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AgriGate

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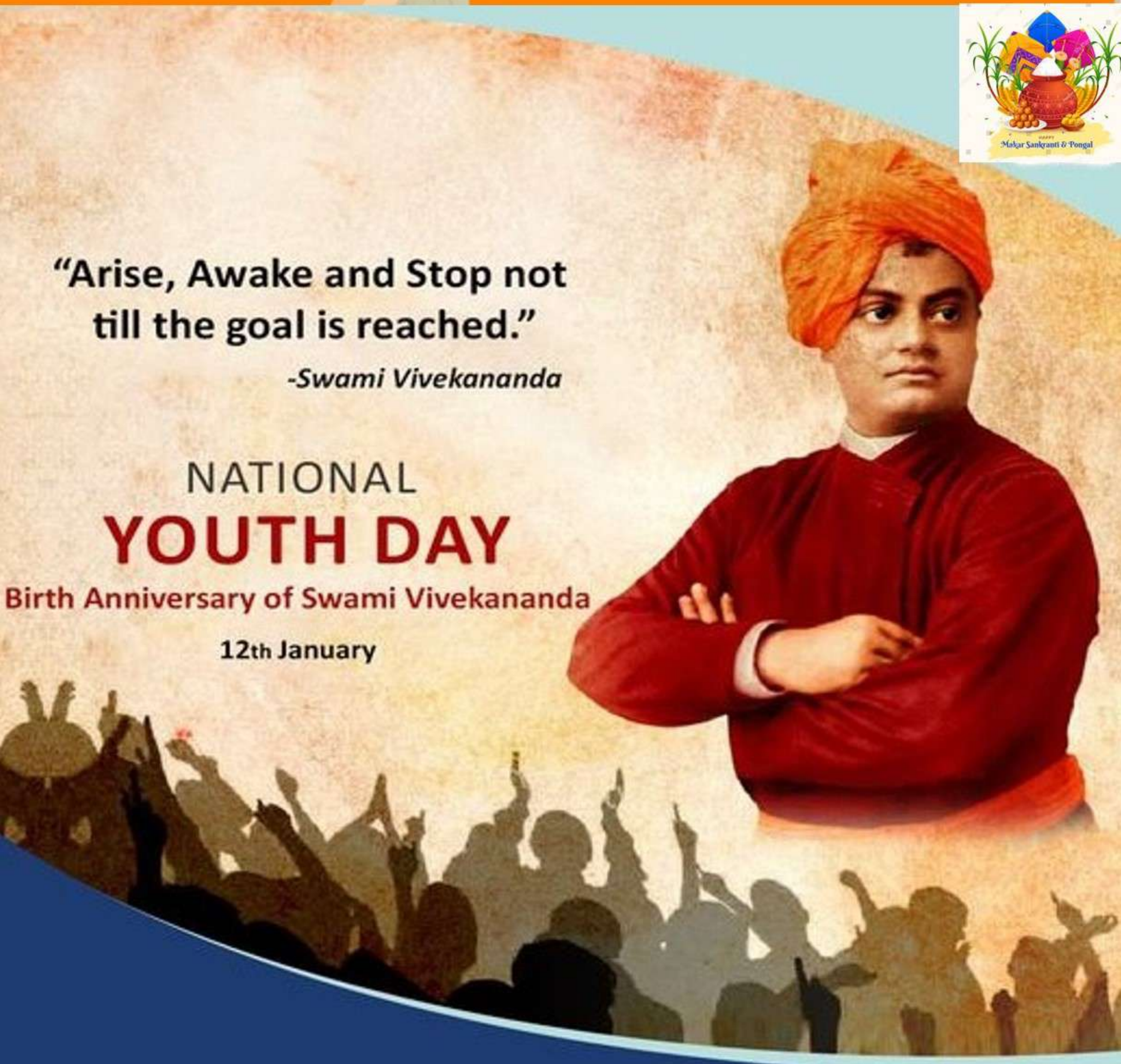
An International Multidisciplinary Monthly e-Magazine



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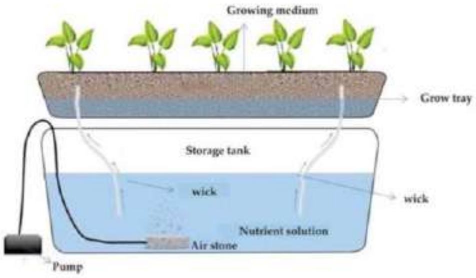

Wick System

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From the Desk of Editor-in-chief

January 2024 |Vol. 04 |Issue No. 01

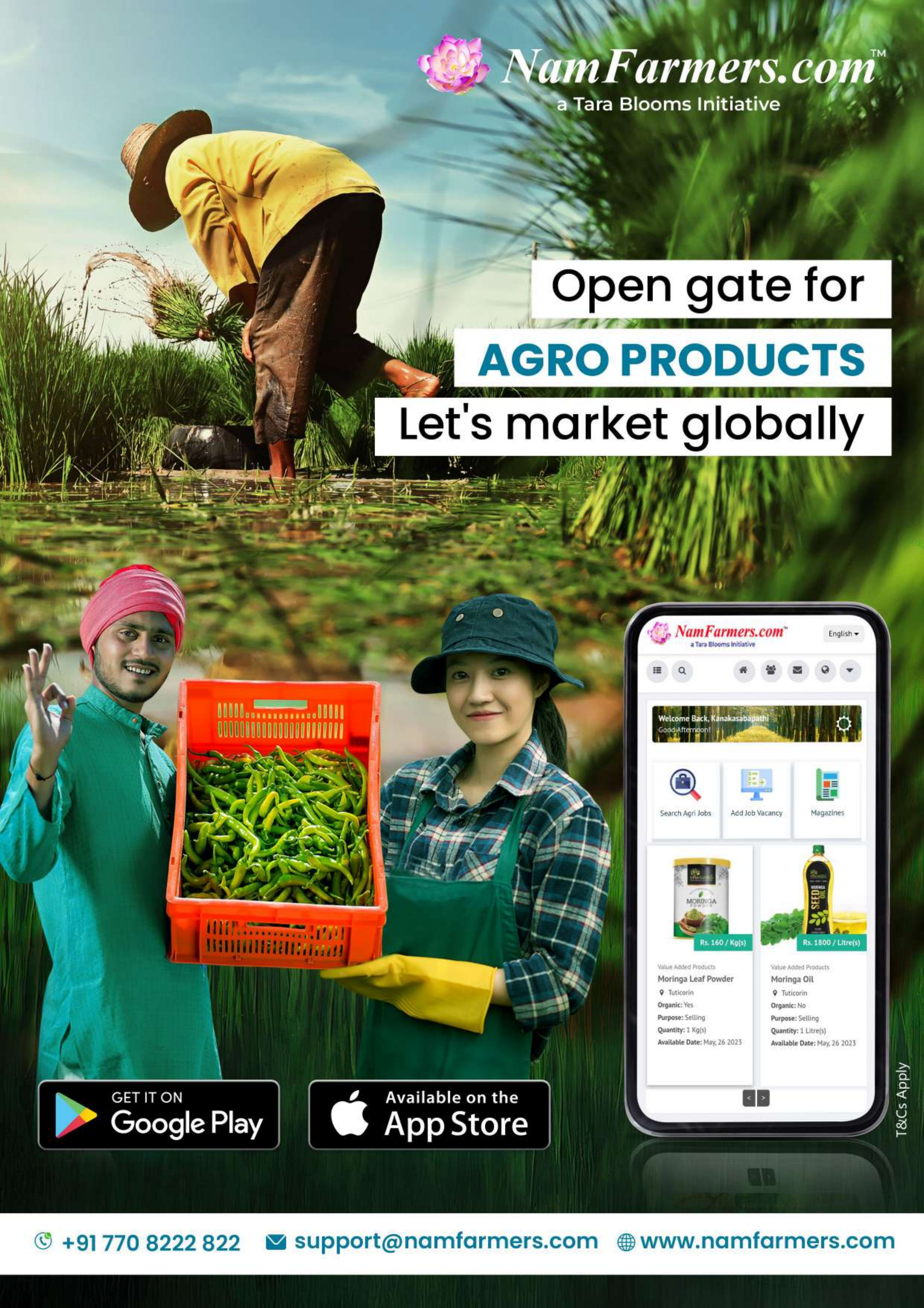
I would like to introduce the launch of **"AgriGate - An International Multidisciplinary Monthly e-Magazine Volume 04 Issue No. 01 – January 2024"** with immense pleasure. Our team is privileged to dedicate this issue to **Swami Vivekananda**. The birth anniversary of Swami Vivekananda celebrated every year on 12 January. The government had decided to observe it as **National Youth day** (Rashtriya Yuva Diwas) because the philosophy of Swamiji and the ideals for which he lived and worked could be a great source of inspiration for the Indian Youth. He had given a speech at the Parliament of the World's Religions in Chicago and glorified India's name.

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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Volume: 04 Issue No: 01

GENOMIC SELECTION IN PLANT BREEDING

Article ID: AG-VO4-I01-01

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Abstract

Improved crop types are being developed by a revolutionary method in plant breeding called genomic selection. To forecast and select desired features, this method makes use of the abundance of genetic information found in the genome of an organism. Genomic selection shortens the time and resources needed for conventional plant breeding techniques by finding certain genetic markers linked to significant agronomic features including high yield, stress tolerance, and disease resistance. The approach speeds up the breeding process by shortening the breeding cycle duration.

Keywords: Genomic Selection, GEBV, Genotyping, Phenotyping, Statistical Model.

Introduction

Genomic selection is a novel method that has been effectively applied in the breeding of plants and animals, revolutionising the process of choosing individuals with desired qualities for progeny. This strategy makes use of sophisticated genomic technologies and statistical techniques to estimate an individual's genetic potential from their DNA data (Abhirami et al., 2023). Multiple traits, even those with minimal heritability or those that are challenging to measure directly, can be improved simultaneously by genomic selection.

Genomic selection (GS)

The conventional breeding approach for enhancement of low heritable multi-genic quantitative traits, such as yield, quality, biotic and abiotic stress tolerance, through the phenotypic selection (PS) become challenging and time-consuming. PS is challenging by being laborious, population size, cost ineffective, time-consuming, less rapid, and reliable and the characters are highly influenced by the environment (Figure 1). Hence, an effective rapid selection method based on genetic evaluation is needed. Genomic selection (Genomic breeding or genomic prediction), grasps the genetic information of an individual through molecular markers and predicts the genetic potential of various traits of interest. The application of genome selection was proposed by Meuwissen et al. (2001) to the breeding population as a solution for the inadequacy of MAS in improving polygenic traits controlled by many loci of small minor effects. The selection of parents either for breeding or generation advancement based on the genotypic breeding value increases the heritability and genetic gain of the interested trait. Molecular markers are commonly used for the indirect selection of trait of interest and thereby provides the genetic status. A combination of marker data from a single cross and estimates of marker effects are used to compute the genomic estimate of breeding value or GEBV. High-density molecular markers are used for the search across the genome of the training and breeding populations (Desta and Ortiz, 2014).

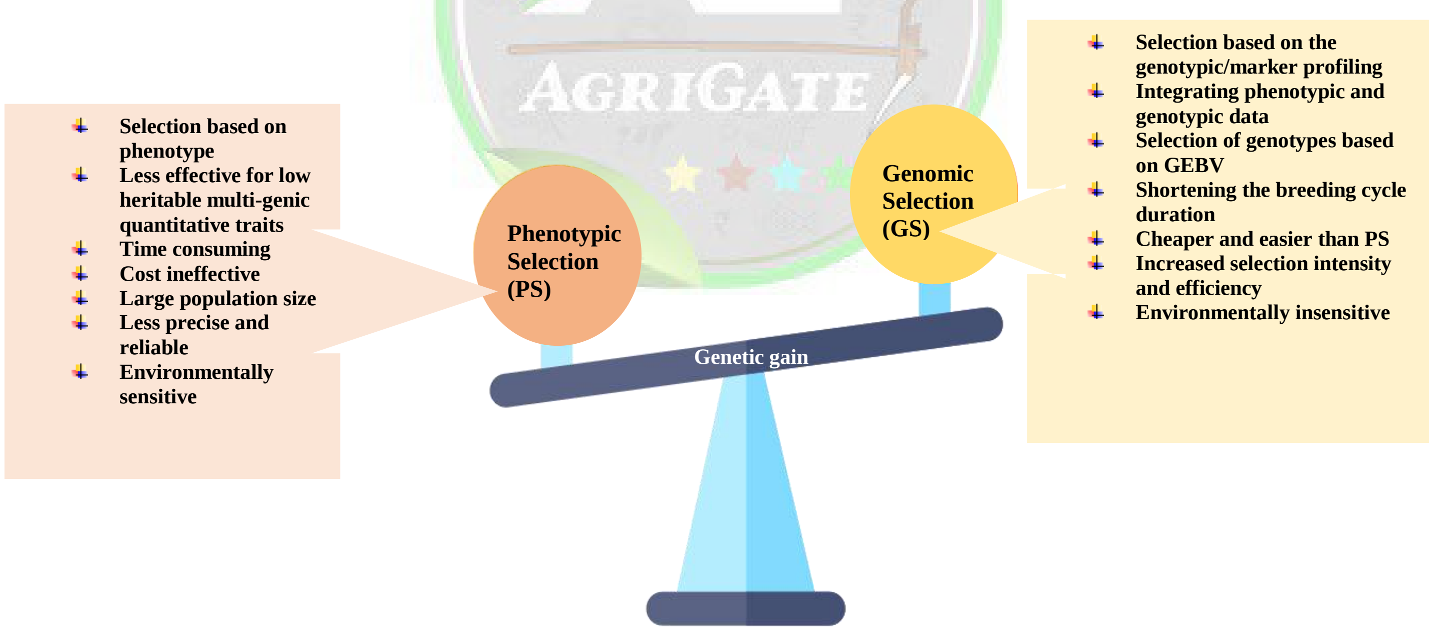

Figure 1. Comparison of Phenotypic Selection (PS) and Genomic Selection (GS)

Genomic selection consists of two populations, such as training population and the breeding population. The primary step of GS is calculating GEBVs for individuals with only genotypic data by applying a model that was "trained" on individuals with phenotypic and genotypic data.

The term "training population" refers to individuals possessing both genotypic and phenotypic data. This group is utilised to determine model parameters, which are then employed to determine the GEBVs of selection candidates, such as breeding lines, that solely have genotypic data (Heffner et al., 2009). The individuals chosen for further development in the breeding cycle are subsequently selected using these GEBVs. Consequently, a model that predicts an individual's breeding value can be utilised for selecting an individual in the absence of phenotypic data (Meuwissen et al., 2001). The training population needs to be representative of selecting candidates in the breeding programme where GS will be used to optimise GEBV accuracy (figure 2).

