issues. Together, these methods provide a comprehensive assessment of seed quality and viability.
- ***Hyperspectral Imaging and Non-Imaging:*** This technique captures detailed spectral data across a wide range of wavelengths, providing in-depth chemical and physical information about seeds. By analyzing reflectance values, researchers can assess seed viability and detect subtle changes in seed composition without causing any harm. This method has shown immense promise in identifying key quality traits and predicting seed performance.
- ***Metabolomics:*** This comprehensive approach analyzes the metabolic profiles of seeds to understand biochemical changes during aging. By identifying biomarkers associated with seed longevity, metabolomics provides insights into the mechanisms of seed deterioration and vitality. This technology not only helps in improving seed storage but also enhances our understanding of the biochemical processes that govern seed longevity.

Table 1: Different Remote Sensing Spectral Techniques for Analyzing Seed Quality and Viability.

Spectrum (nm)	Region of Spectrum	Commonly Used Techniques	Technical Details
400-450	Ultraviolet (UV)	Fluorescence Imaging	Used to detect UV-induced fluorescence in seeds, which can

			indicate stress or damage.
450-490	Blue Visible Light	Spectral Reflectance Imaging	Measures light reflectance to assess seed health and longevity. Blue light can penetrate deeper into seed tissues.
500-550	Green Visible Light	Hyperspectral Imaging	Provides detailed spectral information for analyzing seed viability and deterioration.
550-600	Yellow to Orange Visible Light	Chlorophyll Fluorescence Imaging	Measures chlorophyll fluorescence which can indicate seed vitality and health.
600-700	Red Visible Light	NDVI (Normalized Difference Vegetation Index)	Assesses vegetation health, which can be correlated with seed longevity.
700-750	Red Edge	Spectral Reflectance Imaging	Enhances sensitivity to changes in chlorophyll content and seed health.
750-800	Near Infrared (NIR)	Reflectance Spectroscopy	Used for assessing seed moisture content and structural properties.
800-900	NIR	Hyperspectral Imaging	Helps in analyzing seed density and internal structures.
900-1000	Shortwave Infrared (SWIR)	Spectral Reflectance Imaging	Used for detecting changes in seed moisture and chemical composition.
1000-1400	SWIR	Spectral Reflectance Imaging	Provides information on seed moisture and internal chemical changes.
1400-2000	SWIR	Hyperspectral Imaging	Detailed analysis of seed quality and degradation over time.

GIS Techniques for Assessing Seed Longevity

Geographic Information Systems (GIS) can effectively assess seed longevity by mapping environmental variables influencing seed preservation. Techniques include spatial analysis of soil moisture, temperature, and other climate factors that affect seed viability. GIS also enables the integration of historical data on seed storage conditions, helping to predict seed longevity across different regions. By visualizing these factors, researchers can identify optimal seed storage locations and conditions.

Table 2: Different GIS Techniques for Analyzing and Predicting Seed Longevity

Technique	Description	Applications
Spatial Analysis	Analyzing the spatial distribution of seed populations and environmental factors.	Identifying areas with favorable conditions for seed longevity.
Climate Modeling	Modeling climate variables to predict their impact on seed longevity.	Assessing how future climate scenarios may affect seed survival.
Spatial Interpolation	Estimating seed longevity in unmeasured locations based on known data points.	Filling gaps in data to create continuous seed longevity maps.
Mapping and Visualization	Creating visual representations of seed longevity data.	Visualizing patterns and trends in seed longevity.
Environmental Impact Assessment	Assessing the impact of environmental factors on seed longevity.	Evaluating how changes in land use or climate affect seed survival.
Predictive Modeling	Developing models to predict seed longevity based on various environmental factors.	Forecasting seed longevity under different scenarios.

The Future of Seed Science

The integration of different imaging, non-imaging and metabolomics represents a leap forward in seed science. These technologies not only streamline the process of evaluating seed quality but also offer a deeper understanding of the factors influencing seed longevity. By focusing on non-destructive, rapid assessment methods, researchers can better predict seed performance and ensure high-quality seed supply for future generations.

Conclusion

In conclusion, as we navigate the challenges of global food security and agricultural sustainability, innovative techniques like hyperspectral imaging and metabolomics will be crucial in optimizing seed quality and longevity. The journey of transforming rice seed science is just beginning, promising a future where every seed sown contributes to a more resilient and productive global food system.

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References

Fahlgren, N., Gehan, M. A. and Baxter, I. (2015). Lights, camera, action: High-throughput plant phenotyping is ready for a close-up. Current Opinion in Plant Biology, 24: 93-99.

Gujja, B., & Thiyagarajan, T. M. (2009). New hope for Indian food security? the system of rice intensification. London: International Institute for Environment and Development.

United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision, Key Findings and Advance Tables.

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SUCCESS STORIES OF ICAR-IIHR TECHNOLOGICAL INTERVENTIONS IN NORTH EASTERN REGION (TRIPURA) : ARKA ABHED (H-397) - A POPULAR TOMATO VARIETY IN DHALAI DISTRICT, TRIPURA

Article ID: AG-V04-I08-112

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Introduction

Tomato cultivation in Dhalai district of Tripura is a lucrative agricultural venture given the state's favorable climatic conditions. Tripura's subtropical climate is suitable for tomato cultivation. The optimal temperature range for growing tomatoes is between 20°C and 25°C. Tomatoes thrive in well-drained, loamy soil rich in organic matter. Soil pH should be between 6.0 and 6.8 for optimal growth. The total area of tomto cultivation in the district is 281 ha and production is of 6144 MT and it is one of the major vegetable crops.

CHALLENGES:

Tomato cultivation in Tripura faces several challenges, including:

1. **Unavailability of Improved Varieties-** farmers are facing the top most problem is that they are unable to get the registance varieties of tomato along with higher yields.
2. **Climatic Conditions**:
   - **Heavy Rainfall**: Tripura experiences heavy rainfall during the monsoon season, which can lead to waterlogging, root rot, and other fungal diseases.
   - **High Humidity**: The high humidity levels can foster the growth of fungal and bacterial diseases, affecting plant health and yield.
   - **Temperature Variations**: Fluctuations in temperature can stress the plants and reduce fruit quality.

3. **Pest and Disease Infestation**:
    - **Pests**: Common pests like aphids, whiteflies, and tomato fruit borers can cause significant damage to tomato crops.
    - **Diseases**: Diseases such as late blight, early blight, and bacterial wilt are prevalent and can severely impact yields.
4. **Soil Health**:
    - **Soil Fertility**: Poor soil fertility and low nutrient levels can limit plant growth and productivity.
    - **Soil Erosion**: The hilly terrain of Tripura can lead to soil erosion, affecting the soil structure and nutrient availability.
5. **Lack of Modern Agricultural Practices**:
    - **Traditional Farming Methods**: Reliance on traditional farming methods rather than modern, efficient techniques can limit productivity.
6. **Market and Infrastructure**:
    - **Market Access**: Farmers may face difficulties in accessing markets to sell their produce, leading to post-harvest losses.
    - **Storage Facilities**: Lack of adequate storage facilities can result in spoilage and reduced market value of tomatoes.
7. **Financial Constraints**:
    - **Lack of Credit Facilities**: Limited access to credit can hinder farmers' ability to invest in quality seeds, fertilizers, and other inputs.
    - **High Input Costs**: The high cost of inputs like fertilizers, pesticides, and irrigation equipment can be a barrier for small-scale farmers.
8. **Extension Services**:
    - **Limited Agricultural Extension Services**: Inadequate extension services mean that farmers may not receive timely advice and support on best practices and new technologies.
9. **Water Management**:
    - **Irrigation Challenges**: Inconsistent water supply and lack of efficient irrigation systems can affect tomato cultivation, especially during dry periods.

INITIATIVE

Tomato variety Arka Abhed was introduced by KVK Dhalai in collaboration with ICAR-IIHR, Bangalore. Thought the potentiality of the variety is much more higher but it performed well compared to other check and local varieties under Tripura conditions. Farmers are highly influenced by the performance of this variety. They preferred for early sowing in the 1st week and 2nd week of September to overcome any chances of late blight or any climate related irregularities. Initially, OFT was conducted during the year 2019-20 on Arka Abhed and subsequent years it has been undertaken for FLDs. Improving tomato cultivation in Dhalai Tripura can be achieved through a combination of governmental initiatives, support from agricultural institutions, and the adoption of modern farming practices.

KEY RESULT/INSIGHT/INTERESTING FACT:

. **Title of intervention: Assessment of Performance of Multiple Disease Resistance Tomato varieties (OFT)**

Details of the Technology

T_1- Arka Abhed (H-397) T_2 – Kashi Aman

T_3- Arka Rakshak T_4- Farmers Practice(Chiranjeevi)

Results of parameters assessed				
	T1	**T2**	**T3**	**T4**
Size fruit (g)	98.38	95.21	95.98	98.32
crop duration (Days)	144	135	132	146
Bacterial wilt incidence (%)	0.0	0.0	0.0	9.56
TLCV incidence (%)	1.06	3.6	1.7	17.93
Late blight incidence (%)	0.0	5.3	3.2	6.1
Yield (mt/ha)	63.84	52.90	59.02	43.10
B:C ratio	4.1:1	3.55:1	3.8:1	3.0:1

Details of the Technology (Arka Abhed as FLDs)

Tomato variety – Arka Abhed. Staking – laying overhead G.I wires on bamboo to which individual plants are tied at 45-degree angle 4 weeks DAT, yield increases 15-20%. Spacing – 90x 60 cm, FYM- 40 Mt/ha, Urea: SSP: MOP- 450:1400:400 (kg/ha).

Demonstration Yield (Qt/Ha)			Yield of local Check	% increase	Gross Cost (Rs/Ha)/ (Rs./ unit)	Gross Return (Rs/Ha) / (Rs./ unit)	Net Return (Rs/Ha) / (Rs./ Unit)	B:C Ratio (GR/GC)
H	L	A	(Qt/Ha)	%				
635.0	413.56	614.87	450 .00	36.23	179,000	6,98,100	5,19,100	3.90:1

Arka Abhed, Arka Rakshak and Arka Samrat those improved variety of tomato cultivation offered several key results, insights, and interesting facts that significantly benefited farmers of the district in different ways as follows:-

1. **Increased Yield**:
    - **Higher Productivity**: Improved tomato varieties are often bred for higher yield potential, leading to increased productivity per unit area.
    - **Consistent Performance**: These varieties tend to perform consistently across different growing conditions, ensuring stable yields.
2. **Disease and Pest Resistance**:
    - **Reduced Losses**: Improved varieties are often resistant or tolerant to common pests and diseases, such as late blight, early blight, and bacterial wilt, reducing crop losses.
    - **Lower Pesticide Use**: The need for chemical pesticides decreases, leading to cost savings and reduced environmental impact.
3. **Enhanced Quality**:
    - **Better Shelf Life**: Many improved varieties have longer shelf life, which reduces post-harvest losses and extends marketability.
    - **Improved Nutritional Content**: Some improved varieties are bred for higher nutritional content, such as increased levels of vitamins and antioxidants.
4. **Adaptability to Climate Conditions**:
    - **Climate Resilience**: Improved varieties are often more resilient to varying

climatic conditions, including temperature fluctuations and drought, ensuring better growth and yield.