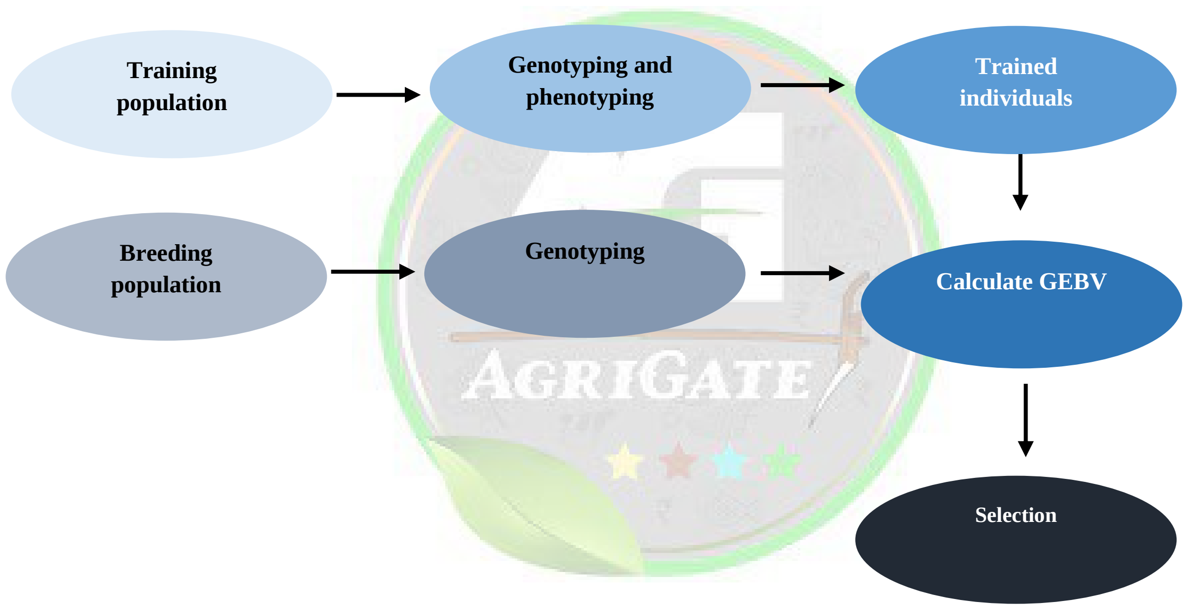

Figure 2. The flowchart of the genomic selection (GS) approach

1. **Genotyping:** To start the process of genomic selection, a breeding population's individuals must be genotyped in large numbers. This entails locating and classifying genetic markers spread throughout an individual's genome, such as single nucleotide polymorphisms (SNPs).
2. **Phenotyping:** Individuals in the breeding population undergo meticulous phenotyping in tandem with genotyping, which involves assessing the individual's actual performance for desired attributes (such as yield, disease resistance, drought tolerance, etc.). The predictions made by the genomic selection model will be increasingly accurate and comprehensive the more phenotyping data available.

3. **Training the model**: Subsequently a statistical model based on the genotyping and phenotyping data is developed. This model establishes the correlations between genetic markers and the observed phenotypes. For this, machine learning algorithms like Lasso Regression, Ridge Regression, and Bayesian techniques are frequently employed.
4. **Prediction**: once the model is trained, the model uses only the genotyping data to estimate the performance of untested individuals in the breeding population. This is especially helpful for characteristics that are costly or challenging to measure directly because the model may yield precise estimates without requiring a lot of phenotyping.
5. **Selection**: Breeders can choose individuals with the most desired genetic profiles for additional breeding by using the predictions provided by the genomic selection model—the likelihood of having offspring with the desired features.

Genomic selection in crop improvement

The discovery and accessibility of molecular markers for crop improvement turned into a new era of science and it reshaped the breeding programme by facilitating rapid gain from selection. However, the molecular markers had limitations in improving polygenic traits which are controlled by many genes with minor effects. In traditional MAS the markers are associated with known traits and those are helpful for desired trait improvement (Jose et al., 2023). But, in the GS the markers covering the whole genome are used for quantitative trait loci (QTL) with linkage disequilibrium. The decreased cost and availability of markers and NGS for sequencing leads to easier genotyping of the plants than the time-consuming, labour and land-intensive, resource-dependent plant phenotyping. So, genotyping with predicted statistical models enables the selection of superior individuals without going for a phenotyping procedure. Hence, genomic selection is more important in crop improvement than traditional MAS practices. Breeding is accelerated greatly by genomic selection. Genomic selection allows breeders to choose plants with the required traits earlier in the breeding programme than traditional breeding approaches, which may take several generations to produce the desired features. Because genetic information can be used to predict performance before plants are grown in the field, genomic selection can lessen the need for time-consuming phenotyping and extensive field trials. This will save time and resources. Genetic variety can be introduced into crops by genomic selection, which is essential for increasing crop resistance to pests, diseases, and shifting environmental circumstances. Genomic selection can be used in precision agriculture to enhance crops as well as to help farmers make data-driven decisions on pest management, fertilisation, and crop management.

Haplotype- Genomic Selection (HaploGS)

The haplotypes are used in the prediction with improved accuracy and efficiency. The haplotype maps help in the identification and utilization of traits of interest with high accuracy. It provides the identification of rare alleles and epistatic interaction, multiallelic with high polymorphic content, control false positives and negatives, high detection power of marker-trait association and low accuracy in GEBV prediction for genotype selection. In comparison to individual SNPs, the haplotype-assisted GS more accurately illustrates the complex links between genotypic data and phenotypes. Thus, in the end, this strategy might aid in maximising selection gain per unit of time. Using haplotypes in GS is certain to enhance prediction accuracy and help fully exploit genome-assisted breeding potential for crop improvement (Bhat et al., 2021).

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UNLOCKING THE SECRETS OF MILLETS

Article ID: AG-V04-I01-02

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Introduction

Millets have deep historical roots, dating back thousands of years. Originating in Africa and Asia, these small-seeded grasses were among the earliest cultivated crops. Millets played a vital role in the agricultural practices of ancient civilizations, such as those in India, China, and Africa. Their adaptability to diverse climates and resistance to pests made them an integral part of traditional farming systems.

Staple Diets of Ancient Civilizations

In various ancient cultures, millets were a staple in daily diets. Their hardiness allowed them to flourish in regions with challenging growing conditions, becoming a reliable food source for communities. Millets, such as pearl millet, sorghum, and finger millet, were not only consumed as whole grains but were also ground into flour for making a variety of traditional dishes like flatbreads, porridges, and fermented products.

Decline During the Green Revolution

The mid-20th century marked a significant shift in global agriculture with the advent of the Green Revolution. During this period, a focus on high-yielding varieties of rice and wheat led to the neglect of traditional and hardy crops like millets. The emphasis on monoculture and the introduction of hybrid varieties led to a decline in millet cultivation as farmers favored crops with higher yields.

Rediscovery in the 21st Century

In recent decades, there has been a renewed interest in millets driven by a growing awareness of the need for sustainable and resilient agricultural practices. Millets are now recognized for their ability to thrive in diverse climates, including arid and semi-arid regions. As global concerns about climate change, water scarcity, and food security have intensified, millets have emerged as a smart and strategic choice for both farmers and consumers.

Nutritional Renaissance

Millets are not only hardy crops but are also rich in nutrients. Their nutritional composition includes high levels of dietary fiber, protein, vitamins, and minerals. As health-conscious consumers seek diverse and nutrient-dense food options, millets have gained prominence as a valuable addition to a balanced diet. Their low glycemic index also makes them suitable for individuals with diabetes.

Current Role in Agriculture and Nutrition

Today, millets are experiencing a renaissance in both agriculture and nutrition. Governments, NGOs, and agricultural researchers are promoting millet cultivation to enhance food security, reduce environmental impact, and foster sustainable farming practices. Simultaneously, consumers are embracing millets as a wholesome and nutritious alternative to more conventional grains, contributing to a broader movement toward healthier and more sustainable food choices.

Nutritional Value of Millets

Millets, often referred to as "nutri-cereals," are power-packed grains that offer a myriad of health benefits due to their impressive nutritional profile. Here's an in-depth look at the nutritive value of millets:

Protein Content:

Millets are rich in protein, making them an excellent source for vegetarians and those looking to increase protein intake. The protein in millets is of high quality, containing essential amino acids vital for various bodily functions.

Dietary Fiber:

Millets are abundant in dietary fiber, including both soluble and insoluble fibers. This fiber content aids in digestion, regulates blood sugar levels, and contributes to a feeling of fullness, making millets a valuable component in weight management and diabetes control.

Essential Nutrients:

Millets are a good source of essential nutrients such as iron, zinc, magnesium, and phosphorus. These minerals play crucial roles in maintaining bone health, immune function, and overall well-being.

Vitamins:

Millets contain various vitamins, including B-complex vitamins like niacin, riboflavin, and folic acid. These vitamins are essential for energy metabolism, skin health, and the synthesis of red blood cells.

Antioxidants:

Millets are rich in antioxidants, including phenolic compounds and flavonoids. These antioxidants help combat oxidative stress in the body, reducing the risk of chronic diseases and supporting overall health.

Low Glycemic Index:

Millets have a lower glycemic index compared to refined grains, meaning they cause a slower and steadier rise in blood sugar levels. This characteristic makes millets suitable for individuals with diabetes or those aiming to manage blood sugar levels.

Gluten-Free:

Millets are naturally gluten-free, making them an excellent choice for individuals with gluten intolerance or celiac disease. This quality has contributed to the increasing popularity of millets as a substitute for gluten-containing grains.

Cardiovascular Health:

The fiber, antioxidants, and magnesium in millets contribute to heart health. These components help lower cholesterol levels, reduce blood pressure, and support overall cardiovascular well-being.

Weight Management:

The combination of high fiber content and good protein quality in millets can aid in weight management by promoting satiety and supporting lean muscle mass.

Environmental sustainability

Millets play a vital role in promoting environmental sustainability, contributing to a more resilient and eco-friendly agricultural landscape. Here's an exploration of how millets positively impact the environment:

Water Efficiency:

Millets are inherently drought-tolerant and require significantly less water compared to major staple crops like rice and wheat. Their ability to thrive in semi-arid and arid conditions makes them an ideal choice for regions facing water scarcity.

Reduced Carbon Footprint:

Millet cultivation generally involves lower greenhouse gas emissions compared to water-intensive crops like rice. The reduced need for water and associated irrigation contributes to a decreased carbon footprint, aligning with global efforts to combat climate change.

Biodiversity Conservation:

Millets contribute to the preservation of agricultural biodiversity. Their cultivation supports a more diverse range of crops, promoting ecosystem resilience and reducing the risk of monoculture-related issues, such as pest outbreaks and soil degradation.

Soil Health:

Millets have relatively shallow root systems, which can help prevent soil erosion. Additionally, their growth cycle often involves less soil disturbance, preserving soil structure and reducing the need for extensive plowing.

Agroecological Resilience:

Millets are well-suited to diverse agroecological zones, including regions with poor soil fertility. Their adaptability allows for cultivation in areas where other crops might struggle, fostering resilient agricultural systems that can withstand varying environmental conditions.

Low Input Requirements:

Millets are generally hardy crops that require fewer inputs such as fertilizers and pesticides compared to other major grains. This not only reduces the environmental impact of agricultural practices but also makes millet farming more economically viable for small-scale farmers.

Energy Efficiency:

Millets often have shorter growth cycles and require less energy input during cultivation compared to some staple grains. This characteristic enhances the overall energy efficiency of millet farming systems.

Climate Change Adaptation:

The adaptability of millets to diverse climates positions them as key players in climate change adaptation. Their ability to thrive in challenging conditions can contribute to food security in regions vulnerable to climate-related uncertainties.

Preservation of Traditional Knowledge:

The cultivation of millets often involves traditional and indigenous agricultural practices. Supporting millet farming helps preserve and promote traditional knowledge systems that are often more attuned to sustainable and locally appropriate agricultural methods.

Global Food Security:

As climate change poses challenges to traditional food crops, diversifying agricultural practices with climate-resilient crops like millets becomes essential for ensuring global food security.

Millet Culinary Diversity and Innovation

Millets, often regarded as traditional grains, are experiencing a culinary renaissance, captivating chefs, home cooks, and food enthusiasts alike. Their versatility and nutritional benefits have sparked a wave of culinary creativity. Here's an exploration of how millets are contributing to culinary diversity and innovation:

Versatility in Cooking:

Millets are versatile and can be incorporated into various dishes, including cereals, bread, porridge, and even desserts. This versatility makes it easier for individuals to include millets in their regular diet.

Traditional Millet Dishes:

Millets have been staple foods in many cultures for centuries, contributing to a rich tapestry of traditional dishes. Explore the diverse culinary heritage of millets, from Bajra Roti in India to Injera in Ethiopia and Foxtail Millet Porridge in China. These traditional recipes showcase the adaptability of millets across different cuisines.

Gluten-Free Alternatives:

With an increasing awareness of gluten intolerance, millets have gained popularity as gluten-free alternatives. Millet flour is used to create gluten-free bread, cakes, and other baked goods, providing a flavorful and nutritious option for those with celiac disease or gluten sensitivity.

Millets in Mainstream Cuisine:

Millets are making their way into mainstream cuisine as chefs and home cooks experiment with incorporating them into everyday dishes. From millet salads to millet pilaf, these grains are being embraced for their unique texture, nutty flavor, and ability to enhance the nutritional profile of meals.

Millet-Based Snacks:

The snack industry has witnessed a surge in millet-based products. Millet chips, crackers, cakes, biscuits and granola bars are gaining popularity as healthier alternatives to conventional snacks. These snacks not only cater to health-conscious consumers but also introduce millets to a wider audience.

Millets in Global Fine Dining:

Renowned chefs are elevating millets to gourmet status by featuring them in high-end dishes. Millets are being used in fine dining establishments to create sophisticated and innovative culinary experiences, challenging the notion that millets are solely "rustic" or "traditional" ingredients.

Millets in Fusion Cuisine:

The adaptability of millets makes them perfect for fusion cuisine. They seamlessly integrate into dishes inspired by various culinary traditions, creating exciting fusions that showcase the global appeal of millets.

Millets in Breakfast Options:

Millets have become popular choices for breakfast options, offering a nutritious start to the day. Millet porridge, smoothie bowls with millet toppings, and millet pancakes are just a few examples of how millets are revolutionizing breakfast menus.

Millet-Based Beverages:

Millets are being explored as key ingredients in beverages. Millet-based drinks, such as millet milk and millet-based smoothies, are gaining traction as alternatives to traditional dairy and sugary beverages.

Community-Led Innovations:

Communities are innovating with millets, developing recipes that reflect local tastes and preferences. From millet-based street food to community-driven cooking initiatives, these innovations are contributing to the revitalization of millets in contemporary culinary landscapes.

Home Cooking and Social Media Influences:

Social media platforms are playing a significant role in popularizing millet-based recipes. Home cooks and food influencers share creative millet recipes, inspiring others to experiment with these grains in their kitchens and contributing to a broader culinary movement.

I. <u>Challenges and Future Prospects</u>

As millets regain attention and popularity, certain challenges persist while promising prospects emerge on the horizon. Understanding and addressing these aspects is crucial for the sustainable growth of millet cultivation and consumption.

<u>Challenges:</u>

Limited Awareness:

Despite the nutritional and environmental benefits of millets, there is a lack of widespread awareness. Many consumers, especially in urban areas, remain unfamiliar with millets, hindering their integration into mainstream diets.

Market Access and Demand:

The market for millets faces challenges related to access and demand. Establishing reliable supply chains, creating market linkages, and promoting millets as commercially viable products are ongoing challenges that need attention.

Policy Support:

Adequate policy support is crucial for the growth of millet agriculture. Policies that incentivize millet cultivation, provide subsidies, and integrate millets into public distribution systems can significantly boost their production and consumption.

Research and Development:

Continued research is needed to enhance millet varieties, improve agronomic practices, and develop new processing techniques. Limited investment in research and development can impede the scalability of millet cultivation.

Scaling Up Production:

While millets are resilient crops, scaling up their production to meet increasing demand requires overcoming challenges such as mechanization, standardized farming practices, and overcoming yield gaps.

Future Prospects:

Health and Wellness Trend:

The global shift towards healthier eating habits presents a significant opportunity for millets. Their nutritional density, gluten-free nature, and suitability for various diets position them well in the health and wellness market.

Diverse Product Development:

Future prospects include the development of a wide range of millet-based products, from baked goods to snacks and beverages. The versatility of millets allows for innovative culinary applications that cater to diverse consumer preferences.

Climate Resilience:

Millets' adaptability to diverse climatic conditions positions them as climate-resilient crops. As climate change continues to impact agriculture, millets can play a crucial role in ensuring food security in vulnerable regions.

Inclusive Farming Practices:

Future prospects include promoting inclusive and sustainable farming practices. Empowering smallholder farmers, especially women, to cultivate millets and integrating them into agroecological systems can contribute to rural development.

Culinary Tourism and Experiences:

Millets can become key players in culinary tourism, attracting food enthusiasts seeking unique and authentic experiences. Culinary events, festivals, and tours centered around millet-based cuisines can contribute to their cultural and economic significance.

Community-Led Initiatives:

Community-driven initiatives and social enterprises focused on millets have the potential to transform local economies. Supporting grassroots movements and empowering communities to leverage millets can create a more inclusive and sustainable food system.

Collaborations and Partnerships:

Collaboration among governments, NGOs, research institutions, and private sectors is critical for addressing challenges collectively. Partnerships can facilitate knowledge exchange, technology transfer, and the development of effective strategies for millet promotion.

Educational Campaigns:

Comprehensive educational campaigns can raise awareness about the benefits of millets among consumers, farmers, and policymakers. Emphasizing their nutritional, environmental, and economic advantages can drive increased acceptance and demand.

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UNDERUTILIZED AQUATIC VEGETABLES IN INDIA

Article ID: AG-VO4-I01-03

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Introduction

Vegetables being rich in nutrients can be cultivated in wide range of environments. The vegetables growing in water or marshes are called as aquatic vegetables. Aquatic vegetables are all crop species growing in pools or lowlands and paddy fields. And it has a very long cultivation history in world. Aquatic vegetables are all enjoyed for their crisp, tasty qualities and special flavor, and most of them have exceptional health and appreciation value. Many of them originate in Asia, and they are an essential part of the Asian plant germplasm resource. India also produces more aquatic vegetables than any other country in the world. Nowadays, research focuses on germplasm resources and breeding, mechanisms of edible organ development and control, processing, and ecology. During the regulation of rural crop construction, ideal economic and ecological benefits have been achieved in some parts of Asia, when aquatic vegetables were grown instead of rice or inter-planting rotation was applied in some paddy fields around the world. The exploitation and utilization of aquatic vegetables remain efficient paths to enrich the countryside and relieve poverty.

AQUATIC VEGETABLES

Vegetables are the key component of balanced human diet and also the main drivers in achieving global nutritional security by providing nutrients, vitamins and minerals. Several minor vegetables are there which have less importance and more nutrients and minerals and these are considered as underexploited vegetable crops. Aquatic vegetable production in semi-intensive and intensive systems is widespread and commercially significant around many cities in South -East Asia. Aquaculture can be broadly defined as the farming or culture of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants where according to FAO (1995) 'farming implies some form of intervention in the rearing process to enhance production. Aquatic vegetables like water spinach is produced throughout the year, whereas water mimosa is cultivated only in the summer (April to August) and water dropwort and water cress are produced in the winter.

Most production occurs in flooded fields, some of which were converted from rice production to generate a higher income; water spinach is also cultivated floating on canals within the city. Water mimosa and water spinach production is reported from peri-urban backwaters

Table (1). Aquatic vegetables their scientific name, family and edible parts

S.No	**Common Name**	**Scientific Name**	**Family**	**Edible parts**
1.	Aponogeton	*Aponogeton crispum*	Aponogetonaceae	Starchy tuberous rhizome
2.	Achyranthe	*Achyranthes aquatica*	Amaranthaceae	Tender leaves andtwigs
3.	Buffalo spinach	*Enydra fluctuans*	Asreraceae	Leaf vegetable
4.	Chinese Arrowhead	*Sagitaria trifolia*	Alismataceae	Tuberous root
5.	Cattail	*Typha angustifolia*	Typhaceae	Rhizome. petiole
6.	Chinese water chestnut	*Eleocharis* sp.,	Cyperaceae	Rhizome
7.	Common Water plantain	*Alisma plantago-aquatica* L.	*Alismataceae*	Roots, leaves and petioles
8.	Duck lettuce	*Ottelia alismoides*	Hydrocharitaceae	Petioles and tender leaves
9.	Eel grass	*Vallisneria spiralis*	Hydrocharitaceae	Leaf vegetable
10.	Frog bit	*Hydrocharis dubia* (Blume) Backer	Hydrocharitaceae	Mucilaginous leavesand inflorescence

11.	Fragrant Water Lily	*Nymphaea odorata*	Nymphaeaceae	Rhizome
12.	Golden club	*Orontium aquaticum*	Araceae	Edible root
13.	Gorgon nut	*Euryale ferox*	Nymphaeaceae	Nut
14.	Giant chick weed	*Stellaria aquatica* L.Scop.	Caryophyllaceae	Young leaves andstem
15.	Hydrolea	*Hydrolea zeylanica*	Hydroleaceae	Young shoots
16.	Indian blue water Lily	*Nymphaea stellata*	Nymphaeaceae	Rhizome
17.	Indian Red water lily	*Nymphaea nouchali*	Nymphaeaceae	Rhizome
18.	Keysoor	*Scirpus grossus*	Cyperaceae	Starchy root
19.	Lotus	*Nelumbo nucifera*	Nymphaeaceae	Rhizomes, young leaves and lower buds
20.	Monochoria	*Monochoria hastata*	Pontederiaceae	Leaf vegetable
21.	Manchurian Rice	*Zizania latifolia*	Poaceae	Infected culms
22.	Pygmy water lily)	*Nymphaea tetragona* Georgi	Nymphaeaceae	leaf buds and seeds
23.	Parrot's Feather	*Myriophyllum aquaticum*	Haloragaceae	Edible leaves
24.	Paracress	*Spilanthes acmella*	Asteraceae	Leaf vegetable,salad
25.	Papyrus	*Cyperus papyrus*	Cyperaceae	Pith of young shoots
26.	Swamp taro	*Cyrtosperma hamissonis*	Araceae	Rhizome
27.	Sonneratia	*Sonneratia caseolaris*	Sonneratiaceae.	Immature fruit
28.	Velvet leaf	*Limnocharis flava*	Limnocharitaceae	Leaf vegetable
29.	Water lettuce	*Pistia stratiotes*	Araceae	Leaf vegetable
30.	Water mimosa	*Neptunia oleracea* Loureiro	Fabaceae	Young shoots
31.	Water pepper	*Polygonum hydropiper*	Polygonaceae	Leaf vegetable

32.	Water fern	*Dentella repens* Jst.	Rubiaceae	Leaf
33.	Water shield	*Brasenia schreberi*	Cabombaceae	Leaf vegetable
34.	Water chest nut	*Trapa bispinosa*	Trapaceae	Kernel
35.	Water dropwort	*Oenanthe stolonifera*	Apiaceae	Pot herb
36.	water cress	*Rorippa nasturtium-aquaticum*	Cruciferae	Leaf vegetable
37.	Water sprite	*Ceratopteris thalictroides*	Parkeriaceae	Edible fern

NUTRITIONAL IMPORTANCE OF AQUATIC VEGETABLES

1) A number of aquatic vegetables viz. water chestnut, lotus and watercress and *Ipomoea aquatica* are grown as a green vegetable. Earlier references indicate that the Egyptians were fond of to consume rhizomes of *N. lotus* which when cooked resembled egg-yolks.

2) The culms of *Cyperus papyrus* were also chewed raw, boiled or roasted. Orient *Nelumbo nucifera* has been widely cultivated and its fruit and rhizomes used in a variety of cooked and fresh dishes for many centuries, as also have the rhizomes of *Sagittaria trifolia*, the floury seeds of the lily *Euryale ferox*, and the starch and fat-laden horned fruits of *Trapa* spp. The fruits of *T. bicornis*, *T. natans* and *T. incisa* form a staple food in continental Asia, Malaysia and India.

3) Canadian wild rice (*Zizania aquatica*) has been eaten by North American Indians for over 300 years and is nowgrown commercially in the U.S.A. The swollen tubers of *Aponogeton* species and *Cyperus esculentus*,and the rhizomes of *Typha latifolia* and *T. angustifolia* and the rhizomes of several species of *Sagittaria*, and the rhizomes and seeds of *Nelumbo lutea* and Orontium aquaticum have been an important carbohydrate source for the North American Indians.

4) The dried and powdered rhizomes of *Butomus umbellatus*, *Calla palustris* and *Menyanthes trifoliate* have been extensively used to make bread by the Eskimoes and other people of northern Eurasia.

5) In India young leaves, stems and roots of *Ipomoea aquatica* are eaten, and both there and in Malaysia the foliage of *Ottelia alismoides*, and all the plant (except roots) of *Monochoria hastata* and *M. vaginalis* are eaten.

6) In Java juvenile plants of *Limnocharis flava* are a common vegetable. Several species of *Ceratopteris* are cultivated as a green salad crop in parts of Africa and tropical Asia. In temperate regions watercress (*Rorippa* spp.) is cultivated.

	
Aponogeton crispum	*Brasenia schreberi*
	
Cattail	Chinese water chestnut
	
Duck lettuce	Hydrolea

	
Nelumbo nucifera	*Nymphaea stellata*
	
Cyperus papyrus	*Sagitaria trifolia*
	
Vallisneria spiralis	*Alisma plantago-aquatica*

	
Water shield	*Water spinach*

MEDICINAL IMPORTANCE OF AQUATIC VEGETABLES

A number of aquatic vegetables possess immense potential several health related principles. They are medicinally utilized in different parts of the world and local people are well acquainted for their healing properties. A list of the aquatic vegetables and medical attributes has been highlighted in table (2).

Table (2). Aquatic vegetables and their medical attributes

Aquatic vegetables	**Family**	**Medicinal Properties**
Water spinach (*Ipomoea aquatica*)	Convolovulaceae	• Emetic, purgative; • In Assam, the plant used nervous and general disability. It is also used for piles.
Cattail (*Typha angustifolia* and *T. Latipholia*)	Typhaceae	• The leaves are diuretic. • Pollens are dusted on bleeding wounds to prevent the flow of blood. • Used in the treatment of nose bleeds, haematemesis, haematuria, uterine bleeding, dysmenorrhoea, postpartum abdominal pain. • In China, “Puhuang” is the traditional drug obtained from *Typha* plants.

Eel grass (Vallisneriaspiralis)	Hydrocharitaceae	• The plant is aperitif, demulcent, refrigerant, stomachic and is also used in the treatment of women's complaints. • It is also used in the treatment of leucorrhoea and is made into a tea with sesame (*Sesamum indicum*) to improve the appetite.
Duck- lettuce (*Ottelia alismoides*)	Hydrocharitaceae	• Leaves are used in to cure hemorrhoids. • The plant has rubeficient properties
Water plantain (*Alisma plantago-aquatica L.*)	Alismataceae	• The powdered seed is an astringent, used in cases of bleeding. • The seed is also said to promote sterility. • The root contains an essential oil and has a wide range of medicinal uses. • It is antibacterial, anti-cholesterolemic, diuretic and hypotensive It lowers blood pressure, cholesterol and blood sugar levels.
Water shield (*Brasenia schreberi*	Cabombaceae	• Leaves contain Gallic acid and traces of vitamin B12
Papyrus (*Cyperus papyrus*)	Cyperaceae	• The pith is recommended for widening and drying of fistula. Its ash is useful in certain eye diseases; • Its ash checks malignant ulcers from spreading in the mouth or elsewhere.
Dwarf water clover (*Marsilea minuta)*	Marsileaceae	• Leaf juice is used to stop nose bleeding and indigestion is treated by eating the pounded leaves cooked with rice • boiled and rolled in a leaf of Shorea robusta are used to reduce the swelling of the gums

Conclusion

Even though aquatic vegetables possibly will be important to only local communities and contributing to very tiny part of food security, still, its multifaceted benefits in terms of maintaining urban bodies in flood control, amenity uses, wild life and broader environmental benefits may be considered in very holistic manner. There is a need to find techniques that will allow us to use wetlands as wetlands. Cultivating aquatic vegetables is one possible way.

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CANOPY MANAGEMENT IN CASHEW THROUGH TRAINING AND PRUNING TECHNIQUE

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Introduction

Cashew is a tropical nut tree introduced from Brazil during the 16th century to mitigate soil and water erosion in coastal areas. The commercial cultivation of cashew started during late 19th century when the relishing and nutritive status of cashew nuts was explored. Every year cashew growing area has increased exponentially not only for the delicious nut but also for reasonable income with minimum crop management practices. Cashew is a vigorously growing woody perennial tree. Naturally grown cashew trees produce unconditional branches resulting in irregular canopy shapes. Sometimes, the condition of too many branches in one direction results in the lodging of trees. In such kind of orchards, taking up intercultural operations in later years become difficult and those cris-crossed branches affect the quantity of light interception which results in low yield and poor-quality fruit development. Light is an important natural requirement for plant growth, development, yield, and production of quality fruits. The green leaves exposed to sunlight produces photo assimilates such as carbohydrate and sugars which are translocated to the needy and interior plant parts *viz.*, shoots, buds, flowers, and fruits. Since, trees' shape determines light interception, maintaining the shape of the tree through proper training and pruning practices is essential.

Training

Training is a method of regulating plant growth in a desired direction during the early years of planting, to form a definite canopy shape. Such type of initial training provides a good architecture to the plants and is further helpful in good nut production. In the case of the new plantations with the grafts the plants should be trained in the early years i.e., 2-3 years so as to provide better plant architecture which facilitates easy inter-cultural operations. Training indirectly assists in the ease of other operations such as weeding, manuring, and pest and disease management (Satpathy, 1988)

In cashew, the training system and the diameter of the canopy to be maintained are dependent on spacing. In general, two types of training systems are being practiced in cashew, a) Modified leader system and, b) Open center system.

a) Modified leader system

In this system, cashew grafts are allowed to grow as single stem up to a height of 75 to 100 cm by removing side sprouts. Then lateral branches are allowed to grow at desirable direction by de-topping. De-topping height varies from 2.5 to 4 m depending on spacing. Under normal spacing (8m x 8m), de-topping at 4 m from ground level is recommended. Whereas, for high-density planting (5m x 5m), de-topping at 2.5 m from ground level is recommended. Removal of cris-cross branches and trimming of branches has to be resorted to getting dome shape canopy and the same should be maintained in later years by imposing mild pruning. This kind of canopy helps in reducing weak shoots and water shoot development. The modified training system is suitable for both normal and high-density planting systems.

b) Open center system.

Cashew grafts are allowed to grow straight up to 50-60 cm from ground level. The terminal growing point is pinched off to form lateral branches. The branches are regulated to grow in four directions at equal distances. Because of fast vegetative growth, the canopy spreads rapidly. To avoid this, the canopy center needs to be opened once in a while to support more light interception to the interior plant parts. This encourages flowering at the inner and outer surface of the canopy and thus increases the yield.

Pruning systems in cashew

Cashew plantation under normal or less spacing requires regular pruning to avoid unnecessary supply of photo assimilates to unproductive shoots i.e., water shoots and week branches.

In cashew, trimming of exhausted branches induce productive growth and helps to promote the yield. In a high-density planting system, pruning operation plays a vital role to accommodate the canopy within the allotted space. Pruning and canopy shaping along with suitable special operations need to be taken up every year after the harvest of the crop. Cashew trees enter a distinct resting period (quiescent stage) after harvest (May – June) till the next flush production time (September - October). The lateral shoots which bear flowers/fruits are formed in the terminal of the leader shoot after the resting period. The past season leader shoots can produce only one lateral from its terminal. Pruning enhances the production of lateral shoots, thus the yield can be increased. Pruning intensity and time vary for different specific agro-climatic regions. The details of pruning pertaining to the East coast region are furnished in the table below

Region	Best Pruning method	Month of pruning	Collective operations (if any)	Percentage of yield increase	Suitable varieties
Karnataka	Leader shoot pruning (Secondary shoots) 50 % to 60 % canopy	July	-	34.02	H-130,VRI-1, VRI-3,Vengurla-4,Ullala - 1,VTH30/4
	Leader shoot pruning (Secondary shoots) Whole tree	August	-	53.85	VTH-539
Tamil Nadu	Lateral shoot pruning (Tertiary shoots Whole tree	August	Two foliar spray 1. New flush stage (August)- NPK-19:19:19 @1 % 2. Flowering stage (December-January)	44.69	VRI-3
Odisha	Branch thinning (3 branches)	July	-	37.92	Vengurla-4
West Bengal	Leader shoot pruning (Secondary shoots)-whole tree	July	-	53.51	Vengurla-4

The trees which are not received any training and pruning in the initial years grow haphazardly and resulting in canopies without desirable shape and size. Besides, the development of deadwood, inter-mingling of branches with neighboring trees, crisscross branches, development of water shoots, etc. will bring down the productivity of the tree (Nayak *et al.*, 1996). Pruning laterals at a 25% level in September significantly enhanced the yield in the Bhaskara variety under the West coast (Adiga *et al.*,2020)

Deadwood/dry branches:

The dead wood/dry branches develop mainly because of the effect of shade on lower branches caused by overlapping of the upper branches. Deadwood will be an additional burden to the plants. Furthermore, the dead and decaying woods may invite the entry of pathogenic organisms or saprophytic growth which may spread to heal their parts of the plant in due course of time.