5. **Economic Benefits**:
   - **Higher Income**: Increased yields and better quality produce lead to higher market prices, enhancing farmers' income.
   - **Cost Efficiency**: Reduced input costs due to lower pesticide and fertilizer requirements contribute to overall cost efficiency.
6. **Market Advantages**:
   - **Consumer Preference**: Improved varieties with better taste, color, and texture can meet consumer preferences, increasing demand.
   - **Export Potential**: High-quality tomatoes with longer shelf life have better export potential, opening up new markets for farmers.
7. **Sustainable Farming**:
   - **Environmental Impact**: Reduced reliance on chemical inputs promotes sustainable farming practices and protects the environment.
   - **Resource Use Efficiency**: Improved varieties often use resources like water and nutrients more efficiently, contributing to sustainable agricultural practices.

IMPACT

Shri Mahitosh Das – a farmer of Dabbari village of Dhalai district experimentally cultivated this tomato variety and received good economic return after receiving the higher yield he cultivated larger area as demonstration and received better price in the market. Others farmers are very much interested to this technology as it is resistance to mainly bacterial wilt, leaf curl and wants to cultivate every year. Some cases it is reported the incidence of late blight once they did late showing and some of them said it was controlled if spay is done schedule basis. Farmers every year make contact with KVK and give request letter to KVK for procuring the variety and on their payment basis seeds are procured from IIHR Seed section.

Initially, Mahitosh Das, a farmer from a small village in Dabbari, faced numerous challenges in his agricultural endeavors. With a small landholding and limited resources, Mahitosh Das struggled to make ends meet through traditional farming methods. The inconsistent yields and frequent pest infestations in his tomato crops further exacerbated his financial woes.

In 2018, Mahitosh attended a training program organized by KVK Dhalai, which focused on modern tomato cultivation techniques involving IIHR tomato variety Arka Abhed. The program introduced him to high-yielding and disease-resistant tomato varieties, integrated pest management (IPM), and efficient irrigation practices. Inspired and motivated, Mohitosh decided to implement these new methods on his farm.

He chose to plant improved tomato varieties known for their high yield and resistance to common diseases like late blight and bacterial wilt. He started with soil testing to understand the nutrient requirements and amended the soil with organic compost and balanced fertilizers. He adopted IPM practices, including the use of natural predators, organic pesticides, and crop rotation to manage pests and diseases effectively.

Mahitosh Das , a awarded farmers during IIHR National Horticulture Fair 2024 and also awarded by ICAR-NBAIR, Bangaluru

Arka Abhed tomato plots of Sri Mahitosh Das, Dhalai

LESSONS LEARNT

Mahitosh's success inspired other farmers in his village. He began sharing his knowledge and experiences, leading to the formation of a local farmers' cooperative. Together, they leveraged collective bargaining power to negotiate better prices for their produce and access to inputs at reduced costs. Now more than 200 farmers are involved in tomato cultivation in the same village and nearby villages of Dhalai.

Mahitosh's achievements earned him recognition from ICAR, State Govt, local agricultural bodies and NGOs. He received awards and further training opportunities, enabling him to expand his farming operations and diversify into other high-value crops.

Adopting Improved Practices: Transitioning to modern agricultural techniques can significantly enhance productivity and profitability.

Knowledge and Training: Continuous learning and application of new knowledge are crucial for success in farming.

Community Collaboration: Sharing success and working collectively with other farmers can amplify benefits and drive community development.

Sustainability: Sustainable farming practices not only improve yields but also reduce environmental impact and input costs.

Mahitosh Das’s journey from a struggling farmer to a successful tomato cultivator highlights the transformative potential of adopting improved agricultural practices. His story serves as an inspiration for other farmers, demonstrating that with the right knowledge, resources, and determination, significant agricultural success is achievable.

SUPPORTING QUOTES AND IMAGES and FIELD PHOTOS :

Received award from IIHR National Horticulture fair 2024

"The training program was a turning point in my life. Learning about high-yielding tomato varieties and modern farming techniques transformed my farm and my fortunes."

"Adopting integrated crop management has not only increased my yields but also reduced my costs. It's a win-win situation."

These quotes and images would help in illustrating the success story of a tomato farmer like Mahitosh Das, highlighting the transformation brought about by adopting improved agricultural practices and the resulting positive impacts on his life and community.

Farmers of Dabbari and nearby villages farmers FLDs farm produce of Arka Abhed

Let me conclude with a quote,

"Mohitosh Das's success is a testament to the power of knowledge and innovation in agriculture. His journey inspires other farmers to adopt sustainable practices."

"Seeing farmers like Mahitosh thrive using improved practices reaffirms our commitment to providing ongoing training and support."

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GUARDING THE GREEN: EFFECTIVE STRATEGIES FOR VERTEBRATE PEST MANAGEMENT IN AGRICULTURE

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Abstract

Effective vertebrate pest management (VPM) in agriculture requires integrated strategies to address diverse pest species, including rodents, birds, and large mammals. This involves maintaining field cleanliness, using physical and chemical control methods, and leveraging natural predators. Specific strategies include physical barriers like fencing, traps, and nets; biological controls such as predators; and chemical measures like poison baiting. Challenges in VPM include balancing ecological impacts, addressing human-wildlife conflicts, economic constraints, and the adaptability of pests. Continuous innovation, regulatory compliance, and educating farmers are crucial for successful implementation of these pest management practices.

Keywords: Vertebrates, Rats, Wild boar, Birds, Monkey, Squirrel, Management

Introduction

Agriculture is the backbone of human civilization, providing essential resources for sustenance and economic development. However, crop ecosystems are complex and dynamic environments, where various biotic factors interact continuously. Among these factors, vertebrates such as rats, birds, mammals, reptiles, and amphibians play a significant role. While some vertebrates contribute positively by aiding in pest control and pollination, others pose substantial challenges by causing crop damage and reducing yields. Vertebrate pests can devastate crops, leading to significant economic losses for farmers. Birds may feed on seeds and fruits, rodents can damage roots and stems, and larger mammals such as deer and wild boars can trample and consume vast areas of cultivated land. Birds such as starlings, crows, and sparrows can damage up to 20% of crops, with severe cases exceeding 50% in fruit orchards. Rodents, responsible for 5-15% of pre-harvest losses, can reach up to 30% in some regions, particularly affecting stored grains. Large mammals like deer and wild boars can cause localized losses ranging from 10-30%, with extreme instances over 50%. Reptiles and amphibians generally cause less than 5% damage, though localized incidents can result in higher losses. Understanding these impacts is essential for developing targeted management strategies to mitigate the economic and food security consequences of vertebrate pest damage. These interactions necessitate a well-balanced approach to vertebrate management that mitigates the negative impacts while preserving ecological balance. This article explores strategies for managing vertebrates in crop ecosystems, including integrated pest management (IPM), habitat modification, exclusion methods, and biological control. Understanding vertebrate behaviour and ecology is crucial for developing effective management plans.

Rat management

Effective rat management in agriculture involves several integrated strategies. To maintain the field in optimal condition and manage pests effectively, keep the field clean and prevent the spillage of harvested grains. Avoid dumping paddy straw in or around the rice field and regularly clean irrigation channels to keep them weed-free. Physical control methods for managing rice field rats include hunting, rat drives, digging, and exclusion strategies. Maintain narrow bunds (45 × 30 cm) and engage in off-season burrow digging and killing. Implement poison baiting with zinc phosphide or bromadiolone 3 to 4 weeks after planting. Set up Thanjavur or bamboo bow traps (100 per hectare) sequentially. Locate burrows opened by rats and insert two pellets of 0.5 or 0.6g of aluminium phosphide per burrow, plugging the entrance with a mud ball. For poison bait, mix 1 part zinc phosphide with 49 parts popped corn, rice, or dry fish, or use bromadiolone at 0.005% (1:49 ratio) and place the bait in the field. Alternatively, use Warfarin at 0.5% mixed with 19 parts popped corn, rice, or dry fish. Additionally, set up 40-50 owl perches per hectare to encourage natural predators. Wildcats, snakes, and birds also act as natural predators of rice field rats, contributing to the pest management strategy.

Birds' management

For effective bird pest management in crops, several methods can be employed. The wrapping method involves covering maize cobs with adjacent green leaves, reducing parakeet and crop damage to negligible levels by camouflaging the cobs and making them less detectable. Reflective ribbons, made of polyester film, should be installed at 0.5 m height and 5 m intervals to scare away birds through their reflection, positioning the ribbons from north to south enhances effectiveness. Bioacoustics involve using a stereotape recorder with distress calls of birds, which can keep birds away from fields but comes with high costs, making it suitable for high-value crops. The automatic mechanical bird scarer uses calcium carbide and water to produce sound continuously, effectively covering one hectare though its initial cost is high. Planting thick sorghum or fodder maize screens can significantly reduce bird damage and provide additional fodder. Cultivating crops in large blocks, such as a minimum of 21 acres, can also reduce bird damage. Netting with small-mesh nylon provides complete protection but is costly for large areas. Botanical repellents like neem formulations and tobacco leaf decoction effectively deter birds and are cost-effective. Integrated Bird Pest Management (IBPM) combines methods such as reflective ribbons and botanicals to reduce costs and improve pest control, proving effective for sorghum and maize crops. Biological control of birds can be achieved by using kestrels or sparrow hawks to manage populations of starlings, blackbirds, and sparrows. This can be facilitated by installing nest boxes and perches to attract these predators.

Frugivorous bats management

Managing frugivorous bats involves several strategies to protect commercial fruit crops. One method is using scaring devices such as beating drums, flashing torches, and using firecrackers can be effective, as well as broadcasting alarm calls to deter bats. Partially covering vulnerable portions of the canopy and erecting nylon and mist nets can protect fruit crops. Block plantations and planting trap trees with edible fruits around orchards can divert bats from commercial fruits. Another approach is to divert bats by planting trap trees with edible fruits around orchards or growing trap crops like Singapore cherry (*Muntingia calabura*) to attract bats away from the commercial fruits. For managing tree-roosting bats, two netting methods are used. If the fruit is valuable and the orchard is small, the entire fruiting tree can be covered with a fine mesh fishing net. In larger orchards with less expensive fruit crops, bats can be managed by capturing them using mist nets.