Crisscross branches:

The lower branches remain crawling on the ground for want of space and sunlight, where the plants are not trained or pruned in the initial years. Similarly, the branches at higher level also grow haphazardly in search of sunlight resulting in irregular canopy architecture.

The intermingling of branches:

The problem of entangling branches starts after 10-12 years in regular spaces (8x8 m) plantations. The exterior branches get entangled with neighboring trees as a result only a portion of the canopy (crown portion) remains exposed to sunlight. Such a development inside the plantation is a hindrance to the regular intercultural operations and general maintenance of the orchard.

Water shoots/sprouts:

Water shoot is vegetative shoots that are extraordinarily vigorous growth from dormant buds at higher points on the main stem in an upright direction. They grow at the expense of parent branches from which they arise. They are erect in growth and much thicker in size than the normal branches and bear much longer and coarser leaves. These branches outgrow the rest of the neighboring drooping branches. If water shoots are not removed in time they soon cover the center of the canopy and obstruct sunlight. The old trees with deadwood, crisscross branches, water shoots and intermingling branches should be pruned at least once in 2-3 years. Pruning can be taken up in the dormant season i.e. at least 2-3 months earlier to productive flushing. All the types of unwanted growth mentioned before are to be pruned off. However, the plant should have a better look and structure after pruning. This can be achieved using one's discretion and experience in pruning and orchard management.

Leader shoot pruning

Cashew trees enter a brief resting period after the harvest of the crop (May - June) and it continues up to next productive flushing season (September - November). The flushes or flower bearing twigs are known as lateral shoots. These shoots usually form the terminal portion of a leader shoot will give a single shoot (lateral) from its terminal bud. If the terminal bud is disturbed by means of pruning the dormant lateral buds will sprout resulting in more number of lateral shoots per unit area. This will result in increased number of productive inflorescences. Pruning the leader shoots can be taken up at least 2-3 months (July to August) before flushing. In a tree about 50-60% of the leader shoots may be headed back to one-third of their original length. A pair of leaves may be retained while pruning wherever possible. While pruning, the leader shoot should be of a pencil thickness and should not have turned to ash color before taking up pruning.

Precautions to be taken while pruning

As a natural response, the cuts resulting from pruning will heal faster if cuts are smooth and non-jagged. While attending pruning the following points are to be considered

a) While removing the deadwood the cut must be made back to living tissue as good callus formation and healing cut end is only possible to form properly made cut end only.

b) It is essential to make the cut close to the branch. The cut should be nearly even along the stem or trunk leaving a minimum stub and clear wound for faster healing.

c) In the case of pruning off the diseased part care should be taken to remove all the infested parts.

d) Wherever larger branches are being removed, care should be taken to avoid breaking way of bark or wood portion of the plant.

e) When a cut is made a considerable amount of hardwood will be exposed and it should be protected from pests and pathogens. All the larger cuts may be treated with 10% Bordeaux paste while the leader shoot pruned canopy may be sprayed with 1% Bordeaux mixture.

f) It is essential to relate the appearance of the plant while pruning. The plant should have a balanced and natural appearance after pruning. The yield increase in pruned trees

The past season leader shoots can produce only one lateral from its terminal. Pruning enhances the production of lateral shoots, thus the yield can be increased. Pruning intensity and time vary for different specific agro-climatic regions. Pruning of dead wood and crisscross branches can increase yield by 30- 40% (Khan *et al.*, 1987). Leader-shoot pruning doubled the yield in cashew (Mohan and Room Singh, 1988) Results of pruning on 28-year-old trees revealed that trees with three branches pruned recorded the highest number of panicles/sq.m (39), the highest number of flowers/panicle (588.70) and fruit-set to an extent of 14.42%, while unpruned trees recorded only 7.75% increase in yield (Panda, 1990). Under Jhargram conditions, pruning of leader shoots during July enhanced the number of productive laterals and increased the number of bisexual flowers per panicle, fruits per panicle, and yield per tree (Chattopadhyay and Ghose, 1994). Pruning treatment increased the number of laterals/leaders but did not affect the duration of flowering and harvest (Mohan and Rao, 1995).

Effect of the pruning in different shoots in two varieties namely, BPP-4 and BPP-6 were conducted at the Cashew Research Station, Bapatla, Guntur district (AP). The shoots were decapitated back to 5 cm in mid-July, mid-August, and mid-September months of the leader shoots, lateral shoots, and leader as well as lateral shoots were pruned separately and different growth parameters on individual trees were studied. The response to the pruning, the variety 'BPP-4' performed better as compared to BPP-6. The production of flowering shoots and nut yield as influenced by the cultivar, level of pruning, and time of pruning that a moderate incremental growth with a large number of flowering shoots could be obtained by pruning the leader shoot in mid-August under local agro-climatic conditions. The study further indicated that the vigorous cultivar 'BPP-4' and off-season production cultivar 'BPP-6' performed well during a rainy year compared to the dry year which was associated with prolonged dry spells and delayed rains in the August- September months. Another important observation from the study indicated that the off-season cultivar of cashew needs essentially the pruning of the leader shoot in mid-August so as to avoid off-season flowering and to increase productivity in the normal season. Pruning of leader shoots in mid-July was found to be beneficial during both the years of study to produce higher tree yield of nuts (Prasanna Kumar *et al.*, 2015).

Advantages of training and pruning

- Harvesting and utilization of maximum solar energy by regulating plant growth for the betterment of yield and quality of nut and apple
- Development of a stronger framework of branches with equal distance at the desirable direction
- Equi-distant branches enhance resistance against a strong wind in wind prone areas
- Trimming of tangled and low-lying branches facilitates the intercultural operations
- Less vegetation restricts the micro-climate congenial for pest infestation
- Maximum exposure to the ground helps to disinfect pest and disease inoculum during summer
- Removal of dried branches, dead woods, and cris-cross branches reduce the effect of shade and extra burden on trees
- Thinning out of dead branches reduce the chance of secondary infection Precautions and aftercare during training and pruning
- Training must be made in live tissue to facilitate good callus formation for rapid healing
- Sharp tools should be used for implementing training or pruning to avoid the damage to bark/phloem
- After training or pruning, 10% Bordeaux mixture paste swabbing for large cut ends or 1% Bordeaux mixture spray for pruned shoots is recommended
- As a preventive measure, the pruned trees are to be sprayed with 0.2% l-cyhalothrin twice or thrice in the initial 24 months of pruning
- The tender shoots should be protected against Tea mosquito bug attack by spraying l–cyhalothrin 0.003% (6 ml in 10 L of water)

Tools used for pruning

Training and pruning done through manual method is cumbersome in cashew. There are tools available to make the operation simple and easy.

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Tools used for pruning

Secateur: Used to prune lateral shoots and small twigs of 1.5 to 3 cm diameter

Pruning saw: Used to prune small woody branches of 5 to 10 cm diameter

Pole tree pruner and Pruning shears: Used to prune 10 to 20 cm diameter upto its reachable height

Chain saw: Power or fuel operated chain saw is used to prune woody shoots of any size

Telescopic power tree pruner: Used to prune woody branches of smaller size upto its reachable height

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HORMONAL CONTROL OF NODULE DEVELOPMENT IN LEGUMES

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Introduction

Biological nitrogen fixation is the second largest source of nitrogen in agriculture. Legumes, such as soybeans and clover, engage in a mutualistic relationship with nitrogen-fixing bacteria called *Rhizhobium*. Legumes are members of FaFaCuRo clade (Fabales, Fagales, Cucurbitales, Rosales) which engage in symbiosis with formation of nodule. Nodule enables reciprocal transfer of carbon from plant and fixed nitrogen from bacteria. This symbiosis is crucial for nitrogen acquisition, as it enables legumes to thrive in nitrogen-deficient soils.

The hormonal control of nodule development in legumes is a fascinating aspect of plant-microbe symbiosis.Establishment of symbiotic nitrogen fixation requires coordination of both nodule development and infection events. Among the different mechanism controlling the nodule development, plant hormone signalling is one of the major factors in symbiotic signalling process.

In addition, the ability of legumes to form nodules exemplifies the intricate interplay between plants and microorganisms, highlighting the sophistication of nature's cooperative strategies. Understanding the hormonal control of nodule development not only provides insights into fundamental plant biology but also holds promise for advancing sustainable agricultural practices in the face of global challenges.

Liang and Harris, 2005 have studied the ability of various legumes and non legume plants to respond to the phytohormone sespecially emphasizing on role of ABA in increasing lateral root density. They hypothesized that common predisposition of plant to form nodules may be linked to the difference in the ABA sensitivity. Similarly different hormones have different impacts on nodule formation and development. The different hormones impacting different aspects of nodule development are described below.

Stages of nodule development and different hormones

1. Beginning of nodulation

Nodulation begins with a sophisticated molecular dialogue between the legume roots and the rhizobia in the soil. The process is begins by specific flavonoid compounds exuded by the plant roots, which act as signalling molecules to attract compatible rhizobia. In response to these signals, the rhizobia produce nod factors—lipochitooligosaccharides—that trigger a cascade of events in the root hairs of the legume.

These events include the initiation of root hair curling, a crucial step in creating an environment conducive to nodule formation. As the root hairs curl, they create a protected niche for the invading rhizobia, marking the beginning of a finely tuned symbiotic relationship. The interplay of these events is under the control of various plant hormones, with auxin and cytokinin playing key roles in the early stages of nodulation.

2. Growth and formation of mature nodules

As the initiation phase unfolds, the process transitions into the formation of mature nodules. Once the rhizobia have entered the curled root hairs, they trigger the division of nearby cells, forming a structure called a "nodule primordium." The plant hormones, particularly auxin and cytokinin, continue to regulate cell division and differentiation within the primordium.

As the nodule develops, the plant allocates resources to support both its own growth and the needs of the rhizobia. This resource allocation involves a complex interplay of hormones such as gibberellins and abscisic acid, fine-tuning the balance between plant and bacterial demands. The result is the formation of a mature nodule—a specialized organ where nitrogen fixation takes place. This intricate hormonal regulation not only ensures the successful establishment of a symbiotic relationship but also influences the efficiency of nitrogen fixation within the nodules. The balance of these hormonal signals is crucial for optimizing the mutualistic benefits for both the legume and the rhizobia.

Impact of hormones and their levels on nodulation

1. Auxin

Auxins play a crucial role in the initiation of nodulation by promoting root hair curling. They stimulate cell division in the root cortex, facilitating the formation of nodule primordia. Auxins also contribute to the overall development of the root system, creating a suitable environment for the establishment of a symbiotic relationship. Elevated levels of auxin can enhance root hair curling and cell division, potentially promoting excessive nodule initiation. However, an excessive increase may lead to abnormal nodule development, affecting the overall efficiency of nitrogen fixation. Reduced auxin levels may hinder proper root hair curling and limit nodule initiation, negatively impacting the establishment of the symbiotic relationship.

Local oxygen accumulation in the pericycle cells is sufficient to trigger lateral root formation in Arabidopsis. It is also involved in the preparation of lateral root emergence from the main root. Auxin perception proceeds and possibly triggers the division of other sales layers contributing to lateral load formation in the layers, namely endodermis and inner cortex. Auxin perception helps in the nodule development as well as in preparing lateral root emergence. The legumes transcriptome, studies indicate that the expression of many, if not all of the transcription factors relating to hormonal level alterations. Auxin, along with cytokinin influence the cell cycle initiation and progression required for nodal initiation. In soybean six auxin receptor genes encoding either GmTIR1 or GmAFB3 are important for proper nodule development. Studies have shown that miRNA and siRNA contribute to the maintenance of robust auxin signalling.

2. Gibberellin and Brassinosteroid

Gibberellin is involved in the regulation of cell elongation and division during nodule development. It contributes to the growth of the nodule primordium and the expansion of the nodule itself. It ensures proper development and enlargement of nodules, optimizing the overall efficiency of the nitrogen-fixing process. Higher levels of gibberellins can promote excessive growth, potentially leading to larger nodules. However, an excessive increase may disrupt the balance of resources allocated to nodule formation and other plant processes. Over expression of gain of function in SLEEPY genes is involved in this process. Reduced gibberellin level may hinder proper nodule development, potentially resulting in smaller and less efficient nodules.

miRNA miR396 over expression in response to brasnostroid application has shown to reduce mycorrhizal colonisation but not nodulation in *Medicago* plants.

3. Cytokinin

Cytokinin plays a crucial role in cell division and differentiation during nodule initiation. They promote the formation of nodule primordia and are involved in the regulation of the balance between shoot and root growth. Cytokinin collaborates with auxin to create an environment conducive to successful nodulation. Elevated cytokinin levels can stimulate increased cell division, promoting the formation of more nodules. However, an excessive increase may lead to uncontrolled nodule proliferation and may divert resources from other plant processes. Reduced cytokinin levels may limit cell division during nodule initiation, affecting the overall efficiency of nodulation.

All isoprenoid class cytokinins, including most relevant ip type and tz type cytokinins are induced upon infection with *Rhizobium* or a Nod factor (NF) treatment in *Medicago truncatula* and *Lotus japonicus.* With formation of cytokinins, several LOG family genes increase in abundance within 24 hours of inoculation and throughout nodule primordia establishment. Cytokinin response is high at base of the lateral root. Loss of function in cytokinin receptor genes like MtCRE1 and LjLHZ1, both reduces nodulation and enhance lateral root formation.

4. Ethylene

Ethylene has a dual role in nodulation. Initially, it inhibits the formation of nodules by suppressing the initiation process. However, as nodules mature, ethylene becomes essential for nodule development and functioning. It promotes the differentiation of cells within the nodule, contributing to the overall nitrogen-fixing capacity.

Elevated ethylene levels initially inhibit nodule initiation but are crucial for nodule maturation. Excessive ethylene can lead to premature senescence of nodules, reducing their nitrogen-fixing capacity.Reduced ethylene levels may result in enhanced nodule initiation but may compromise the maturation and functionality of nodules.

5. Abscisic Acid (ABA)

ABA plays a role in regulating the balance between water stress responses and nodule development. It influences the formation and maintenance of nodules under varying environmental conditions. ABA helps modulate the plant response to water availability, ensuring the stability of the symbiotic relationship during fluctuations in environmental stress.

Increased ABA levels may enhance the legume's response to water stress, potentially affecting nodule development negatively. It may lead to reduced nodulation under water-limiting conditions. Reduced ABA levels may compromise the ability of legume to respond to water stress, impacting nodule formation and stability under varying environmental conditions. The impact of ABA and other hormones are summarized in the table 1.

Table 1: Summery of impact of different hormones on nodulation

Hormone	Impact on nodulation
ABA	Negative effect on nodule development and nodule factor signalling
Nitric oxide	Needed for early infection and nodal primordia formation accelerates nodule senescence
Jasmonicacid	Negative effect on nodulation by acting on NF signalling
Brassinosteroids	Both positive and negative effects reported
CLE and CLV1	Negative effect on nodulation through Aon Pathway
CEP and CRR-RLK	Enhance the nodulation in systemic pathway.

6. Strigolactone

Strigolactone seems to negatively regulate lateral root formation in Arabidopsis with a direct connection to oxygen transport though, their action may depend on the overall phosphate status of the land.

Conclusion

Understanding the delicate balance of these hormones is crucial for optimizing nodulation and nitrogen fixation in legumes. Any disturbance in the hormonal equilibrium can influence the symbiotic relationship and, consequently, the plant's ability to utilize atmospheric nitrogen for growth.

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IMPORTANCE OF MILLETS: A WAY FORWARD FOR NUTRITIONAL AND FOOD SECURITY

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Introduction

India faces a large nutritional challenge due to the large dependency on major food grain such as rice, wheat, maize ext. It is known to us that many underutilized or minor millets are the reservoir of a broad range of micro, macronutrients, fiber, protein and vitamins as well as gluten-free properties as compared to available major staple crops. The gluten-free properties with low glycemic index, making them ideal for the people who are having celiac disease or diabetes. Millets are the integral part of our diet, they provide a good health benefit and require low input with low moisture requirement for their production. From the Latin word 'Milum' Millet originated which means grain. It is a group of cereals which belongs to the family Poaceae commonly known as the grass family.

Importance of millets:

- They are very good source of minerals such as iron, calcium and zinc and also have superior micronutrients and bioactive flavonoids
- Millets are low in calories and fat and good source of antioxidants

- Ø Millets can help to improve digestion and gut health and also help to lower blood pressure and cholesterol levels
- Ø Millets have low glycaemic index which helps to prevent diabetes
- Ø They survive under a wide range of environmental conditions as well as rain-fed and arid climate , required minimum fertilizers, pesticides and water.
- Ø Millets are associated with a beneficial effect such as weight reduction, prevent hyperlipidemia, risk of cardiovascular diseases etc
- Ø Millet based value added products are easily accessible such as ready to cook, ready to eat categories
- Ø Millet can be utilized for making bread, pasta, cake and other confectionery items
- Ø Millets are used under dual purposes such as food and fodder, which make it more relevant for efficient farming
- Ø Millets can help to boost energy levels and improve athletic performance and also can help to improve cognitive function and memory

Considering all these benefits under millets, Government of India (GoI) has prioritized Millets hence in April 2018, Millets were named as "Nutri Cereals". The Government of India in 2018 declared it as the National Year of Millets, to encourage the production, consumption and research of millets in India. Since then, several states in India, such as Tamil Nadu, Karnataka, Rajasthan and Odisha have developed millet policies and action plans to promote millets as a climate-resilient and sustainable crop

Through the support of 72 other countries, the Indian government suggested to the United Nations to declare 2023 as the International Year of Millets for creating awareness among the people about the benefits of millet for the Consumer, Cultivator and Climate. The international year of millet gives the opportunity to increase the millet contribution of food security, global production of millets, ensure efficient processing, transport, storage and consumption and with the involvement of the stakeholder for sustainable production and quality of millets

Classification of millets

According to the colour, texture, appearance, grain size and species there are various types of Millets, mostly on the basis of the size of grain, millets are classified into two categories such as major or large millets and small or minor millets.(Table 1)

Large (Major) Millets: Jowar (Sorghum), Bajra (Pearl Millet), Finger Millet (Ragi). Foxtail

Millet (Kagni), and Proso (Cheena)Millet

Small (Minor) Millet: Kodo Millet (Kodra), Barnyard Millet (Sama), Browntop Millet (Hari Kagni), Little Millet (Kutki)

	
	

Table 1: Types of millets

Millets name	Vernacular name	Scientific name	Chromosome number	Domestication	Benefits/ uses
Sorghum Millet	Jowar	*Sorghum vulgare*	2n = 2x = 20	Ethiopia	High in fiber, protein, and minerals such as phosphorus andiron
Pearl Millet	Bajra	*Pennisetum typhoids*	2n = 2x= 14	Western Africa	High in fiber, protein, iron, magnesium, and calcium. It usesas flour, porridge, soups and stews, snacks, fermented dishes and animal feed

Finger Millet	Ragi	*Eleusine coracana*	2n = 4x = 36AABB	Ethiopia and Uganda	It is an excellent source of calcium and is suitable for bonehealth, blood vessels, muscular contraction, and nerve function.
Kodo millet	Kodra	*Paspalum scorbicula t um*	2n = 4x = 40	India	It is rich in iron. It purifies the blood, reduces hypertension, and regulates the body's immune system.
Foxtail millet	Kangni/Motki	*Setaria italica*	2n =2x = 18 AA	China, Europe and Leba non	It keeps neurons (brain cells) healthy
Little millet	Kutki	*Panicum miliare*	2n = 4x = 36 AABB	India	It is good for the thyroid
Barnyard millet	Sanwa	*Echinochl o a esculenta*	2n = 6x = 54	India	It is usually eaten during religious fasts and is suitable for liver health
Brown top millet	Korale	*Urochloa ramosa*	2n = 2x = 18 2n = 4x = 36,72	South East Asia	It has anti-cancerous properties.
Proso millet	Cheena	*Panicum miliaceum*	2n = 4x = 36	China and Europe	It has high content of amino acids , minerals, low glycemic index and gluten free

Pearlmillet:

It is an important crop extensively grown as food grain in India as well as well adapted to high temperature, drought tolerance and require minimal inputs mostly free from biotic and abiotic stress. It is one of the most important source of iron, fibre, potassium and magnesium.It has beneficial carbohydrates dietary fibre which regulate the blood glucose levels, lower the risk of diabetes due to digestible starch,It prevent the arterial blockage formation due to low LDL cholesterol

Sorghum:

It is widely cultivated and consumed across many states in India. It is rich in potassium, phosphorus,calcium,iron, zinc and a rich source of antioxidants. It is rich in fibre which reduces the risk of high blood pressure, diabetes, cardiac disease and digestive issues.

Finger millets:

It is widely distributed and consumed in the southern state of our country. It has good sources of micronutrients such as calcium, iron and high fiber etc. It helps to reduce diabetes, risk of fractures and osteoporosis, prevents skin damage, boosts the hair growth, anti cancer properties, prevents cardiovascular diseases and anemia.

Foxtail Millets:

It is cultivated throughout the world including India. It is one of the staple foods and feeds in several parts of Asia and Africa. It is nutritionally superior due to high content of protein, vitamins (B6 and folate) , minerals, antioxidants, essential amino acids and micronutrients such as zinc and iron. It is rich in dietary fibre so it aids in digestion. It lowers the glucose level in blood, gastro protective properties, anti carcinogenic properties and manages the fungal infection.

Proso Millets:

It is mostly grown in India, Nigeria and China. In Europe and North America it is used as fodder, cattle feed and birdseed even though it is having high nutritive value and health benefits. Due to its high content of amino acids , minerals, low glycemic index and gluten free properties it attracted manyindustries.

Kodo Millets:

It is grown mostly in tribal regions in India under poor environments. It is rich in iron. It purifies the blood, reduces hypertension, and regulates the body's immune system. It is consumed as whole grain or preparation of traditional food products such as chapati, soup, dosa, pongal etc.

Barnyard millet:

It is one of the oldest, quickest growing short duration (six weeks) crops cultivated for fodder and food grain specially in hilly areas of India. It is a nutritious crop and cooked like rice after shelling. The grain is used to feed birds and cattle. It is suitable for liver health.

Little Millet:

It is predominantly cultivated in India, mostly eastern parts under tribal regions. It is well known for its magnesium, phosphorus, protein and high crude fibre content. It is rich in flavonoids and PUFA content. The taste of little millet grain is similar to rice, so it can be used as a good alternative staple in cereal diets.

Browntop Millet:

It is cultivated in the southern parts of our country. It is a small seeded annual grass grown in dry areas in tropical, subtropical and temperate regions. It is considered as signal grass and one of the rare millet. It is rich in micronutrients such as potassium, zinc, calcium, magnesium, phosphorus and vitamins, hence considered as a therapeutic diet.

The nutritional composition of millets comparison with major cereals is given in table 2.

Government Measures to Increase Millets in India:

As millets contain a good concentration of minerals, vitamins and other nutrients, the Government of India took several initiatives to increase the cultivation, production and consumption of millets in the country. Some of the measures of Government of India are as follows-

1. Inclusion of Millets in different policies of Government: The Indian government has recognized the potential of millets to improve food and nutritional security of the country and has included millets in various policies, such as the National Food Security Act, 2013 and the National Nutrition Strategy, 2017. Besides this, the government has also included millets in various schemes such as the Pradhan Mantri Fasal Bima Yojana, the Rashtriya Krishi Vikas Yojana, and the National Food Processing Policy.
2. Concept of Millet Parks: The Indian government has started millet parks in several states to promote the cultivation and consumption of millets. The focus of these parks is to demonstrate the cultivation of various millets, the nutritional benefits, and the preparation of various value-

added products that can be made from millet.

3. Improvement of Research and Development of Millets: The Indian Council of Agricultural Research (ICAR) and other research institutions have increased their focus on millets and are engaged in developing new varieties of millets that are more productive, disease-resistant, and have better nutritional qualities.

4. Extension activities for awareness and promotion of millet cultivation: For awareness regarding the millets, the Indian government is conducting campaigns to educate farmers and consumers about the nutritional benefits of millet. The government is also promoting millets through various events such as the National Millets Fair and other food festivals by showcasing the various value-added products from the millets.

5. Encouragement of Entrepreneurship through various schemes: The government has started various entrepreneurship schemes to encourage farmers and entrepreneurs to take up millet cultivation and value addition. This includes schemes such as the Pradhan Mantri Mudra Yojana and the Start-up India scheme.

Table 2: Nutritional composition of small millets comparison with major cereals (Source: Lydiaetal.2023 and Hariprasanna, 2023)

Crop	CHO (g)	Protein (g)	Fat(g)	Crude fiber (g)	Ash (g)	Ca (mg)	P(mg)	Fe (mg)	Zn (mg)	Mg (mg)
Sorghum Millet	67.68	9.97	1.73	10.22	1.39	27.60	274.00	4.14	1.96	171.00
Pearl Millet	61.78	10.96	5.43	11.29	1.37	27.35	289.00	8.45	2.76	137.00
Finger Millet	72.60	7.70	1.50	3.60	2.70	344.00	250.00	6.30	2.30	130.00
Kodo millet	66.20	8.90	2.60	5.20	1.70	15.30	188.00	2.30	0.70	147.00
Foxtail millet	60.90	12.30	4.30	8.00	3.30	31.00	290.00	2.80	2.40	81.00
Little millet	65.60	10.40	1.30	7.60	1.30	16.10	220.00	1.30	3.70	133.00

Barnyard millet	65.50	6.20	4.40	13.60	2.20	20.00	280.00	8.00	3.00	137.00
Browntop millet	71.32	8.98	1.89	8.50(natural fibre)	2.13	28.00	276.00	7.72	2.50	1.99
Proso millet	60.90	12.50	1.10	5.20	1.90	14.00	206.00	0.80	1.40	81.00
Rice	78.20	7.90	0.50	1.00	11.19	7.50	160.00	0.70	1.30	64.00
Maize	18.70	3.27	1.35	2.00	4.83	10.00	89.00	0.52	0.46	37.00

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BHUPARIKSHAK: CHEMICAL-LESS RAPID SOIL NUTRIENT TESTING DEVICE

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Abstract

Soil testing is often a routine procedure for the assessment of fertilizer doses to crop nutrition. Soil testing by conventional methods is time consuming and needs more chemicals for analysis. Recently, *Bhuparikshak* has been introduced as soil testing device based on the principle of NIR spectroscopy Chemical less, user friendly, rapid, AI ML powered IoT technology, with a smart soil testing device with advisory, reports, derived using *Bhuparikshak* mobile app suited for Android mobile. The device can display N,P,K,OC,CC,CEC can be retrieved in about 90 seconds.

Key words: *Bhuparikshak*, Mobile app, Near Infra Red based, Rapid Soil testing, Device

Introduction

Soil testing is often a routine procedure for the assessment of fertilizer doses to crop nutrition. Nowadays Soil test based fertilizer recommendation is highly essential for maintaining the appropriate and judicial use of inorganic complex fertilizers. The basic soil tests in any soil analytical laboratory includes analysis of soil type, pH, Electrical Conductivity (EC), Cation Exchange Capacity (CEC), Organic Carbon content, Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Zinc, Iron and other micronutrients.

Constraints of soil testing in practice

In the conventional system, for organic carbon estimation, Ferrous Ammonium Sulphate is used, Alkaline permanganate method for the estimation of nitrogen content uses hazardous chemical like potassium permanganate, sodium hydroxide, boric acid, sulphuric acid, bromocresol green. In Bray method, for Phosphorus estimation, chemicals like orthophosphate and triple acid extracts and in Olsen's method $NaHCO_3$ is used. Flame photometer is normally used for potassium analysis, in which soil is extracted with ammonium acetate. In all the methods, acid digestion is the very crucial step for nutrient extraction in the test solution.

In today's market, *Mridhaparikshak*, a digital true type auto analyzer and mobile soil kit developed by scientists of Indian Institute of soil science, Bhopal, India. It can analyze soil health parameters like pH, EC, Organic carbon, N,P,K, sulfur, and micronutrients like Zinc, Boron and Iron. Though the minikit is easier for working, the entire soil testing kit involves use of chemicals and a buyer has to depend upon chemical suppliers. PUSA soil test fertilizer recommendation meter kit (STFR) had been released by Ministry of Agriculture and Indian Institute of Agricultural Research, Pusa, New Delhi, India. This can also analyze the various soil parameters but reagent kits are involved for preparations of extracts.

***Bhuparikshak:* A new technologyfor rapid soil testing**

Bhuparikshak (In Hindi *Bhu* means soil, *parikshak* means to test) is a soil testing device based on the principle of NIR spectroscopychemical less, user friendly, rapid, AI ML powered IoT technology which is a smart soil testing device with advisory, reports, derived using *Bhuparikshak* mobile app suited for Android version with smart phone to connect through wifi with Software as a Service (SaaS) platform with low power consumption for charging the machine, dashboards, Web portal access, fertilizer recommendations, product suggestions and farmer's plot mapping. In the year 2022, a sensor based mobile app interlinked state of art technology using near infrared optical spectroscopy and a chemical less portable soil testing kit called as *Bhuparikshak* was developed by Prof. Jayant Kumar Singh and team of Indian Institute of Technology, Kanpur, India. With the aim to utilize the new technologies amenable for the farmers, it was through agritech start-up AgroNxt services in the year 2016. The results such as N,P,K,OC,CC,CEC can be retrieved in about 90 seconds counting to an approximately 100 soil scans per day and 250 soil scans in single charging of the device.

Operating procedure of *Bhuparikshak*

The first step is to switch on the*Bhuparikshak* (AgroNxt Press the power Button, simultaneously opening the Andriod mobile Bluetooth menu, and allow pairing with ‘HC-05’ by entering manually the password ‘1234’. The device has to be calibrated by placing the device on flat surface and make sure that the sensor area is clean. Tap on the Connect icon and pair HC-05 after pairing you will get two options “Calibrate” and “Scan”, tap on “Calibrate”, once the calibration is 100%, the app will show that the calibration is completed, After calibration, the samples should be scanned, Put 5-10 grams of dry soil samples in soil cup(Collected as per ICAR Standards) spread it evenly so that the white glossy paper is completely covered. Lock the soil cup clockwise.Tap on scan and wait for 100%. The results canbe takenas print out using Printer Step-by-Step process: Press the power Button. Pair ‘BPT/MPT/M581’ by entering ‘0000’ Password (Manually). Once the pairing is done, Open RawBT Mobile application (Download from Play store). Going on to the settings, we can see see connection parameters and by clicking connection parameter below it and tapping on the “BPT/MPT/M581” will lead to generate a image or pdf file, which can be retrieved by going to image file or PDF file and clicking on select the required image/PDF can be printed.