Wild boar management

Protecting crops from wild boars can be challenging, but several strategies can help mitigate the damage. Installing sturdy fencing, preferably electric and buried at least a foot underground, can effectively deter wild boars from entering crop areas. Using commercial repellents, including chemical and ultrasonic options, can create an unpleasant environment for the animals. Employing scare tactics such as motion-activated lights, loud noises, or radio sounds can further discourage wild boars. Guard animals, like livestock guardian dogs, can be trained to protect crops from wildlife. Humane traps can be set up to capture and relocate wild boars, though it's essential to check local regulations and consult wildlife experts before attempting this. Modifying the habitat around the farm by removing sources of food, water, and shelter can make the area less attractive to wild boars. Additionally, practising crop rotation can make the area less predictable and reduce wild boars' interest over time.

Elephant management

Elephants are highly intelligent animals capable of adapting to various human strategies aimed at reducing crop losses caused by their raids. No single method can effectively contain them, requiring scientists, managers, and farmers to develop appropriate plans considering the behaviour, ecology, and habitat of the elephants. The management of crop-raiding elephants involves three phases: passive prevention, vigilance, and active measures. Passive prevention focuses on preventing elephants from leaving their habitat by digging trenches and erecting both electric and non-electric fences. Vigilance aims to detect approaching elephants early, employing strategies like maintaining buffer zones, building watch towers, using whistles to alert villagers, keeping continuous fires at the edges of fields where elephants are likely to encroach, and placing cow bells along string fences to alert farmers when elephants enter crop fields. Active measures involve more direct actions such as throwing fire and flame balls, using pepper sprays, shooting to scare, shouting, beating drums, and making other loud noises. These measures can be categorized into short-term and long-term solutions. Short-term measures provide immediate protection against elephant raids, while long-term measures aim to eliminate or reduce the factors causing elephants to raid crops and to create self-sustaining living conditions for elephants within the forest.

Monkey management

Effective monkey management includes a variety of technological interventions. Installing solar fencing and electric fencing around the field can create a physical barrier to keep monkeys out. Using monkey repellents and scare guns, as well as laser-guided alarms, can help deter monkeys from entering crop areas. Annoying and strong-smelling substances like dry fish packets spread around the field can also be effective in repelling monkeys. Additionally, maintaining a balance in the ecosystem by releasing natural predators or enemies, such as langurs, can help control the monkey population. These combined strategies can effectively reduce monkey-related damage to crops.

Bear and squirrel management

Bear management involves several strategies to mitigate damage and ensure safety. One effective method is using 20,000-volt double-insulated wire electric fencing, which is recommended for managing bear-related damage. Additionally, removing attractants such as food and garbage is crucial to prevent bears from being drawn to human areas. Trail and campsite closures can also be implemented to reduce human-bear interactions in high-risk areas. Utilizing the terrain effectively, such as placing campsites and trails away from bear habitats and natural travel routes, further helps in minimizing encounters and potential conflicts with bears. Squirrel management involves a combination of habitat modification, trapping, and biological control. Removing weeds and crop residues helps reduce the habitat and food sources available to squirrels. Live trapping with wooden or wire mesh traps, at a density of 20 traps per acre, is an effective method for managing the *Funambulus Palmarum* species. In addition, natural predators such as wildcats, red foxes, and golden eagles can help control squirrel populations. For the *Funambulus Pennanti* species, poison baiting using grains like wheat, millet, and sorghum is another strategy to manage their numbers.

Challenges in VPM

Vertebrate pest management in agriculture faces several challenges due to the diversity and behaviour of pest species, such as birds, rodents, and mammals, each requiring unique control methods, maintaining ecological balance while managing pests is crucial, as these animals often play beneficial roles in ecosystems. Human-wildlife conflict and the economic constraints of implementing effective control measures add further complexity. Vertebrate pests can adapt to management strategies, necessitating continuous innovation. Regulatory and ethical considerations, along with the need for accurate monitoring and data collection, also complicate management efforts. Finally, raising public awareness and educating farmers on best practices are essential for successful vertebrate pest management.

Conclusion

Effective vertebrate pest management is essential for maintaining crop productivity, economic stability, and ecological balance in agriculture. By understanding pest behaviours and implementing integrated pest management (IPM) strategies, stakeholders can develop sustainable solutions to mitigate crop damage. Addressing human-wildlife conflicts, economic constraints, and adhering to regulatory and ethical standards are crucial for success. Continuous innovation, research, and collaboration among farmers, scientists, and policymakers are vital to meet the evolving challenges. With comprehensive and adaptive practices, agriculture can maintain productivity and resilience, contributing to food security and environmental health.

References

Sridhara, S. (2016). Vertebrate pests in agriculture. Scientific Publishers, India.

Figuerola Borras, J., Beltrán Gala, J. F., & Jacob, J. (2017). Vertebrate pest management: research for science-based solutions. *Pest Management Science, 73, 271-272.*

Lindell, C., Eaton, R. A., Howard, P. H., Roels, S. M., & Shave, M. E. (2018). Enhancing agricultural landscapes to increase crop pest reduction by vertebrates. Agriculture, Ecosystems & Environment, 257, 1-11.

Van Vuren, D., & Smallwood, K. S. (1996). Ecological management of vertebrate pests in agricultural systems. *Biological Agriculture & Horticulture*, *13*(1), 39-62.

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MAKHANA (FOXNUT): POWERHOUSE OF NUTRIENTS

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Introduction

Makhana (*Euryale ferox* Salisb.) is a type of seed, and also referred to as fox nuts or lotus seeds, is a flowering plant classified in the water lily family Nymphaeaceae. Other common names include prickly water lily seeds, popped lotus seeds, foxnut or gorgon nut. Its cultivation in India is restricted to a few states, including Bihar, Assam, Manipur, and West Odisha, Tripura, and Bengal (Pratap, 2021). Highly nutritious, it is a fully organic non-cereal food found principally in India (Bihar state alone accounts for 90% of world production) but also in Korea, Japan, as well as parts of eastern Russia. In India, Makhana is famously known as Phool Makhana; due to its unique and flowery appearance. The edible portion of the plant that is consumed in the shape of small, rounded makhana seeds with an outer covering that ranges in color from black to brown of processed lava that has burst.

These seeds can be consumed raw or in cooked form. Makhana is also used for medicinal purposes. It is extensively grown in marshy wetlands, tanks, ponds and lakes. Dry fruits are marketed in the form of a cash crop of pop makhana, sometimes referred to as Makhanalawa (Kumar *et al*., 2016). It generally produces edible nut and it is superb medicinal plant used in ancient medicine in India and China 3000 years ago. The seeds of fox nut are used in ayurvedic preparations (Jha *et al*., 1991).

It gives a feeling of fullness when taken as a snack and prevents overeating thereby helping in weight loss. Makhana seed also called as black diamond (Kumar *et al*., 2016). Makhana is beneficial for overall skin health (wrinkles and signs of aging) due to the presence of antioxidants and certain amino acids that have anti-aging property. According to Ayurveda, Makhana has aphrodisiac property. Eating Makhana might also help to control diarrhea as its strong astringent property helps slow down the passage of stool through the digestive tract thereby reducing the frequency of passing stool. Makhana seeds are widely used and have been found to have therapeutic effects used in Chinese and Ayurvedic remedies for the treatment of a number of illnesses, including renal disease, ongoing diarrhea, severe leucorrhea, splenic hypo function and it also supported good treatment for respiratory, circulatory, digestive, and reproductive systems (Kumari *et al*., 2019). Antioxidant activity of raw seed was maximum than that of popped, which was due to the outcome of processing at high temperature (Haleema *et al*., 2016).

Nutritional Aspects of Makhana

Makhana is an aquatic cash crop with high carbohydrate, protein, and low-fat content. Makhana contributes high market value, 1.72% consumption out of 3.46% production remain it loose as wastage. (Khadatkar *et al.*, 2020) . The raw makhana contains 76.9% carbohydrates, 12.8% moisture, 9.7% protein, 0.9% phosphorus, 0.5% minerals, 0.1% fat, 0.02% calcium and 0.0014% iron. In popped makhana 84.9% carbohydrate, 4% moisture, 9.5% protein, and 0.5% fat (Singh *et al.*, 2020). Biochemical analysis of makhana seed had a high protein content of 15.6% and 1.36% fat, makhana plant composition is been illustrated in table 1. The calorie value of 100g of raw and puffed makhana gives 362kcal and 328kcal. Due to its high protein and fat content, the makhana is similar to almonds, walnut, cashew nut, and coconut. Makhana reported 16 types of amino acids in the kernel. (Khadatkar *et al.*, 2020). The makhana is rich in macro as well as micronutrients as well as a good source of minerals. Cu, Na, Ca, Fe, and Mg these trace metals have been reported by different researchers. The vegetative part of the makhana contains a good amount of N, P, and K. The high content of the P, Fe, and Zn is due to the muddy field condition. The makhana also contains a high amount of vitamins such as vitamin A and vitamin C ranging from 62.23 to 63.84 IU/g and 0.18% to 0.20% respectively (Khadatkar *et al.*, 2020) .

Minerals	Value per 100g	% of RDA
Calcium (Ca)	60 mg	6%
Iron (Fe)	1.4 mg	6%
Magnesium (Mg)	67.2 mg	17%
Phosphorus (P)	200 mg	20%
Potassium (K)	500 mg	14%
Sodium (Na)	210 mg	8%

Note: RDA (Recommended Dietary Allowance) values are based on 2000 calorie diet.

Health benefits of makhana

Makhanas were previously underappreciated. Makhana has become more popular in recent years as people have become more health conscious. People are rediscovering the once-forgotten snack for its nutritional value. Makhanas of various varieties can also be found in supermarkets. Because of their high nutritional value, makhanas/fox nuts are becoming extremely popular in recent years. Here are some of the health benefits of eating makhana. (Tehseen *et al*., 2020)

1. **Improves heart health**

   The low amount of sodium and high amount of potassium in makhanas help decrease the blood pressure in hypertension patients. The low sodium helps in keeping the blood pressure in check. The magnesium in makhanas helps improve the quality of blood and oxygen in the body. Low magnesium levels in the body increase the risk of heart disease. The low sodium and high magnesium content in makhana helps regulate blood pressure and supports a healthy cardiovascular system.

2. **Strengthen your bones and teeth:**

   Makhanas have a decent amount of calcium, which makes them perfect for strengthening your bones. Rich in calcium, makhana helps strengthen bones and teeth, reducing the risk of osteoporosis. Makhana is an excellent source of calcium, magnesium and proteins, which are essential for healthy bone and teeth growth and development.

3. **Promotes weight loss:**

   Makhanas are rich in protein, which keeps one full for longer. This in turn stops one from overeating later. In addition to this, makhanas are low in calories, which make them a perfect weight-loss snack. The least amount of saturated fats in makhanas makes them even healthier. Makhana's high fiber content helps keep you feeling full for longer, reducing the chances of overeating and promoting weight loss.

4. **Promotes healthy digestion**

   Makhana's high fiber content aids in digestion and prevents constipation. The high fibre content in makhanas helps to improve one's digestive health. Including them in your daily diet can help improve the bowel movement. In fact, regular consumption can helps to improve digestion and keep constipation at bay.

5. **Boosts immunity:**

   The antioxidants present in makhana helps to combat free radicals and improve overall immunity.

6. **Controlling blood pressure:**

   The high magnesium content and low fat and sodium levels in makhana make it effective in managing and maintaining blood pressure levels, especially for individuals with hypertension.

7. **Helps in controlling blood sugar levels :**

   Makhanas are rich in protein and carbohydrate and are in low in glycemic index making them good for people with high blood sugar. The glycemic index of makhanas is lower than that of several staple foods. The high magnesium and low sodium content in makhanas make them the right food to fight obesity and diabetes.

8. **Anti-ageing:**

   Makhanas make for great anti-ageing food because they have an abundance of antioxidants. The catch is they should not be consumed as a fried snack. The presence of antioxidants in makhanas makes them even better for digestive health. They also help in the prevention of excessive and frequent urination. Lotus seeds or fox nuts are rich in antioxidants, making them a great anti-ageing food.

9. **Nerve function:**

   Lotus seeds or makhana also contain thiamine, which is essential in aiding cognitive function and contributes to the process of neuro transmission, key in maintaining good nerve function.

10. **Good for fertility:**

    Makhana also benefits both men and women in dealing with infertility problems.

Makhana benefits for females and male include improving semen quality and preventing premature ejaculation.

11. **Detoxifying the liver:**

    The nutritional benefits of makhana also contribute to maintaining liver function and enhancing metabolism.

12. **Kidney functioning maintenance:**

    Makhana acts as a detoxifying agent, flushing out toxins and cleansing the spleen, which is responsible for removing blood cells. This contributes to maintaining good kidney health, as it helps control blood flow and regulates urination by eliminating toxins from the body.

13. **Preventing inflammation:**

    Lotus seeds have a natural compound known as kaempferol which helps in reducing inflammation in the body. Inflammation is responsible for many diseases such as arthritis and rheumatism. Thus, it is good for patients suffering from arthritis.

Current Status of Makhana

Makhana has a high nutritional content and several health advantages, thus demand has been steadily rising recently. The modern makhana in India is devoured all across the nation. Nonetheless, commercial Makhana production is only permitted in a few parts of West Bengal, Assam, Manipur and North Bihar, and through a network, reaches all of the country's largest cities including producers, processors, local vendors and other dealers. Farmers in production areas are estimated to receive About 55% of the final retail price in the local market. However, when it comes to makhana, its share declines rapidly. Due to the high price of pops, they are sold in distant markets receive. Retail margins are his second most important components in final price accounting for about 19% f the retail price of Puff Macana. For exports, the export potential is not used yet. Currently, India exports only 1-2 percentage of total production. almost 100 tons of Pop Makhana are exported to other countries (Singh *et al*., 2020).

Conclusion

This article is discussed about the importance of makhana. More than 7,000 people, according to ethnobotanical surveys Only a few plant species are grown or harvested from the forest. On a broad scale, 150 crops are sold worldwide. This review emphasises a plant species that will require greater consideration in the near future because it significantly contribute to the enhancement of human health overall. Due to a shortage, the usage of this nourishing superfood is restricted of information and study. Policymakers have not given foxnut enough attention since it cannot compete with important commodity crops that command high economic interest.

Reference:

Jha V, Barat G.K, Jha U.N. 1991, A Nutritional evaluation of *Euryale ferox* Salisb (Makhana). J Food Sci, & Technol; 8(5):326-28.

Singh D.K., Kumar U, Kumar A, Singh I.S.,2020, Strategies for Export Promotion of Popped Makhana in India. September, 30-33.

Kumari R, Jakhar D.S, Kumar P., 2019, Nutritional and medicinal importance of Makhana (*Euryale ferox* Salisb.). Marumegh; 4(2):53–55.

Kumar L, Singh A.K., Bhatt B.P., 2016, Nutritional status of recently developed Makhana (Gorgon Nut) variety "Swarna Vaidehi." J.Agri.Search;3(4):3-8

Haleema K, Srigiripura C.V., Urooj A., 2016, Antioxidant content and in vitro antioxidant activities of extracts from popped Euryale ferox seeds. Agric. Sci. Res. J; 6(4):86-92.

Mandal R.N, Saha G.S, Sarangi N.,2010, Harvesting and processing of Makhana (*Euryale ferox* Salisb.)-An unique assemblage of traditional knowledge. Ind. J Trad. Knowledge; 9(4):684-688

CSIR. The wealth of India: Raw Materials, CSIR, New Delhi III, 1952, 232.

Khadatkar A, Mehta C.R, Gite L.P. Makhana (*Euryle ferox* Salisb.): A high-valued aquatic food crop with emphasis on its agronomic management:2020, A review. Scientia Horticulturae;261:108995

Tehseen S, Sarfraz F, Ateeq N, Ashfaq F, Yasmin I, Mehmood T.,2020, Foxnut (*Euryale ferox* Salisb.): A Health Promising Fruit. Acta Scientific Agriculture;4(12):68–72.

Pratap A., 2021.Value Chain Analysis of Samsung. Febreary, 20-25

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RECENT EMERGING TECHNOLOGIES IN PLANT BREEDING AND GENETICS

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Introduction

Plant breeding and genetics have long been acknowledged as essential techniques for crop development, contributing significantly to increased agricultural productivity, better nutritional value, and food security. Agriculture has undergone a revolution thanks to the discipline of synergistic integration, which has made it possible to create crop types that are more adaptable to changing environmental conditions and have desirable features. The study of genetics lays the groundwork for comprehending genetic diversity and inheritance laws, as well as for deciphering the intricate processes that underlie plant characteristics and their expression. It provides information on how particular features, like disease resistance, abiotic stress tolerance, yield potential, and nutritional content, are inherited. By analysing the genetic composition of crops, scientists can pinpoint important genes and alleles linked to desired features, opening the door for specialized methods of plant breeding.

On the other hand, the applied field of genetics known as plant breeding uses this understanding to create new crop types with enhanced traits. To create offspring with a combination of advantageous genetic features entails the purposeful crossing of plants with desirable traits. To improve food plants' genetic potential and add genetic variety, conventional breeding techniques including hybridization and recurrent selection have long been used.

Recent developments in genomics and molecular biology have completely changed the area of plant breeding. Breeders may now more effectively detect and choose plants with desirable features thanks to genetic markers, such as DNA-based markers and molecular tools. Breeding efforts can now be more focused and precise because of the mapping of quantitative trait loci (QTL) linked to complex traits made possible by the development of high-throughput sequencing technology. Furthermore, the development of genome editing technologies, like CRISPR-Cas9, offers enormous promise for the accurate alteration of particular genes, hastening the breeding process. Significant strides in crop improvement, such as the creation of high-yielding cultivars, disease-resistant cultivars, and crops with improved nutritional profiles, have been made possible by the combination of genetics and plant breeding. Nonetheless, obstacles like the requirement for the inclusion of resistance to newly developing pests and diseases, as well as the evaluation of socioeconomic and environmental factors, are necessary to strike a balance between yield enhancement and other significant agronomic features.

FUNDAMENTALS OF GENETICS INHERITANCE AND GENETIC VARIATION

The production of superior crop varieties and the advancement of agriculture are made possible by the critical roles that genetics and plant breeding play in crop improvement. Effective plant breeding techniques require a solid understanding of genetics, including inheritance patterns and genetic variation.

Inheritance Patterns

Inheritance patterns dictate how traits are passed down from generation to generation. Mendelian genetics, founded on the work of Gregor Mendel, discusses the inheritance of features controlled by single genes with distinct dominant and recessive alleles. Other inheritance patterns, such as cytoplasmic inheritance, include the transfer of genetic material via organelles like as mitochondria or chloroplasts. Furthermore, quantitative inheritance incorporates features regulated by several genes and environmental factors, resulting in continuous variation.

Genetic Variation

Plant breeding relies heavily on genetic variation. Mutations, genetic recombination, and gene flow are among the mechanisms that contribute to its emergence. Mutations introduce new genetic variants into populations, while recombination during sexual reproduction increases genetic diversity.

The Importance of Genetic Variation in Plant Breeding

Plant breeders rely on genetic variety to choose from a varied pool of genes, improving attributes and creating crop varieties with increased yield, quality, and resilience. Genetic variety enhances flexibility and resilience to both biotic and abiotic stressors. Incorporating different genetic materials into breeding programs can increase crop diversity and lessen susceptibility to diseases, pests, and environmental changes.

Integration of Genetics into Plant Breeding Strategies

Plant breeding tactics incorporate an understanding of inheritance patterns and genetic variation to create better crop types faster. Molecular markers and DNA sequencing help breeders identify individuals with desirable genes or genomic regions through phenotypic mapping and marker-assisted selection.

Quantitative trait loci (QTL) mapping and association studies can uncover genetic areas linked to critical traits, enabling targeted breeding efforts. Understanding genetics, including inheritance patterns and variation, is essential for improving crops through plant breeding. Integrating genetic knowledge into plant breeding procedures enables breeders to create crop varieties with improved characteristics, productivity, and resilience. Using genetic markers and understanding genetic variation can help breeders generate new crop varieties and meet global food security challenges.

GENETIC MARKERS AND QUANTITATIVE TRAIT LOCI (QTL) MAPPING

Genetic markers and quantitative trait loci (QTL) mapping are effective methods in genetics and plant breeding to detect and track traits. Identifying genetic areas linked to key attributes. This topic discusses the use of genetic markers and QTL mapping in crop development, including its applications and methodology.