Groundnut grown field soil sample was collected from farmers field near Krishi Vigyan Kendra,Vridhachalam, Tamil Nadu, India and subjected to analysis using *Bhuparikshak* app and device. The device and the results intrepreted are given in Fig. 1,2. The results show that, the soil type belonged toclay loam type, low nitrogen content of 202.80 kg/ha and very high Phosphorous content of 61.62 kg/ha.

Fig. 1. *Bhuparikshak* device kit

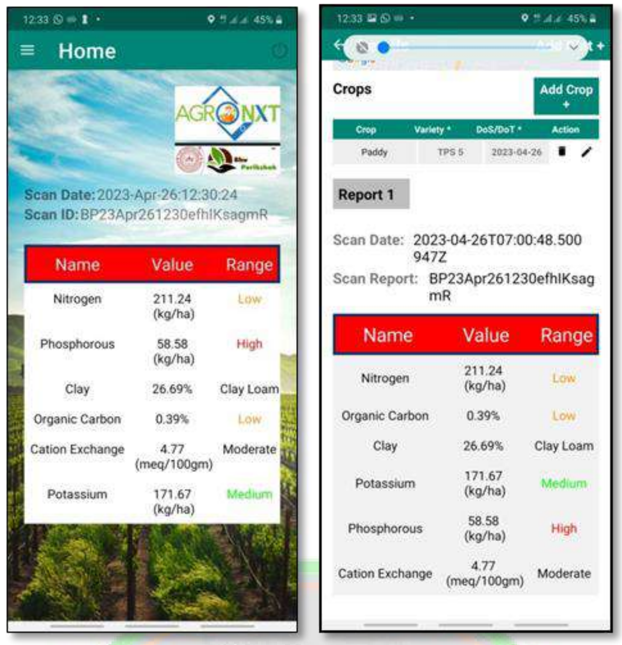

Fig.2. *Bhuparikshak* device generated soil test value in Android mobile app

Demerits of *Bhuparikshak*

Though *Bhuparikshak* is a break through cutting edge technology, the very vast diversity of soil that has been classified and categorised needs to be analysed by conventional or other regular methods and the soil nutrient mapping database must be made available in the library for each and every geological location. Since, the NIR in the device interprets and generate data through the available dataset in the library uploaded earlier, soil profiling for particular location must be readily available, so as to correlate the data generated by *Bhuparikshak.* So, before using the technology, the complete soil mapping containing, the type, texture of the soil in particular location must be analysed in prior and uploaded in the library, or otherwise false proof data are generated in the device, since, location where the soil sample was collected remains the basic dataset while uploading the samples.

Hence, a proper construction of soil geographical location, soil mapping, physical and other chemical parameters must be made available to use the new device and can be effectively used for rapid testing of soil very easily.

Acknowledgement

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ETHONOBOTANY, BOTANY AND ITS DIVERSIFIED USES OF LOTUS

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Introduction

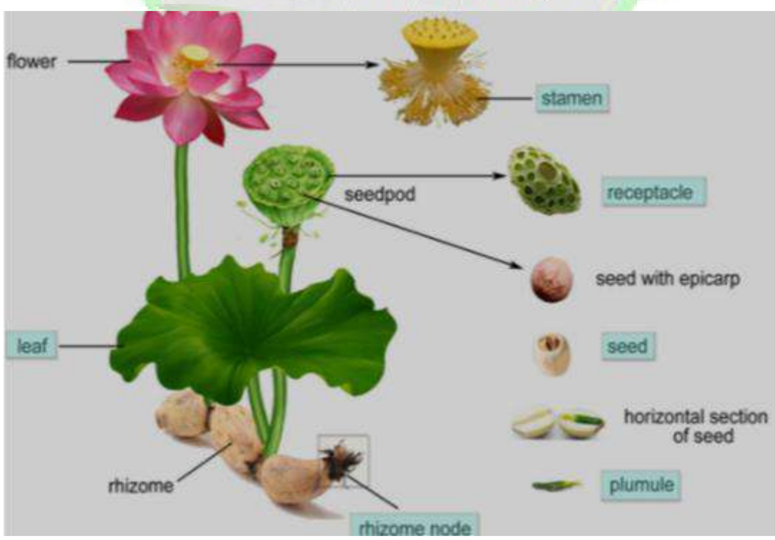
Lotus, scientifically called as *Nelumbo nucifera* Gaertn. is an unique and culturally significant aquatic perennial plant comes under Nymphaeaceae family with chromosome number of 16 (diploid). The lotus genome size is 926 Mb which is based on the flow cytometry analysis. It is generally called as Sacred lotus, Padma, Tamara, Sveta kamala, Kamal, Indian lotus, Ambuja, Ambal, Thamarai, Pankaj, Suriya Kamal, Thambal, Erra-Tamara *etc* in India. The unique and aesthetically pleasing structure of the lotus flower along with its cultural significance has made it a symbol of beauty, purity and spirituality in various cultures around the world. In India, Hinduism and Buddhism, the flower is a symbol of enlightenment and spiritual growth. It is also associated with various deities including Brahma, Vishnu, Lakshmi and Saraswathi and is often used in religious ceremonies and art.

Hence in 1950, lotus was officially recognized as the National flower of India in honor of its cultural significance and its association with the country's heritage. In Buddhist culture, the lotus is regarded as a holy thing and in Confucian culture, it is often used as a metaphor for gentlemen.

Ethanobotany of Lotus:

The family Nymphaeaceae is the monogeneric family which consist of only one genus *Nelumbo* with two species namely *Nelumbo nucifera* Gaertn. which is commonly called as Asian lotus and another one is *Nelumbo lutea* Pear., which is popularly called as American lotus. Asian lotus primarily distributed in Asia and North of Oceania whiles the American lotus majority present in Eastern and Southern parts of North America as well as the North or South America.

Lotus is one of the most primitive angiosperm and it is known as the "living fossil". Before 100 million years ago there were 10 – 12 species of lotus. After the ice age most of them became extinct due to cold and above mentioned two species alone survived. The two species have the same chromosome numbers (2n=16) and show aquatic life style with more than 5 months of life span, these two species differ in their external morphologies, petal colours, petal shape, leaf shape and plant size while crossing these species produce fertile F_1 population due to chromosomal homology.



Botany of Lotus:

Understanding the botany of the lotus provides insights into its unique adaptations to aquatic environments and its cultural significance in various societies.

Habit	:	Aquatic, perennial herb
Habitat	:	Warm temperate to tropical climate in a shallow aquatic environments such as fresh water ponds, lakes, marshes, swamps and backwater reservoirs.
Etymology	:	The genus name is derived from the Tamil word “Nelum” which means blue and the specific epithet “nucifera” derived from the Latin words, nux (=nut) and fera (=bearing) for nut bearing.
Root	:	Rhizomatous root system; rhizomes is a thick, fleshy and tuberous structure that grows horizontally beneath the soil or mud; it has multiple nodes and internodes, nodes are the points along the rhizome where roots and shorts emerge, internodes are the segment of the rhizome between nodes, root develop from the nodes anchor the plant in the substrate and absorb water and nutrients from the surrounding environment; roots are often thick, long and flexible; rhizome contains aerenchyma tissue which consists of air-filled spaces that provide buoyancy and helps rhizome to float and maintain an optimal position for gas exchange in the submerged parts of plant. Apart from that, rhizome acts as a storage organ, storing energy in the form of starch and other nutrient. This stored nutrients act as a source of energy for growth and development during lean period when photosynthesis is limited. In addition to these, rhizome acts as a vegetative propagule and useful for the plant to spread and colonize new area. Rhizomes also have scale like leaves at node which are often reduced in size compared to the aerial leaves.
Shoot	:	Buds are present at the nodes of the rhizome these buds gives rise to new shoots, which eventually grow into aerial stem and produce leaves and flowers.
Leaves	:	Leaves are usually large, borne on a long petiole, cordate / peltate, flat and floating on the water surface. Two types of leaves are there, aerial leaf as well as floating leaf. Petioles are smooth, greenish / greenish brown in colour with small brown dots sometimes rough with very small but distinct princkees, leaves are entire non-wettable, glaucous, cup shaped in case of aerial leaves and flat in case of floating leaves, radiantly nerved, fresh leaves are leathery, petioles of aerial leaves are erect and stout while floating ones are not strong

enough, the transverse cut of petiole shows 4 distinct large cavities in the centre and small cavities in periphery, leaves are dark green above and pale beneath, covered with a microscopic hairs.

Flowers	:	Large, showy, solitary having a pleasant fragrance borne on a long pedicel and are usually floating, bisexual, entomophilous; usually 4 sepals which gradually merge into the petals, elliptic/ovate, green/pinkish green leaf like structure that enclose and protect the inner floral parts during the bud stage; petals are numerous arranged in multiple whorls and gradually merge into the stamens, elliptic, obovate to spathulate, obtuse / subacute, concave, rose, pink / white, surface of petals has a hydroplastic effect causing water to bead up and roll off the petals, this helps to keep the flower clean and free from contamination; stamens are numerous, free, arranged in concentric circles, consists of a slender filament and an anther which contains pollen, usually perigynous and adnate to the fleshy thalamus that envelops the carpels, which are numerous loosely embedded in cavities on flattened top of receptacle, ovary is unilocular with one ovule / multilocular with many ovules on superficial placentation, stigmas are sessile, free/unified, radiating and often with horn like appendages.
Pollination	:	Cross pollinated (the pistil matures a day earlier than the stamen which ensures natural cross pollination)
Fruits	:	Aggregate of indehiscent nutlets
Seed pod	:	After pollination and fertilization, the carpels develop into a seed pod at the centre of the flower. It has compartments that house the developing seeds.
Seed	:	Ripe nutlets are ovoid, roundish/oblong upto 1.0 cm long 1.5 cm broad with hard smooth, brownish/greenish black pericarp and provides protection to the internal structure of the seed; hilum – a small scar/mark on the surface of the seed where it was attached to the seed pod; micropyle – is a tiny opening in the seed coat near the hilum, it allows the entry of water inside the seed during the process of germination; embryo – is the young, undeveloped plant within seed, it consists of plumule (embryonic shoot), radical (embryonic rood) and cotyledons (seed leaves); endosperm – a tissue that surrounds and nourishes the

embryo; cavity – hollow space in the centre of the seed, is often filled with air and acids in buoyancy, allowing the seed to float on water. Lotus seed has long term seed viability.

Diversified used of Lotus:

Lotus, not only aesthetically pleasing with its beautiful flowers, but also has been used for various purposes. They are as follows,

1. Environmental uses:

- **Water purification:** Lotus plant is well known for its ability to absorb pollutants from water. The plant can assist to absorb contaminant nutrients and contribute to improve water quality naturally.
- **Phyto-remediation:** Lotus plant is utilized a phyto-remediation which involves using plants to clear out contaminated water by absorbing and accumulating heavy metals and other pollutants, thereby it helps to remediate polluted water bodies.
- **Oxygenation:** Lotus plant discharge oxygen into the water through leaves and stems. This oxygenation process helps aquatic life and promoting the health of fish, other organisms in the eco system.
- **Erosion control:** Extensive roof system of lotus plants helps to stabilize the soil in the aquatic environment and maintain the integrity of shorelines and protecting the habitat.
- **Climate resilience:** Lotus plants are well adapted to varied climatic conditions including tropical and subtropical. The lotus plants ability to survive in various environmental conditions contributes to the resilience of aquatic eco system.
- **Algal control:** The large leaves of lotus plant create a shade on the water surface and reduce sunlight penetration. This helps to control algal blooms in ponds and lakes
- **Aesthetic and recreational value:** Planting lotus in ponds and water bodies enhances their aesthetic look. The presence of lotus flowers and leaves may contribute to overall beauty of the aquatic environmental and make it a desirable place for recreation.
- **Habitat provision:** Lotus plant offer shelter for various aquatic organisms such as fish, insects and amphibians which may use the submerged parts of the plant as a refuge and there by lotus plant contribute to the overall biodiversity in aquatic eco systems.

2. Culinary uses:

- **Leaves as wrapper:** leaves are used as wrappers for cooking and steaming because the wrapped leaves add a flavor and aroma to the final prepared food.
- **Flower petals:** used in salads and as garnish for various dishes; the petals are edible and add a floral flavor to dishes.
- **Rhizomes:** are edible and used in various dishes, they are commonly sliced and used in stir fries, curries, papad and soups. Rhizome has a crispy texture and slightly sweet flavor.
- **Seed:** Lotus seed (Makhana) normally used in culinary preparation, they are often roasted / fried to make a popular and nutritious snack. Roasted seed can be seasoned with various spices for added flavor candied seeds are used as a sweet snack or added to desserts and confections.
- **Stem:** are commonly used in stir fries, curries and pickles.
- **Lotus tea:** Lotus leaf tea / petal tea is made by steeping dried lotus leaves/petals in hot water. It is generally consumed for its potential health benefits.

3. Cultural and religious usage:

- Lotus flowers are generally used in Hindu religious ceremonies and rituals.
- The blooming lotus is a recurring theme in the design of pillars, ceilings and various decorative elements in temples and historical buildings.
- The unfolding petals of the lotus are metaphorically linked to the expansion of the soul and spiritual awakening.
- The lotus posture (Padmasana) in yoga is named after the flower.
- Lotus imagery is frequently used in Indian literature and poetry to convey themes of beauty, purity and spiritual awakening.
- Lotus is a symbol of meditation and its use in yogic practices reflects the idea of inner peace and spiritual enlightment.

4. Cosmetic industry:

In traditional system of Indian medicine, lotus extracts are believed to have therapeutic benefits for the skin. They are as follows,

- Lotus extracts one often incorporated into anti-aging skin products as the plant possess

- lot of antioxidants that may help to neutralize the free radicals which may leads to aging process.
- Lotus extracts are used in the formulations of skin products including creams, lotions and serums as there extracts are having moisturizing properties they help to hydrate the skin.
- Lotus extracts are included in formulations designed to brighten up the skin and even out skin tone as the plant is connected with purity and clarity, making it a symbolic choice for products aimed at promoting radiant skin.
- Lotus extracts has soothing and calming properties they may be used to calm irritated / sensitive skin.
- Delicate and pleasant fragrance of lotus flowers is sometimes used in perfumes and scented lotions.
- Lotus seed powder may be used as a natural exfoliant in skin care products as lotus seed powder may help to remove dead skin cells and promoting smoother, brighter skin.
- Lotus extracts added to facial cleansers and cleansing oils as it is believed that it purify the skin and contributing to a refreshed complexion.

5. Food industry:

- Native / acetylated lotus rhizome starch is mixed with maize starch and used for pudding preparation.
- Resistant starch obtained from seed is used to manufacture prebiotic material.
- Starch obtained from seed along with nisin, antimicrobial agent and glycerol is used as edible coating on cut fruits.
- Lotus seed milk serves as vegetarian milk and used to prepare bread, bakery goods, ice cream etc.
- Lotus seed flour replaces pectin upto 5% for film casting.
- Lotus seed flour mixed with wheat flours and made for bread making.
- Noodles are prepared with 5% lotus seed flour was accepted due to less fat and increased fibre.

6. Therapeutic uses:

All parts of the lotus plant has various types of bio active principles, because of these compounds and its nutrient content of the plant having following therapeutic activity *viz.*, diuretic, anthelmintic, antioxidation, anticancer, antimelanogenic, anti-inflammatory, anti-radidation, cardioprotection, hepatoprotection, cognitive impairment, antibacterial, antiglycative, neuroprotection, anti-tyrosinase, retinal protection, anti-insomina, anti-diabetes etc.