Genetic Markers

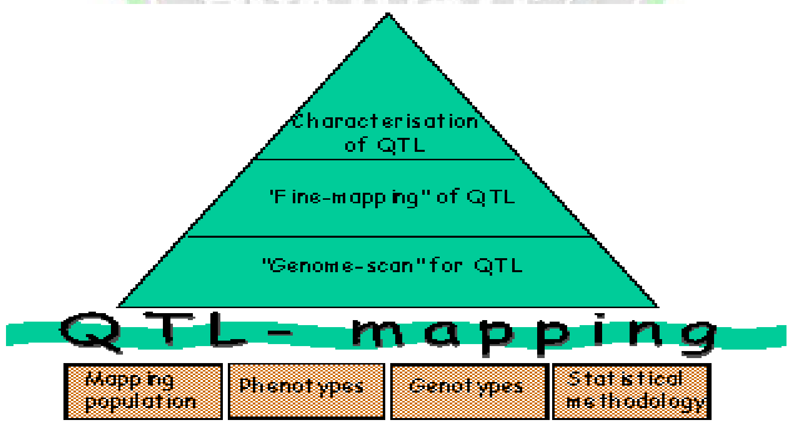
Genetic markers are DNA sequences that are easily detectable and differ between individuals. Signposts along the genome guide researchers to pinpoint regions of interest. Genetic markers include RFLPs, AFLPs, SSRs, and SNPs. Plant breeding uses genetic markers for trait mapping, MAS, and genomic selection. Trait mapping identifies the genetic areas linked to certain qualities of interest. Breeders can identify regions responsible for trait variation by comparing the expression of target traits to genetic markers.

Marker-Assisted Selection (MAS)

Marker-assisted selection (MAS) uses genetic markers to choose plants with desirable features. Breeders can use markers connected to target genes or genomic areas to indirectly select specific features during breeding. This leads to more efficient and precise selection than traditional phenotypic-based methods. MAS has been used successfully in crops to improve disease resistance, abiotic stress tolerance, and quality features. In rice breeding, markers associated with genes giving resistance to diseases such as blast and bacterial blight are used to select resistant individuals.

Quantitative Trait Loci (QTL) Mapping

Quantitative trait loci (QTL) mapping is a statistical method for identifying genomic areas linked to quantitative variables that show continuous change. QTL analysis involves genotyping and phenotyping individuals to identify the target characteristic. Correlating genotypic and phenotypic data allows researchers to identify genomic areas that influence trait variation.QTL mapping helps breeders better understand the genetic control of variables including yield, plant height, and stress tolerance. This knowledge can be used to create superior crop types with better performance.



Over time, QTL mapping methodologies have advanced from traditional interval mapping to composite interval mapping and genome-wide association studies (GWAS). These methods use statistical models and advanced algorithms to reliably identify and map QTLs. Genetic markers and QTL mapping are essential techniques in genetics and plant breeding to discover and track genomic areas linked to key traits. Genetic markers enable effective trait mapping and marker-assisted selection, making it easier to pick desired features for breeding programs. QTL mapping helps breeders improve crop varieties by revealing the genetic architecture of complex traits and enhancing their performance.

GENOMIC SELECTION IN PLANT BREEDING

Genomic selection is a potent approach in plant breeding that predicts breeding value and selects superior genotypes. It has transformed breeding by accelerating genetic gain, improving selection precision, and allowing for the selection of traits that are difficult or costly to detect directly. Genomic selection uses information from the whole genome of an individual or community. High-throughput genotyping technologies, like SNP arrays or whole-genome sequencing, are used to identify genetic markers throughout the genome. Markers represent genetic variation within a population. Genomic selection can forecast an individual's breeding value before phenotyping, making it a valuable tool. Genomic estimated breeding values (GEBVs) can be computed for individuals in a breeding population using statistical models that correlate genomic markers with phenotypic data from a training population. GEBVs measure an individual's genetic potential for a given trait of interest.

Genomic selection is highly successful for polygenic traits, which are impacted by multiple genes with tiny effects. Traditional phenotypic selection strategies can be ineffective for improving complex features. Breeders can use genomic selection to capture the cumulative effects of several small-effect genes, resulting in more precise genetic predictions and faster genetic gain. Furthermore, genomic selection allows for the selection of features that are difficult to assess directly or require destructive sampling. Phenotyping for features like as disease resistance, abiotic stress tolerance, and nutritional quality can be time-consuming and costly. The genomic selection allows breeders to pick phenotypes based on linked markers, eliminating the requirement for labour-intensive phenotypic examinations.

Genomic selection requires varied training populations with genotypic and phenotypic data to be effective. The accuracy of forecasts is determined by the genetic link between the training and breeding populations, as well as the heritability of the traits under consideration. Incorporating new genetic and phenotypic data in each breeding cycle can increase prediction accuracy. Genomic selection in plant breeding has led to significant breakthroughs in crops like maize, wheat, rice, and soybeans. It has led to improved cultivars with increased yield, disease resistance, abiotic stress tolerance, and quality attributes. Genomic selection has been used in plant breeding efforts for trees, forages, and perennial crops. Genomic selection has transformed plant breeding by using genomic data to predict breeding value and improve selection precision. It has great potential for improving complicated features and selecting those that are difficult to evaluate directly. Genomic selection can accelerate genetic gain and generate crop varieties with improved agronomic and qualitative features as genotyping technologies advance and genomic resources become more accessible.

RADITIONAL BREEDING METHODS AND HYBRIDIZATION

Plant breeding initiatives rely heavily on traditional methods and hybridization to improve crops. These strategies use natural genetic diversity to improve crop types with desired features. This section will explore the use of traditional breeding methods and hybridization in plant breeding, including its applications. Traditional breeding methods rely on regulated cross-pollination or self-pollination to produce desired features. Breeders strive to combine beneficial features in their offspring by selecting and crossing individuals with complementary characteristics. This mechanism is based on genetic diversity in plant populations and Mendelian genetic principles.

BALANCING YIELD IMPROVEMENT WITH AGRONOMIC TRAITS

Plant breeding aims to improve crop productivity. Consider agronomic features that enhance crop performance, sustainability, and adaptation, in addition to yield improvement. This section emphasizes the need to strike a balance between yield improvement and agronomic qualities, as well as the methods for doing so. Agronomic features refer to characteristics that influence crop growth, development, and performance in agriculture. systems. These characteristics include disease resistance, drought tolerance, nutrition efficiency, lodging resistance, maturity, plant height, and grain quality. Focusing primarily on yield optimization without addressing agronomic factors may result in restrictions on crop production. Crop resilience to biotic and abiotic stressors is an important factor to consider when balancing yield improvement with agronomic attributes. Creating high-yielding cultivars that are vulnerable to pests, diseases, or environmental changes might harm overall production and sustainability. Breeding efforts aim to include resistance genes for pests and diseases, as well as tolerance for abiotic conditions such as drought, heat, salinity, and nutritional deficits.

Nutrient utilization efficiency is an important agronomic attribute that refers to a crop's ability to efficiently acquire, utilize, and allocate nutrients. Improving nutrient efficiency through breeding can boost crop output and reduce the environmental impact of over-fertilization. Genetic selection can improve nutrient absorption, utilization, and remobilization efficiency. Balancing plant height with lodging resistance is crucial for stable and high-yielding crop types. Agronomic traits such as maturity or flowering time require careful study. Early maturing cultivars may be advantageous in locations with short growing seasons or where early harvest is required. Delayed flowering and longer growth seasons can lead to better biomass buildup and production potential in some crops. Breeders can use these technologies to improve yield and agronomic features while focusing on specific traits of interest.

ENHANCING BIOTIC AND ABIOTIC STRESS RESISTANCE

Plant breeding and genetics are vital for improving agricultural stress resistance, both biotic and abiotic. Breeders can create more resilient kinds by modifying genetic factors and selecting desirable qualities. This article will explore how genetics and plant breeding might improve resilience to biotic and abiotic stressors, with sources provided. Biotic Stress Resistance: Biotic stressors are induced by living creatures like diseases, insects, and weeds. Plant breeders use many ways to improve biotic stress resistance.

a) Genetic Resistance: Breeding for resistance entails combining naturally occurring genes from wild relatives or other sources into cultivated crop variants. This strategy has proven effective in creating disease-resistant cultivars. For example, the introduction of resistance genes from wild relatives resulted in the production of wheat types that are resistant to stem rust caused by the *Puccinia graminis* fungus.

b) Marker-Assisted Selection (MAS): MAS is a breeding strategy that involves using molecular markers to identify desired features. This enables breeders to pick plants with desired resistance features more efficiently. MAS has improved soybean cyst nematode (SCN) resistance, leading to the establishment of resistant cultivars

c) Transgenic Approaches: Genetic engineering has enabled the introduction of genes that provide resistance to pests and diseases. The Bt gene, which encodes an insecticidal protein, has effectively protected crops such as cotton and corn against pests.

ABIOTIC STRESS RESISTANCE

Abiotic stressors include drought, salt, severe temperatures, and nutritional shortages. Plant breeders use many ways to improve abiotic stress resistance

a) Phenotypic Selection: Traditional breeding methods pick plants with desirable features by visual inspection. Breeders can choose individuals with high resistance to specific abiotic conditions like drought or salinity based on their phenotypic traits. This method has successfully developed stress-tolerant crop types, including drought-tolerant maize hybrids.

b) Quantitative Trait Loci (QTL) Mapping: QTL mapping identifies genomic areas linked to stress tolerance features. Breeders can use this strategy to target genomic areas and create markers for marker-assisted selection. QTL mapping has helped develop rice cultivars that are more resistant to submergence stress.

c) Genomic Selection: Genomic selection predicts individual breeding values without relying on phenotypic evaluations. Breeders can select plants with high-stress tolerance based on their genetic profiles. Crops like maize have shown improved drought resistance through genomic selection.

Conclusion

Genetics and plant breeding play a crucial role in improving crops to solve global concerns such as food security, climate change, and sustainable agriculture. Advancements in genetics, genomics, and breeding have led to faster development of crop varieties with higher yield, resilience, and nutritional quality. Germplasm collections, molecular techniques, and participatory approaches have helped uncover plant genetic potential. Germplasm conservation helps plant growers preserve genetic variety for future breeding. Genetic diversity helps improve traits and adapt to changing environments. Evaluation of germplasm resources has helped breeders find valuable features and choose acceptable parents for hybridization. Molecular tools and genetic engineering improve breeding precision and efficiency, enabling targeted trait alteration and faster variety generation. Participatory plant breeding emphasizes the need to include farmers and local communities in the breeding process. Participatory breeding incorporates farmer preferences, traditional knowledge, and local adaptation to create varieties that match regional needs and promote sustainable agriculture.

References

Tanksley SD, McCouch SR. Seed banks and molecular maps: Unlocking genetic potential from the wild. Science. 1997;277(5329):1063-1066.

Baenziger PS, Russell WK, Graef GL. Plant breeding: Importance of genetic diversity. In Plant Breeding Reviews. Wiley-Blackwell. 2007;129-162.

Huang S, Li R, Zhang Z, Li L, Gu X, Fan W, Xiong Z. The draft genome of the cucumber (Cucumis sativus L.) reveals insights into genome evolution and fruit development. Nature Genetics. 2009;41(12):1275-1285.

Li JY, Wang J, Zeigler RS, The B. Molecular mapping of genes for resistance to rice stripe virus in two indica rice cultivars (Oryza sativa L.). Theoretical and Applied Genetics. 2001;103(4): 526-532.

Sweeney MT, McCouch SR. The complex history of the domestication of rice. Ann Bot. 2007;100(5):951-957.

Myles S, Boyko AR, Owens CL, Brown PJ, Grassi F, Aradhya MK, et al. Genetic structure and domestication history of the grape. Proc Natl Acad Sci USA. 2011;108(9):3530-3535.

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TRANSGENICS IN MANAGEMENT OF ABIOTIC STRESSES

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Introduction

Abiotic stresses remain the greatest constraint to crop production. Worldwide, it has been estimated that approximately 70% of yield reduction is the direct result of abiotic stresses. Climate change has exacerbated the frequency and severity of many abiotic stresses, particularly drought and high temperatures, with significant yield reductions reported in major cereal species such as wheat, maize, and barley. Transgenic approaches are one of the many tools available for modern plant improvement programs. Gene discovery and functional genomics projects have revealed multitudinous mechanisms and gene families, which confer improved productivity and adaptation to abiotic stresses. These gene families can be manipulated into novel combinations, expressed ectopically, or transferred to species in which they do not naturally occur or vary.

Plant responses to abiotic stresses:

When a plant is subjected to abiotic stress, a number of genes are turned on, resulting in increased levels of several metabolites and proteins, some of which may be responsible for conferring a certain degree of protection to these stresses. A key to progress towards breeding better crops under stress has been to understand the changes in cellular, biochemical and molecular machinery that occur in response to stress.

Stress-induced gene expression can be broadly categorized into three groups:

(1) genes encoding proteins with known enzymatic or structural functions,

(2) proteins with as yet unknown functions, and

(3) regulatory proteins.

Initial attempts to develop transgenics (mainly tobacco) for abiotic stress tolerance involved ‘‘**single action genes**’’ i.e., genes responsible for modification of a single metabolite that would confer increased tolerance to salt or drought stress. In fact, metabolic traits, especially pathways with relatively few enzymes, have been characterized genetically and appear more amenable to manipulations than structural and developmental traits. However, that approach has overlooked the fact that abiotic stress tolerance is likely to involve many genes at a time, and that single-gene tolerance is unlikely to be sustainable.

Therefore, a second ‘‘wave’’ of transformation attempts to transform plants with the third category of stress-induced genes, namely, regulatory proteins has emerged. Through these proteins, many genes involved in stress response can be simultaneously regulated by a single gene encoding stress inducible transcription factor, thus offering possibility of enhancing tolerance towards multiple stresses including drought, salinity, and freezing. Further, genetic engineering allows controlling the timing, tissue-specificity, and expression level of the introduced genes for their optimal function.

Single action genes

1. Osmoprotectants
2. Detoxifying genes
3. Late embryogenesis abundant (LEA) proteins
4. Transporter genes
5. Multifunctional genes for lipid biosynthesis
6. Heat shock protein genes

Regulatory genes

Many genes that respond to multiple stresses like dehydration and low temperature at the transcriptional level are also induced by ABA which protects the cell from dehydration. In order to restore the cellular function and make plants more tolerant to stress, transferring a single gene encoding a single specific stress protein may not be sufficient to reach the required tolerance levels. To overcome such constraints, enhancing tolerance towards multiple stresses by a gene encoding a stress inducible transcription factor that regulates a number of other genes is a promising approach.

1. Transcription factors

An attractive target category for manipulation and gene regulation is the small group of transcription factors that have been identified to bind to promoter regulatory elements in genes that are regulated by abiotic stresses. The transcription factors activate cascades of genes that act together in enhancing tolerance towards multiple stresses. Dozens of transcription factors are involved in the plant response to drought stress.

2. Signal transduction genes

Components of the same signal transduction pathway may also be shared by various stress factors such as drought, salt and cold. Although there are multiple pathways of signal-transduction systems operating at the cellular level for gene regulation, ABA is known component acting in one of the signal transduction pathways, while others act independently of ABA. Abiotic stress signaling in plants involves receptor-coupled phospho-relay, phosphoionositol induced Ca^{2+} changes, mitogen activated protein kinase (MAPK) cascade, and transcriptional activation of stress responsive genes.

Conclusion:

- The use of transgenics to improve the tolerance of crops to abiotic stresses remains an attractive option.
- Options targeting multiple gene regulation appear better than targeting single genes.
- A well focused approach combining the molecular, physiological and metabolic aspects of abiotic stress tolerance is required for bridging the knowledge gaps between short-and long-term effects of the genes and their products.

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THE ROLE OF RHIZOBIAL ENDOPHYTES AND PASSENGER ENDOPHYTES IN ROOT NODULES

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Introduction

Leguminous plants develop a specialized structures call root nodules as a result of the symbiotic relationship between plants and some bacteria, most probably rhizobia which includes the genera *Rhizobium*, *Sinorhizobium*, *Bradyrhizobium*, *Mesorhizobium* and *Azorhizobium* which includes several species of nodule forming endophytes. They are termed as Rhizobial Endophytes (RE) which are essential part of biological nitrogen fixation. Apart from the Rhizobial Endophytes the root nodules also harbours various non-rhizobial bacteria called Passenger Endophytes (PE) which plays indirect role in the activities of plant growth promotion (Preyanga *et al*., 2021). Therefore knowledge on the role and interaction of RE and PE are essential for the understanding the plant-microbe interactions and in achieving sustainable agricultural practices (Li *et al*., 2022).

Rhizobial Endophytes (RE): The Primary Nitrogen Fixers

Rhizobial endophytes refers to a group of bacteria, which are primarily found inside the plant tissues, particularly within root nodules. They form a symbiotic relationship with their host plants, particularly legumes, where they play a crucial role in the biological nitrogen fixation (BNF). These bacteria infects the root hair cells which triggers the formation of root nodules, and further they are differentiated into bacteroids. In these differentiated bacteroids, rhizobia express nitrogenase enzymes which convert atmospheric nitrogen (N_2) into plant available form of nitrogen, ammonia (NH_3). This BNF process is very much essential for the growth of plants in nitrogen-deficit soils, and contributes to soil fertility in agricultural systems. The BNF is governed by the *nif* and *nod* gene clusters in *Rhizobium* which are responsible for nitrogen fixation and nodule formation, respectively. These genes establish the successful formation of symbiotic relationship between the bacteria and plants and thereby effectively fixing the atmospheric nitrogen.

Apart from BNF, RE promotes plant growth by synthesizing several phytohormones, improving nutrient uptake, and inducing systemic resistance against biotic and abiotic stresses.

Passenger Endophytes (PE): Supportive Non-Rhizobial Inhabitants

In contrast to rhizobial endophytes, passenger endophytes are non-symbiotic microbes that inhabit the root nodules and indirectly participate in the biological nitrogen fixation. They primarily contribute to the health and functioning of the nodules by performing various mechanisms. They promote plant growth by producing growth-promoting substances such as indole-3-acetic acid (IAA), 1- Aminocyclopropane 1-carboxylate- deaminase (ACCD), siderophores, and volatile organic compounds (VOCs). These compounds enhance the root development, nutrient uptake, and stress tolerance, thereby indirectly supporting the nitrogen-fixing activity of RE.

Several studies has shown that PEs play a crucial role in enhancing the plants tolerance against abiotic and biotic stresses like drought, salinity, and heavy metal stress by modulating stress-responsive genes and antioxidant enzyme activities. Additionally, some PEs exhibit antagonistic activity against soil-borne pathogens thereby promoting plant growth by reducing the incidence of diseases. Therefore, the interactions between plants and microbes within root nodules are made more complex by the presence of PEs in these structures.

Mechanism of root nodule formation and biological nitrogen fixation (BNF)

Rhizobium and leguminous plants have a symbiotic relationship that is necessary for the bacteria to fix nitrogen biologically. The transformation of atmospheric nitrogen (N_2) into, ammonia (NH_3), the form that plants can utilize depends on this process. This involves various mechanisms such as root infection and nodule formation, nitrogen fixation process, and ammonia assimilation.

Root infection and nodule formation

The root exudates produced by the root hairs of leguminous plants attract *Rhizobium* bacteria where they attach and causes root infection induced by curling of the root hairs induced by the release of several nodulation (*Nod*) factors which acts as signaling molecules for the plants. These curled root hair forms an infection thread, which allows the bacteria to move from root cells to root cortex region. In cortex, these bacteria causes the plant cells to differentiate, forming a specialized structure called root nodules that can fix atmospheric nitrogen.

Nitrogen fixation process

The differentiated nodules structures contains *Rhizobium* which provides nitrogenase enzyme which catalyzes the reduction of atmospheric nitrogen (N_2) to ammonia (NH_3). This process is an energy-consuming and requires 16 ATP molecules and a strong reducing environment.

$$\mathbf{N_2 + 8H^+ + 8e^- + 16ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16Pi}$$

Nitrogenase enzyme is highly sensitive to oxygen so the leghemoglobin present in the nodules, binds to oxygen and maintains a low-oxygenic environment while supplying enough concentration of oxygen required for bacterial respiration. The resulting ammonia is either taken up by the bacteroids or transferred to the cytoplasm of the plant, where it is combined with other nitrogen-containing substances necessary for plant development, such as nucleotides and amino acids.

This symbiotic connection between RE and plants naturally enriches the soil with nitrogen, which benefits both the host plant and future crops in cycle, it is crucial for soil-fertility, especially in agricultural settings.

Interactions Between RE and PE: A Synergistic Relationship

The presence of PE and RE in root nodules points to a mutually beneficial relation that improves the functioning of nodules. Although RE are principally involved in nitrogen fixation, PEs have the ability to support this process to work efficiently by modifying the microenvironment if the nodules. For example, ethylene, a plant hormone that prevents the nodule development and nitrogenase activity, can be reduced by PEs that generate ACC deaminase. PEs reduce the effects of ethylene, making the environment more conducive for RE to fix nitrogen. Furthermore, the structure and function of the microbial community within nodules can be influenced by the diversity of PEs present, which may result in nodule ecosystems that are more robust and effective. Research has indicated that a heterogeneous PE community might support the resilience and stability of the nodule microbiome, especially under stresses like salt or drought. Additionally, because of this, there are more chances to use advantageous PEs as bioinoculants to increase the production of legumes and their resistance to stress in agricultural systems.

The intricate relationships between RE, PE, and their host plants have been made possible by developments in metagenomics and transcriptomics. Researchers have been able to determine the variety of PEs found within root nodules and investigate their functional functions thanks to high-throughput sequencing technology. Furthermore, transcriptome investigations have established the molecular processes underlying the connections between RE and PE by revealing the gene expression patterns of both in response to different environmental signals. Subsequent investigations are probably developing to concentrate on clarifying the precise roles that each PE species plays in nodule function and plant health. Furthermore, to improve legume production and sustainability, there is rising interest in creating synthetic microbial communities (SynComs) that combine RE with advantageous PEs. By customizing these SynComs to particular environmental circumstances, a focused strategy for enhancing crop yields and climate change resilience might be implemented.