7. Other uses:

- Lotus rhizome starch was used to make T_iO_2 sponge for CO_2 photo conversion and hydrocarbon fuel production.
- Lotus rhizome and seed starch are used to make edible starch film which will enhance the self life of cut fruits.
- Lotus seed pod is highly state electrode material for development of super capacitors.
- Lotus seed pod derived hard carbon with hierarchical porous material is a stable anode for Sodium-ion batteries.
- Carbon quantum dots produced from seed pod could be used for Fe (III) detection.
- Seed pod derived biochar can be used for developing effective bio sorbents for cadmium, methylene blue along with Co_3O_4 microwave absorbent.
- Essential oil obtained from lotus flower is used in aromatherapy for its pleasant fragrance. The oil is having calming and soothing properties.
- Lotus silk is a luxurious and rare fabric made from the fibres extracted from the stem of lotus plant. The procedure of obtaining lotus fibre is labour demanding and involves carefully extracting the thread from the stem. The resulting textile is well known for its smoothness, light weight and lustrous look. Hence it is called as "Vegetarian Silk".
- Dried lotus seed pods are used in floral arrangements and crafts for decorative purposes.

Conclusion

Lotus plants are not only aesthetically pleasing with their beautiful flowers but also have been used for diversified purposes including traditional medicine, culinary uses, food industry, environmental protection etc. The plant also contains lot of bioactive compounds that contribute to its medicinal and nutritional properties. Hence, the lotus plant is considered as an important plant for the betterment of human being and his surroundings.

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GLUCOSINOLATE-DERIVED ISOTHIOCYANATES IN CRUCIFERS

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Abstract

The chemopreventative effect of cruciferous crops is thought to be partially due to their relatively high content of glucosinolates (β-thioglucoside N-hydroxysulfates). These compounds are hydrolyzed to an aglycone by the enzyme myrosinase. The aglycone fragments eliminate sulfate and form isothiocyanate. Isothiocyanates are naturally occurring small molecules that are formed from glucosinolate precursors of cruciferous vegetables. Many isothiocyanates, both natural and synthetic, display anti-carcinogenic activity because they reduce activation of carcinogens and increase their detoxification. This article summarizes the current knowledge on isothiocyanates and focuses on their role as potential anti-cancer agents.

Introduction

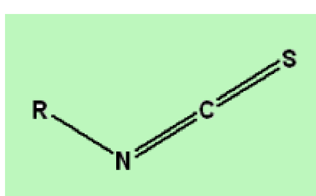
Oil seed crops occupy an important place in the agriculture and industrial economy of the country. India is perhaps the only country in the world having the largest number of commercial varieties of oil seeds. Mustard seeds (*Brassica Napus*) also known as Rape, Oilseed rape, Rapeseeds and Canola are very widely cultivated throughout the world. The seeds can come from three different plants: black mustard, brown Indian mustard, and white mustard. Mustard seed is the third leading source of vegetable oil in the world after Soya bean oil and palm oil. It is world's second leading sources of protein meal after soybean meal. It accounts for nearly 20-22% of the total oilseeds produced in the country.

Members of family cruciferae contain many health promoting and potentially protective phytochemicals including folic acid, phenolics, carotenoids, selenium, glucosinolates and ascorbic acids (Johnson et al., 2016). These bioactive compounds offers powerful, broad-spectrum support for protecting against the ubiquitous cancer provoking agent encountered every day in our environment. This fact is due to the presence of a type of bioactive components i.e. Isothiocyanates.

Glucosinolates, a diverse class of sulfur- and nitrogen-containing secondary metabolites, are found in Brassica vegetables including broccoli. These compounds have gained renewed interest in recent years due to the chemoprotective properties of their major hydrolysis products, isothiocyanates. Glucosinolates are chemically stable until they come in contact with the degradation enzyme myrosinase, which is stored in different compartments of the plant cells to separate from glucosinolates. When plant tissues are damaged, myrosinase rapidly hydrolyzes the glucosinolates to glucose and other unstable intermediates, which spontaneously rearrange to a variety of biologically active products, including isothiocyanates, thiocyanates, epithionitriles, or nitriles depending on chemical conditions (Sharma et al., 2016). The hydrolysis products vary depending largely upon the level and activity of myrosinase, presence of specifier protein, e.g., epithiospecifier protein, and hydrolysis conditions, e.g., pH, metal ions and temperature, and these can be influenced by species, cultivar, and cooking time and conditions. Epidemiological studies and experimental researches with cell and animal models have shown that isothiocyanates have the health-promoting effects, e.g., cancer protection.

An isothiocyanate is a compound with the structure R-N=C=S, where R is an alkyl or aryl group. Isothiocyanates are reactive compounds, particularly with respect to nucleophilic attack at the electron-deficient central carbon atom (Westphal et al., 2017). Nucleophilic attack of isothiocyanates by thiols forms dithiocarbamates R-N(=S)-SR′. These compounds are unstable under physiological conditions and undergo a reverse reaction, which results in the establishment of an equilibrium**:**

R-N=C=S + R′SH ⇌RNHC (=S)-SR′



Formula: R-NCS

Isothiocyanates synthesis has drawn attention of chemists' worldwide. This is very useful for the synthesis of heterocycles e.g. triazoles, thiazoles, oxazines, benzimidazole etc.

Distribution:

Isothiocyanates occur naturally as glucosinolate conjugates in cruciferous vegetables. These compounds are also responsible for the typical flavour of these vegetables. These are found in cruciferous vegetables such as broccoli, cauliflower, kale, turnips, collards, Brussels sprouts, cabbage, radish, turnip and watercress. Isothiocyanates with the strongest anticancer effects are phenylethylisothiocyanate (PEITC), benzylisothiocyanate (BITC) and 3-phenylpropylisothiocyanate and sulforaphane (SFN). Recently, the isothiocyanate sesquiterpenes have been isolated from a sponge of the genus Axinyssa (Bricker et al., 2014)

Biological activity:

Glucosinolates are precursors of isothiocyanates. Glucosinolates, β-thioglucoside-N-hydroxysulfates (cis- N-hydroximinosulfate esters), are sulfur-enriched, anionic secondary metabolites of plants synthesized from amino acids and sugars. They are synthesized in all vegetables and oilseed plants of the order Brassicales. All known glucosinolate producing plants have at least one β-thioglucosidase often named myrosinase (Bones and Rossiter, 2006). Myrosinases hydrolyses glucosinolates into several potentially toxic compounds dependent on the reaction conditions and the presence of specifier proteins (Figure 1) (Kong et al., 2012).

Glucosinolate degradation products are contributing to the distinct taste and flavor of cruciferous vegetables such as broccoli, mustard and wasabi and they constitute a potent defense system against herbivores and pathogens. To prevent constitutive production and potential damage to the plant cells, myrosinase is stored separately from its substrates in specialized cells called myrosin cells. The hydrolysis products are produced upon attack by herbivores or pathogens when damage to the plant tissue and disruption of the cells causes myrosinase to come into contact with glucosinolates.

The small sulfur-containing isothiocyanates (ITCs) are among the biodegradation products of glucosinolates. Due to their anticancer and chemopreventive properties, the ITCs have been the target of substantial research efforts over the last years (Zinoviadou et al., 2017). Many isothiocyanates, both natural and synthetic, display anticarcinogenic activity because they reduce activation of carcinogens and increase their detoxification. Recent studies show that they exhibit anti-tumor activity by affecting multiple pathways including apoptosis, MAPK signaling, oxidative stress, and cell cycle progression.

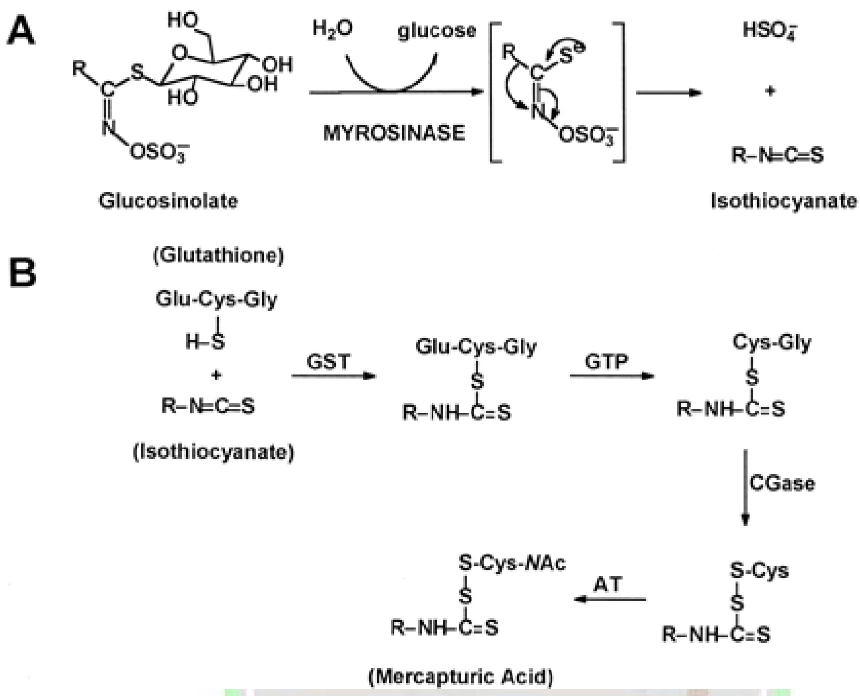


Figure 1.

A, glucosinolates are converted to isothiocyanates by the enzymatic action of myrosinase. For glucoraphanin (a glucosinolate) and sulforaphane (its cognate isothiocyanate), the R group is CH3SO(CH2)^{4}–.

B, isothiocyanates are conjugated to glutathione by glutathione S-transferase (GST), then metabolized sequentially by γ-glutamyltranspeptidase (GTP), cysteinylglycinase (CGase), and acetyltransferase (AT) ultimately to form mercapturic acids.

(Source: Google.com)

ITCs occur primarily in cruciferous vegetables, many of which show significant cancer chemopreventive activities, and therefore are widely suspected to account in part for the cancer preventive activities of these vegetables in humans. Sulforaphane is perhaps the most widely known crucifer-derived cancer chemopreventive ITC. In addition to their anti-carcinogenic properties in the animals that consume them, glucosinolates are anti-oxidative and help defend against herbivores and microbes. Isothiocyanates (ITCs) have negative effects on the growth of various fungal species. In line with this, it has been shown that following exposure to ITC, fungal cells displayed a response similar to that elicited during oxidative stress with over-expression of several genes potentially involved in cell protection against oxidative damage (Calmes et al., 2015).

The mechanism by which ITCs causes cell death is not yet fully understood and they may mediate their effects either via direct protein modification or indirectly by disruption of redox homeostasis and increased thiol oxidation (Brown and Hampton, 2011).

Once isothiocyanates are ingested or formed in the lumen of the gastrointestinal tract, they cross the gastrointestinal epithelium and the capillary endothelium by passive diffusion. They bind rapidly and reversibly to thiols of plasma protein and cross the plasma membrane into cells of tissues.

Inside cells, isothiocyanates react with glutathione to form the glutathione conjugate, which is expelled from cells by transporter proteins and further metabolized to mercapturic acids. These isothiocyanate metabolites can be measured in the urine and are highly correlated with dietary intake of cruciferous vegetables.

Health Benefits of Isothiocyanates

Isothiocyanates act as blocking agents by modifying the metabolism of carcinogenic compounds through their influence on biotransformation enzymes. Isothiocyanates act by inhibition of cell proliferation and induction of apoptosis. In mice, a combination of isothiocyanates and selenium slowed production and blocked the signaling network of a protein called Akt3 which plays a role in melanoma development, and reduced tumor growth by 60% (Dinkova et al., 2012).The isothiocyanates with the strongest anticancer effects are phenylethylisothiocyanate, benzylisothiocyanate and 3-phenylpropylisothiocyanate. Studies have shown that isothiocyanates help to prevent lung cancer and esophageal cancer. Isothiocyanates can also lower the risk of other cancers, including gastrointestinal cancer (Boreddy et al., 2011). Researchers at the Johns Hopkins University School of Medicine in Baltimore studied the metabolism of isothiocyanates and found that isothiocyanates were about six times more bioavailable than glucosinolates.

Many isothiocyanates, particularly SFN, are potent inducers of phase II enzymes in cultured human cells (Fimognari et al., 2007). Phase II enzymes, including GSTs, UDP-glucuronosyl transferases (UGTs), quinone reductase, and glutamate cysteine ligase, play important roles in protecting cells from DNA damage by carcinogens and reactive oxygen species.

Isothiocyanates induce cellular oxidative stress by rapidly conjugating and thus depleting cells of GSH in leukemia cells. PEITC induced apoptosis of human leukemia HL-60 and myeloblastic leukemia ML-1 cells, which were associated with an initial decrease in GSH and GSSG (oxidized GSH) and concomitant formation of the GSH adduct S-(N-phenethylthiocarbamoyl) glutathione inside cells. This adduct was then exported from cells. A number of isothiocyanates, including AITC, BITC, PEITC, and SFN, have been found to induce cell cycle arrest in cultured cells.

Isothiocyanates works in three different ways: 1) They don't allow carcinogens to be activated; 2) they counteract the poisonous effects of carcinogens that have been activated; and 3) they speed up their removal from the body.

Food Sources

Isothiocyanates can be found in cruciferous or "cabbage family" vegetables such as broccoli, cauliflower, kale, turnips, collards, Brussels sprouts, cabbage, kohlrabi, rutabaga, Chinese cabbage, bok choy, horseradish, radish, and watercress (Table 1). These vegetables add crunch or flavor to many of our familiar dishes, such as coleslaw, vegetable stir-fry, collard greens, and salads.

Table 1. Food Sources of Selected Isothiocyanates and Their Glucosinolate Precursors

Major Isothiocyanate	Glucosinolate (precursor)	Food Sources
Allyl Isothiocyanate (AITC)	Sinigrin	Broccoli, Brussels sprouts, cabbage, horseradish, mustard, radish
Benzyl Isothiocyanate (BITC)	Glucotropaeolin	Cabbage, garden cress, Indian cress
Phenethyl-Isothiocyanate (PEITC)	Gluconasturtiin	Watercress
Sulforaphane (SFN)	Glucoraphanin	Broccoli, Brussels sprouts, cabbage

Significant losses of isothiocyanates are expected during food processing. Some isothiocyanates are volatile and will be lost to the atmosphere by vaporization at the boiling point and evaporation at temperatures below the boiling point for example, loss of allyl isothiocyanate occurs at a boiling point of 88 °C. Isothiocyanates also are hydrolyzed at physiological temperatures, a process that becomes more rapid at higher cooking temperatures (Zhenxin et al., 2009).

However to reduce the glucosinolate losses from the food sources, different cooking methods are involved that uses less water such as steaming, microwaving (Bell et al., 2007). Hence there will be more chances of myrosinase to work on glucosinolate & increases the bioavalability of isothiocyanates. Whereas there are some other cooking practices also which may reduce enzyme myrosinase such as microwaving at high power, boiling and steaming at high temperature thereby reduce the isothiocyanate concentrations (Frandsen et al., 2004).

Conclusion

It can be concluded that isothiocyanates are chemopreventive agents and also exhibit antitumor activity. Their tumorigenesis ability depends on the structure of the isothiocyanates, the animal species, target tissues, and the specific carcinogen employed. The MAPK pathway, oxidative stress, and the cell cycle machinery etc are the main pathways which are targeted by isothiocyanates. The mechanism of these activities is not fully understood. Future research should focus on the elucidation of these pathways to explore defense mechanism.

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MANAGEMENT OF SEED-BORNE DISEASES: A COMPREHENSIVE APPROACH

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Introduction:

Seeds are a biological entity that serves as the progenitor of a plant. Both formal and informal methods are used in the manufacturing of seeds. Most smallholder farmers still use "farmer-saved" seeds that have been preserved from previous planting seasons, despite the fact that certified seeds have several advantages. These seeds are quite popular since they are widely available, affordable, include features that farmers find useful, and are easily accessible.