Conclusion

Rhizobial Endophytes (RE) and Passenger Endophytes (PE) interaction in root nodules is a perfect illustration of how intricate and complex plant-microbe symbioses could be. Although RE are the main agents of nitrogen fixation, PEs are essential for improving nodule function, encouraging the plant development, and providing stress resistance. Several research on understanding the role of each endophytes and their interactions towards PEs and plants are required for developing sustainability in agriculture.

Reference

[1]. Li, H., Zhang, S. and Wang, J. (2022). Synergistic Effects of Microbial Consortia on Plant Growth and Soil Health. *Frontiers in Plant Science*, *13*, 456.

[2]. Preyanga, R., Anandham, R., Krishnamoorthy, R., Senthilkumar, M., Gopal, N. O., Vellaikumar, A. and Meena, S. (2021). Groundnut (*Arachis hypogaea*) nodule *Rhizobium* and passenger endophytic bacterial cultivable diversity and their impact on plant growth promotion. Rhizosphere, 17, 100309.

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PLANT MILK

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Introduction

In the quest for sustainable development researchers are turning towards such food materials that can solve current problems as well as ensure stability in future also. About 60% of peoplein India are lactose intolerant (Lactose Intolerance: Expert on Signs and Symptoms to Identify It, Managing Tips | Health - Hindustan Times, 2022). Plant milks are an excellent option for people who are lactose intolerant and want to consume dairy like products. These plant milks are nutritious as well, thus, a great food for lactose intolerant people.

What is Plant Milk?

Plant milks are non-dairy beverages made from a water-based plant extract for flavouring andaroma. As of 2021, there were about 17 different types of plant milks; the most popular ones worldwide are almond, oat, soy, coconut, and pea. Production of plant-based milks, especiallysoy, oat, and pea milks, can offer environmental advantages over animal milks in terms of greenhouse gas emissions, land and water use. The colour of plant milk is similar to that of milk. The plant milk market was predicted to reach US$62 billion by 2030. Plant milks are suitable for vegetarian and vegan diets, and they are used to make ice cream substitutes, plant cream, vegan cheese, and yogurt substitutes like soy yogurt. Plant milks have been consumed as beverages and as flavouring ingredients in both savoury and sweet dishes, like the use of coconut milk in curries (Plant Milk - Wikipedia, n.d.).

History of Plant Milk

Plant-based formulations that mimic milk have been around for generations prior to the industrial production of "milks" from legumes, beans, and nuts (Tangyu *et al*., 2019). Nuts were used to make milk and baby formula by the Wabanaki and other Native American tribe nations in the northeastern United States (Vegan Kitchen: Americans Have Been Enjoying NutMilk and Nut Butter for at Least 4 Centuries, n.d.). Since 1200 CE, "milk-like plant juices" have been referred to by the name "milk" in the English language (Milk | Etymology of Milk by Etymonline, n.d.). Almond milk was mentioned in recipes from the 13th-century Levant. Soy was a plant milk used in China in the 14th century (White Gold: The Unstoppable Rise of Alternative Milks | Milk | The Guardian, n.d.). In medieval England, almond milk was mentioned in recipes like ris alkere, a sort of rice pudding, and in The Forme of Cury. Coconut milk (and coconut cream) are common ingredients in many cuisines, including those from South and Southeast Asia, and are frequently used in curries (A Brief History of Plant Milks - Vegan Food & Living, n.d.).

Present Scenario of Plant Milk

People nowadays are accepting plant milk as an alternate to dairy milk. Customers' inclination toward a plant-based diet that consists of cereal, legumes, seeds, nuts, fruits, and vegtablehas increased recently for a variety of reasons, including environmental awareness, a dislike of animal abuse, and a desire for a healthy lifestyle. Not eating any form of meat, fish, poultry, pork, eggs, dairy products, honey, or any other product containing any of these ingredients is known as veganism. One of the food categories that cannot be replaced in the vegan food market is plant-based milk substitutes since they are a necessary component of many vegan food items like ice cream, cheese, kefir, yogurt, and butter. The U.S. National Library of Medicine (2020) reports that in 65% of the world's population, there is a decrease in lactose digestion. Between 70 and 100 percent of individuals in East Asia are lactose intolerant. Greek, Italian, Arab Jewish, and West African groups are also affected by this illness (Aydar et al., 2020). In the most recent report from Meticulous Research ®, the market for plant-based milkis expected to grow at a compound annual growth rate (CAGR) of 11.7% from 2023 to 2030, or $47.55 billion (Plant-Based Milk Market to Reach $52.54 Billion by 2031, n.d.). Since 2023was celebrated as International Year of Millet, different millets are now being used to extract milk.

Since, millets are such crops that can grow under difficult conditions, they are the perfect candidate for producing plant based milk as climate change is now very much evitable.

Consumer Acceptance

The public's willingness to try new foods is influenced by a variety of factors, including a product's taste, familiarity or quality, nutritional information, health benefits, and environmental aspect (Mäkinen *et al*., 2016). The consumption of plant-based milk substitutes has been steadily rising, and improving the sensory appeal and quality of these substitutes may play a significant role in raising consumer awareness of the product. However, two issues have been identified in the industry: a final product with a "beany" or "painty" off-flavor due to lipoxygenase activity, and a chalky mouthfeel from insoluble large particles (KWOK & NIRANJAN, 1995, Durand *et al*., 2003). Research is going on in the field of food science on making these plant milk more acceptable by consumers. Some promising results are coming from the research of food science students of different universities from sensory evaluation of plant based milk and their beverages by addition of different flavours and fruits. Different products are also being developed such as chapati spread made from plant based milk and other ingredients so that it could reach to large number of people.

Production of Plant Based Milk Substitute

There are many ways for production of plant based milk substitutes but, some common procedures for milk extraction are: soaking, grinding, filtration and in some cases grinding again for homogenisation.

Limitations and Challenges

The nature of plant based milk is different from dairy milk. Their consistency is not like dairy milk so sedimentation takes place in plant milk. To improve their stability correct way for their homogenisation needs to be found. Shelf life studies is required for different plant milks. Making these plant milks acceptable by consumers in the same as dairy milk is still a big challenge.

Conclusion

Since resources are depleting at a fast rate we need to move towards foods that uses less resources and still fulfill our requirements. Since the plant based milks are lactose free, they are especially beneficial for children who are intolerant to lactose. These milk can also be used to create products that use dairy milk by using plant milk in place of the dairy milk. Producing plant milk in overall uses less resources as compared to producing dairy milk in same amount. More research in this area will help lactose intolerant people a lot as well as in saving environmental resources. These modest changes in the food production sector will help us reach our objective of long-term, steady growth.

References

A brief history of plant milks - Vegan Food & Living. (n.d.). Retrieved July 13, 2024, from https://www.veganfoodandliving.com/features/a-brief-history-of-plant-milks/

Aydar, E. F., Tutuncu, S., & Ozcelik, B. (2020). Plant-based milk substitutes: Bioactive compounds, conventional and novel processes, bioavailability studies, and health effects. *Journal of Functional Foods*, *70*, 103975. https://doi.org/10.1016/J.JFF.2020.103975

Durand, A., Franks, G. V., & Hosken, R. W. (2003). Particle sizes and stability of UHT bovine, cereal and grain milks. *Food Hydrocolloids*, *17*(5), 671–678. https://doi.org/10.1016/S0268-005X(03)00012-2

KWOK, K. -C, & NIRANJAN, K. (1995). Review: Effect of thermal processing on soymilk. *International Journal of Food Science & Technology*, *30*(3), 263–295. https://doi.org/10.1111/J.1365-2621.1995.TB01377.X

Lactose intolerance: Expert on signs and symptoms to identify it, managing tips | Health - Hindustan Times. (n.d.). Retrieved July 13, 2024, from https://www.hindustantimes.com/lifestyle/health/lactose-intolerance-expert-on-signs-and-symptoms-to-identify-it-managing-tips-101670482847983.html

Mäkinen, O. E., Wanhalinna, V., Zannini, E., & Arendt, E. K. (2016). Foods for Special Dietary Needs: Non-dairy Plant-based Milk Substitutes and Fermented Dairy-type Products. *Critical Reviews in Food Science and Nutrition*, *56*(3), 339–349. https://doi.org/10.1080/10408398.2012.761950

milk | Etymology of milk by etymonline. (n.d.). Retrieved July 13, 2024, from https://www.etymonline.com/word/milk#etymonline_v_16158

Plant milk - Wikipedia. (n.d.). Retrieved July 13, 2024, from https://en.wikipedia.org/wiki/Plant_milk

Plant-based Milk Market to Reach $52.54 Billion by 2031. (n.d.). Retrieved July 13, 2024, from https://www.meticulousresearch.com/pressrelease/528/plant-based-milk-market-2031

Tangyu, M., Muller, J., Bolten, C. J., & Wittmann, C. (2019). Fermentation of plant-based milk alternatives for improved flavour and nutritional value. *Applied Microbiology and Biotechnology*, *103*(23–24), 9263–9275. https://doi.org/10.1007/S00253-019-10175-9/FIGURES/6

Vegan Kitchen: Americans have been enjoying nut milk and nut butter for at least 4 centuries. (n.d.). Retrieved July 13, 2024, from https://www.pressherald.com/2020/11/08/vegan-kitchen-americans-have-been-enjoying-nut-milk-and-nut-butter-for-at-least-4-centuries/

White gold: the unstoppable rise of alternative milks | Milk | The Guardian. (n.d.). Retrieved July 13, 2024, from https://www.theguardian.com/news/2019/jan/29/white-gold-the-unstoppable-rise-of-alternative-milks-oat-soy-rice-coconut-plant

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MAGNIFICIANT MANILA AGATHI FOR GREEN MANURING

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Introduction

Manila Agathi is botanically called *Sesbania rostrata* (2n: 12), belonging to Sub Family, Papilionoideae, which is a green manure crop for the Rice based Tropical regions. It is also used as a fodder crop. In cultivation, *Sesbania rostrata* is a small semi-aquatic leguminous tree, in the genus Sesbania. It forms a symbiotic relationship with Gram-negative rhizobia which leads to the formation of nitrogen fixing nodules on both stem and roots. It is mainly used as green manure to improve soil fertility due to its fast growth, high biomass production and ability to convert large amounts of atmospheric nitrogen into a usable form for plants. Other applications include production of high-quality forage for livestock and it is a source of fuel-wood. It is almost always associated with wetland rice.

BOTANICAL DESCRIPTION OF MANILA AGATHI

Habitat: Mostly found naturally in marshes, floodplains, on muddy river banks and the edges of pools, but has also been recorded in open savanna. It tolerates waterlogged soils and flooding to over 1 m deep. It can tolerate acidic pH up to 4.5, but nirogen fixation is poor in acidic condition. It can tolerate low to moderate alkalinity, but seed germination and growth decreases with increase of alkalinity.

Habit: Erect, Soft wooded non aculeated annual or short-lived perennial, 1-3 m tall shrub

Roots: Roots are heavily noduled.

Stem: Pithy sparsely pilose stem of 15 mm thickness. Stem nodules present predominantly.

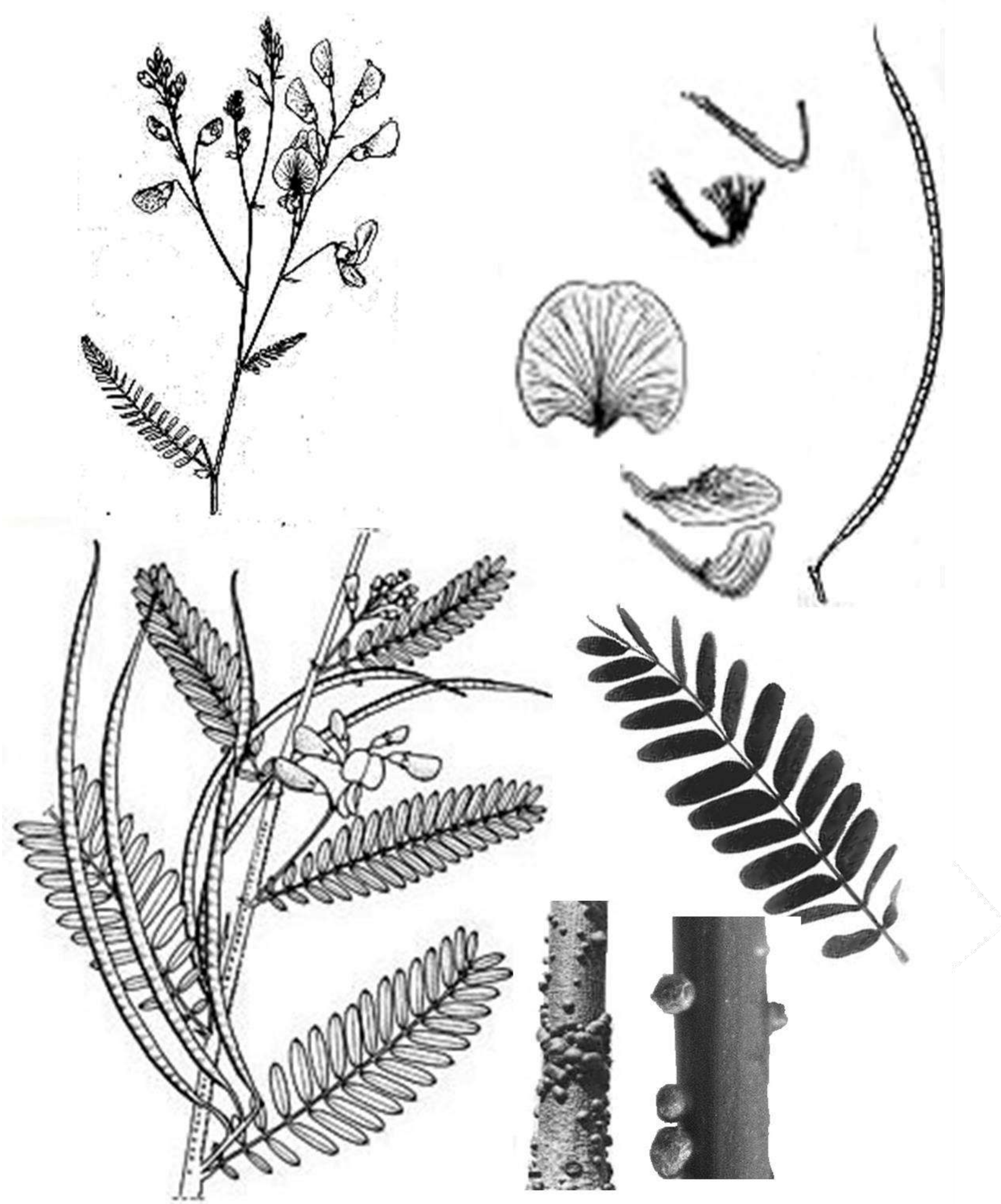

Fig. 1. Sesbania rostrata- Manila Agathi: Botanical illustration

Leaves: Paripinnate compound, 12-22 pairs of small leaflets; stipules lanceolate; stipules linear-lanceolate, 5-10 mm long, reflexed, pilose, very persistent; petiole 3-8 mm long, pilose; rachis up to 19 cm long, sparsely pilose; stipels present at most petiolules; leaflets opposite, in pairs, oblong, the basal pair usually smaller than the others, apex rounded to obtuse to slightly emarginate, margins entire, glabrous above, usually sparsely pilose on margins and midrib beneath.

Inflorescence: Inflorescence an axillary raceme, shorter than subtending leaf, 1-6 cm long, 3-12 flowered; rachis pilose; peduncle 4-15 mm long, pilose; pedicel long, sparsely pilose; bracts and bracteoles linearlanceolate, 5-8 mm long, sparsely pilose, caducous.

Flowers: Pale yellow and papilionaceous.

Calyx: Gamosepalous, campanulate; sparsely pilose, tooth markedly acuminate, subulate, sparsely pilose

Corolla: Standard suborbicular, yellow or orange, speckled dark purple or reddish, apex emarginate, appendages with short, triangular, upward-pointing or slightly incurved, free tips, less than 1 mm long; wings yellow, a small triangular tooth and the upper margin of the basal half of the blade together characteristically in rolled; keel yellow to greenish, basal tooth short, triangular, slightly upward-pointing with small pocket below it on inside of the blade.

Androecium: Stamens 10, vexillary stamen free (Diadelphous), bent sharply near the base, staminal sheath longer than free parts of filaments, auricled

Gynoecium: Ovary superior, sparsely pilose on upper margin or glabrous, style glabrous, stigma small.

Fruit: Pod in outline falcate, beak slender, up to 3.5 cm long, thicker at the center than at the sutures, up to 50-seeded. .

Seed: Subcylindrical, light to dark brown minutely dotted with violet. Hilum in a small, central, circular pit.

Pollination: Predominantly self-pollinated

Center of origin: Tropical Africa

Related Species:

1. *Sesbania pachycarpa*
2. *Sesbania aegyptiaca*
3. *Sesbania bispinosa*

4. *Sesbania sesban*
5. *Sesbania drummandii*
6. *Sesbania formosa*
7. *Sesbania herbacea*
8. *Sesbania punicea*
9. *Sesbania tomentosa*
10. *Sesbania vesicaria*

USES OF MANILA AGATHI

1. Primarily used as a green manure crop between rice crops or as an intercrop in transplanted rice.
2. It is suitable as a fodder for both ruminants and non-ruminants. The above ground parts of 50 days old are fed to livestock. It is fed to sheep, goat and sometimes to Camels.
3. In some countries the leaves are eaten by people
4. Vigorous stand suppresses the weeds of rice.
5. It act as a trap crop for insect pests such as sting bud in soybean
6. Stems are used as fire wood in Madagascar.
7. It can act as a plant trap for the nematodes, *Hirschmanniella oryzae* and *H. spinicaudata*, that damage rice crops.
8. *Sesbania rostrata i*s grown as an intercrop in rice as well as alley cropping system.
9. It can be grown on the banks of water bodies like pools and tanks and prevent soil erosion.

GREEN MANURE VALUE OF MANILA AGATHI

Sesbania rostrata has numerous minute stem nodules which can fix additional nitrogen apart from that is fixed through root nodules. As a green manure it is allowed to grow for 45-65 days between two rice crops and incorporated into the soil. Rice is transplanted 7-10 days after incorporation. The incorporation is equvalent to an application of 160-200 kg/ha N. The crop accumulates 100 kg N/ha within 50 days and 160 kg N/ha within 60 days. When it is left to grow longer than about 55 days, the lignin content increases which decreases the decomposition rate of plant biomass. Initial decomposition is rapid, with 30-45% of the leaf material decomposing in 10 days after incorporation. Decomposition then slows down considerably, reaching 50% after 35 days, while the half-life of stems and root-stubble is about 110 days. It accumulates 8-11 t/ha dry matter in 60 days. Nitrogen fixation rate is 83 to 108 kg/ha.

Sesbania rostrata nodulates with three groups of Rhizobia as detailed below.

1. *Azorhizobium caulinodans* such as TCSR1 and ORS 571 are exclusively specific to *Sesbania rostrata*. It fixes free atmospheric nitrogen both in the stem and root nodules.
2. *Sinorhizobium teranga* fixes atmospheric nitrogen in root nodules only and has symbiotic relationship with many Sesbania species and produces only root nodules.
3. The third strain *Sinorhizobium saheli* forms effective stem and root nodules in *Sesbania rostrata* and only root nodules in other *Sesbania* species.

ADVANTAGES OF MANILA AGATHI

1. It fixes large amount of Nitrogen in stem as well as in root nodules to the tune of 100 to 160 kg per hectare in 50 to 60 days.
2. It can tolerate waterlogging and flooding even up tp one meter depth.
3. It can be grown on field bunds and on banks of water bodies.
4. It can be propagated through stem cutting obtained through pruning of the plants.
5. It can tolerate pH range of 5.5 to moderate alkalinity conditions.
6. Under long day conditions, vegetative growth is extended and more biomass is produced.
7. Both ratooning and stem cutting propagated crops yield more biomass than seed sown crop.
8. It can be a successful companion crop with rice, maize as well as rice bean. For rice crop it should be planted 30 days after transplanting to avoid competition.
9. It tolerates bimodal and summer rainfall pattern.
10. It can act as trap crop for Sting bug in Soyabean and for the nematodes, *Hirschmanniella oryzae* and *H. spinicaudata*, that damage rice crops.

LIMITATIONS OF MANILA AGATHI

1. It is limited to wetland ecosystem, especially the rice.
2. *Sesbania rostrata* is a typical short-day plant to flower and set seed. It requires a critical photoperiod of 12 to 12.5 hours of sunlight.
3. It is susceptible to damping off caused by *Pythium* spp and, *Rhizoctonia* spp., leaf spot by *Cercospora* as well as leaf mosaic virus.
4. It is susceptible to root not nematode *Meloidogyne*, especially during summer.
5. It does not grow well in heavy clay soils.

6. Nitrogen fixation is reduced with increasing soil acidity.
7. Seed germination and growth decreases with increase of salinity.
8. Seed need scarification either by physical abrasion or by hot water soaking.

AgriGate Editorial Team

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