Seed Borne Diseases

It is known that nematodes, bacteria, viruses, and fungi are transmitted by seeds. A major group of pathogens that are both seed-borne and seed-transmitted are fungi. Fungi are reported to naturally associate with the seeds of certain Cistaceae, Ericaceae, and Orchidaceae members, in addition to saprophytes and parasites. It is known that several viruses, including viroids and crypto viruses, can infect seed. Likewise, scant research has been done on the histology of bacteria-affected seeds, with most studies focusing on those infected with *Acidovorax*, *Burkholderia*, *Clavibacter*, *Curtobacterium*, *Pantoea*, *Pseudomonas*, *Rathayibacter* and *Xanthomonas*. Nematodes transmitted through seeds can potentially manifest as seed infection or infestation. The latter results in symptomatic or asymptomatic infections as well as seed gall formation (*Anguina* spp.).

Types of Seedborne Pathogens

Pathogenic fungus can infect seeds and hinder seedling germination and development, or they can infect seeds inside and kill the endosperm and embryo. Any infectious agent that is carried on seeds, either internally or externally, and has the potential to infect seeds or developing plants, is referred to as a seed-borne pathogen. Several of this part of the seed may be penetrated by a pathogen, which would then infect them. The seed may get infected or contaminated during the threshing, processing, and harvesting stages. The pathogen may, thus, be carried with the seeds in three ways.

(i) *Admixture:* Pathogens are independent of seeds but accompany them. Ergot sclerotia are mixed with healthy seeds during threshing.

(ii) *External:* The pathogen may be present on seed surface as spores, oospores and chlamydospores as in case of karnal bunt of wheat, covered smut of barley, downy mildew of pearl millet etc.

(iii) *Internal:* Pathogens establish within the seed with definite relationship with seed parts.

Significance of seed borne diseases

1. Reduction of Crop Yield

Seed borne pathogens are responsible for reduction of crop yield. Most important seed born disease is rice blast (*Magnaporthe grisea*) was responsible for a famine in Japan during in 1930s. In Philippines, losses due to blast may be more than 50%. In 1942, the Bengal Famine in India was the failure of the rice crop because of brown spot (*Bipolaris oryzae*).

2. Loss of Germination & vigor

Many seed borne pathogen active when seeds are sown, which may result is failure of seed germination, seed decay and / or pre- or post-emergence damping-off and reduce seedling vigor.

3. Discoloration and shrivelling:

Discoloration can indicate undesirable physical qualities, some pathogen that cause discoloration in seeds affect seed coat color, damage tissues in the seed coat and embryo.

4. Biochemical change

Many seed borne fungi in the quantitative change in the physico-chemical properties of seeds, such as color, odor, oil content, iodine and saponification value and protein content.

5. Distribution of pathogen to new areas
6. Introduction of new strains or physiologic races of the pathogen along with new germ

plasm from other countries

7. Toxin production in infected seed etc - Due to infection it induced the secretion of toxic chemicals ex: Aflatoxin, Rubra toxin, ochre toxin, chitrinin, patulin etc.

Research has shown that most of these seeds have poor physiological quality and are often contaminated with seed-borne diseases such *Aspergillus, Penicillium, Bipolaris maydis, Rhizopus*, and *Fusarium* species. Reduced productivity, reduced crop vitality, increased vulnerability to seedling diseases, and diminished emergence in the field are the outcomes of this contamination. Thus, in order to ensure the sustainability of crop production, an integrated approach to disease management must be established.

Integrated Disease Management:

The approach was based on the idea of "integrated control," which was defined as the use of biological and chemical control in tandem with other pest management techniques. Chemical controls were to be applied sparingly and only when absolutely necessary to maintain biological control. IDM also involves the prompt application of a variety of strategies and methods. These precautions might include careful site selection and preparation, disease-resistant cultivar cultivation, the use of certified disease-free seed, adjustments to sowing and planting timing and spacing, and the execution of agricultural practices like crop density, irrigation, and agrochemical application, among other things. Furthermore, it is critical to forecast diseases and establish economic thresholds in addition to keeping an eye on environmental factors like temperature, moisture, pH, and nutrients in the soil. These elements are crucial to the process of creating a management schedule. To maximize the benefits of each component, it is crucial to apply these actions in a coordinated, integrated, and harmonized manner.

Regulations for Quarantine

A legal mechanism known as quarantine limits the movement of agricultural products to prevent the spread of diseases and plant pests to unaffected areas. In this case, the purchaser is only given plants that are pathogen-free.

Implementation of Seed Certification Guidelines

A basic and practical method of excluding pathogens is to use certification programs for the production of disease-free seeds and planting material for plants that are vegetatively propagated. In order to supply seed and planting material free of disease, these certification programs use techniques like crop-specific isolation distances, several field inspections at various stages of crop growth, and the removal of sick plants.

Sowing Time

Only when certain environmental conditions are congenial, pathogens may infect susceptible plants. For instance, downy mildew requires prolonged high moisture levels to germinate. Immediate sowing of grains after rainfall can lead to severe root rot caused by *Rhizoctonia*. Early maturing cultivars of peas and wheat are resistant to *Erysiphe polygoni* and *Puccinia graminis tritici*, respectively, therefore they are protected from any damage caused by these infections. Therefore, it may be beneficial to alter the time of sowing or planting in order to lower the frequency of infections.

Irrigation Management

By carefully and strategically managing irrigation water, it is possible to limit the pathogen's life and the progression of the disease by creating an unsuitable environment for the infection. It is advised to stay away from low-lying areas, and using tensiometers and other measuring tools can help with effective irrigation management and best use of available resources. On the other hand, higher soil moisture levels encourage the growth of soil-borne phytopathogens like *Pythium* spp. and *Phytophthora* spp. as well as the development of seed rots and decay in agricultural areas.

Roguing

This involves the timely removal of infected plants. Ear heads contaminated with diseases like ergot of pearl millet, loose smut of wheat, and covered smut of barley, sorghum, or maize must be removed and destroyed as soon as possible. It is also essential to remove and destroy any contaminated plants or plant parts in the fields as once in order to stop the virus from spreading.

Removal of Alternate or Collateral Hosts

Several diseases necessitate the presence of two hosts in order to successfully complete their life cycles. The life cycle of the pathogen is disrupted by the removal of a single wild host. Numerous plant viruses have the ability to endure on weeds that act as alternative or collateral hosts. On *Hibiscus tetraphyllus*, for instance, the Yellow Vein Mosaic Virus of Okra can survive. By carefully eliminating this wild group by suitable weeding, the disease can be managed. Eliminating barberries acts as a preventative measure rather than a final solution for the *Puccinia* *graminis* pathogen that causes wheat stem rust. Eradicating weeds that serve as hosts for multiple diseases or their insect carriers also aids in their elimination such as viral infections.

Crop Rotation

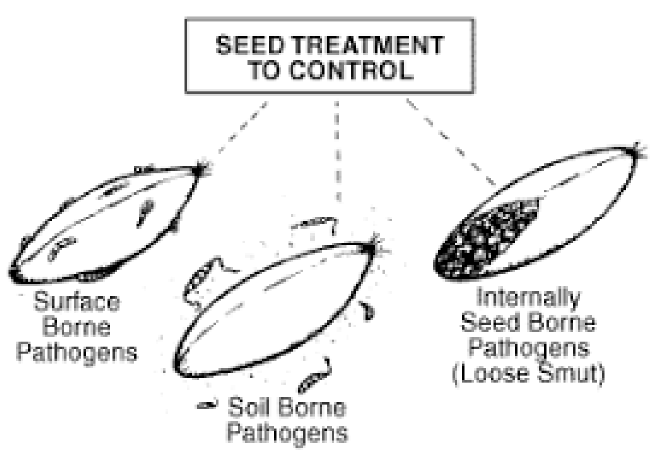
The bakanae disease of rice is one example of a disease that can spread through the soil in addition to through seeds. Short-term crop rotations with non-host crops for one or two years are an efficient way to manage diseases like the soybean cyst nematode *Heterodera glycines* and the take-all disease in wheat, which are both caused by *Gaeumannomyces graminis*.

Field Sanitation

In order to control many infectious plant diseases, field sanitation measures are essential for excluding, reducing, or eliminating the pathogen. It's critical to prevent spreading phytopathogen-contaminated soils or seeds to new locations. In order to control viral diseases like tomato spotted wilt and the populations of thrips on tomatoes, this can be accomplished through soil sterilization, solarization through summer ploughing, and the use of gas-forming compounds like carbon disulfide, methyl bromide, or chloropicrin enclosed by black polyurethane sheets or polyethylene mulch. Pathogen-free seeds and planting stocks can also be used.

Seed treatments

Seedborne infections can be managed with a variety of seed treatments. These treatments may include chemical, physical, and mechanical control. Since seed treatments have the potential to harm seeds, they should only be applied when the benefits of increased germination and seedling survival outweigh the risks. Particularly when it comes to chemical treatments, seeds may be toxic and therefore to be handled carefully.



Some seed treating chemicals and their doses:

1. Vitavax @ 0.25% (2.5g/kg seed)
2. Bavistin - 0.25% (2.5g/kg seed)
3. Thiram 75WP @ 0.25% (2.5 g/kg seed)
4. Captan 75 WP @ 0.25% (2.5 g/kg seed)
5. Carboxin @ 0.25-0.4% (2.5-4.0 g/kg seed)

Seed treatment is required to prevent germination failure, infection of seedlings and subsequent crops by eliminating internally and externally contaminated seed-borne pathogens, and to shield germination-affected seed and seedlings from soil-borne pathogen attacks by creating a protective zone around the seed in the soil.

Hot Water Treatment

Ustilago segetum tritici's latent mycelium, which causes loose smut in wheat, must be removed from the seed by immersing it in water at 20–30 °C for five to six hours. The seed should then be dried after being submerged in hot water (50°C) for two minutes. Jensen (1888) described this technique. The treatment has also demonstrated efficacy in managing seed-borne bacterial infections, such as *Xanthomonas oryzae* in rice, *Xanthomonas axonopodis* pv. *malvacearum* in cotton and *Xanthomonas campestris* pv. *campestris* in cauliflower.

Solar heat treatment

The practice of submerging wheat seeds in water for four hours on a sunny summer's morning and then drying them was suggested by Luthra and Sattar (1934). A study by Bedi (1957) shown that, in Punjab conditions, a drying time of just one hour is sufficient to eradicate the intra seminal mycelium of *Ustilago segetum tritici*.

Anaerobic Treatment

This is a procedure that takes place in an oxygen-free environment. Here, the seed is submerged in water that is between 15 and 20 °C for two to four hours. The damp seed is subsequently stored in hermetically sealed containers for a duration of 65-70 hours and subsequently subjected to a drying process. This method exposes the seed to an anaerobic atmosphere for a maximum of one week.

Hot Air Treatment

This is the technique of treating anything with air that is heated to a high temperature. The dry heat seed treatment works quite well and doesn't do much damage to the seed. Ratoon stunting disease can be efficiently controlled without negatively affecting the germination of sugarcane buds by subjecting the crop to 54 °C for eight hours using thermally expanded air.

Conclusion

The changing environment brought on by global warming affects the spread of pathogens and, in turn, the development of diseases. In an attempt to increase productivity, indiscriminate use of inputs like fertilizers, pesticides, water, or cropping systems has already created problems like sick soils, declining water tables, pesticide residues, accumulation of inoculum threshold levels, and pathogen resistance, all of which are detrimental to the continued existence of our agricultural system. Therefore, it is imperative to develop environmentally safe and eco-friendly integrated disease management technologies and to make sure that chemical pesticides are used properly and sparingly in order to maintain healthy agriculture in the future. All available strategies, including cultural practices, chemical and biological control, the use of resistant cultivars, disease monitoring in the fields, etc., are employed in integrated disease management, that are environment friendly and give product of high quality and yield.

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PHYSIOLOGICAL DISORDERS OF PLANTATION CROPS

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Introduction

Physiological disorder is the abnormal growth pattern or abnormal external or internal conditions of fruits due to adverse environmental conditions such as deviation from normal state of temperature, light, moisture, nutrient, harmful gases and inadequate supply of growth regulators.Physiological disorders are non-pathological conditions which affect the functioning of the plant system. Physiological disorders are distinguished from plant diseases caused by pathogens. While the symptoms of physiological disorders may appear disease-like, they can usually be prevented by altering environmental conditions. However, once a plant shows symptoms of a physiological disorder it is likely that, that season's growth or yield will be reduced.

In plantation crops adequate management are required for better growth and yield. Mismanagement results in large economic losses. Physiological disorders affect the growth and yield of plantation crops. Due to physiological disorder (barren nut, button shedding, crown chocking etc) large economic losses in coconut while, in other plantation crops (arecanut, cashewnut, tea, coffee, rubber etc) comparatively low affect the economic loss. The physiological disorders of plantation crops are as follows:

Physiological disorders Arecanut:

1) **Band or hidimundige disease**:

Due to this disorder production of smaller leaves and ultimately crown forms a rosette shape, Reduction in internodal length and tapering of stem towards apex, mostly unproductive:

nuts if at all produced are small and malformed.

Causes: Poor drainage and low fertility of soil and Sub soil pan / hard clayey pan

Management;

- Better soil management and improvement in drainage.
- Removal of hard pan on the sub soil and foliar application of micronutrients,
- Correction of soil acidity and incorporation of mixture of copper sulphate and lime.

2) **Nut splitting in arecanut:**

Premature yellowing of nuts when they are ½ to ¾ matured. It is seen in patches in individual plantations and common on young palms.

Cause:

- Excessive flow of cell sap into the inflorescence in very healthy palms.
- Excessive flow of sap in to the inflorescence , Excessive nutrient supply
- Prolonged drought followed by sudden irrigation

Management;

- Application of borax @ 2 g per liter of water (0.20 % spray) on bunches during early stages of disease and K2O at the base is found to check nut splitting to a certain extent.
- Improvement of drainage and provide regular irrigation during drought.

Sun scorching:

Cause: Continuous solar radiation causes scorching in stem.

Symptoms: The steady exposure of the stem to solar radiation causes this scorching effect. Young palms are more prone to scorching. Golden yellow patches appear on the exposed stem portions and later fissures develop.

Management;

- Tying areca sheath or leaves on the stem being exposed to Western and southern sun.
- Planting of quick and tall growing shade trees on the south – western side of the garden.
- Adoption of proper alignment while planting to minimize the damage due to scorching.

Physiological disorder of Oil Palm:

Bunch failure

Failure in the development of bunches at any stage during anthesis to harvest is referred as bunch failure. Periodical palm cleaning reduces the load of inoculums and fresh incidence.

Cause : Not specifically known. It is due to:

1) Excess pruning,

2) mutual shading,

3) under pollination : Release of pollinating weevil

4) Moisture stress/ Prolonged drought

5) Inadequate nutrient status

6) Over bearing etc ., increases bunch failure.

Management:

There is no recovery once bunch failure has started and hence all control measures must be aimed at avoiding those conditions favoring bunch failure.

Physiological disorder in Cashewnut

Yellow leaf spot:

It is an enigmatic disorder in cashew associated with low soil pH (4.5 -5.0). The appearance of yellow leaf spot might be due to molybdenum deficiency.

Management:

Spray 0.03% ammonium molybdate solution once during premansoon (June) and another after end of mansoon (September)

- Correcting the soil pH with lime.

Little leaf of cashew:

Little leaf is caused due to deficiency of zinc. The leaves remain small in size giving rosette appearance.

Management: Application of zinc sulphate @ 0.5% to the soil or by foliar means.

Physiological disorder in Coconut

Button Shedding and Premature nut fall

Shedding of buttons in high numbers is serious infestation of coconut. Buttons can be shed after fertilization and some nuts are shed after setting. The economic loss ranges from 10 to 20%.Shedding of buttons and premature nuts may be due to one or more of the following: excess acidity or alkalinity, poor drainage facilities, severe and prolonged drought, genetic disorders, insufficient nutrients, improper pollination, hormone deficiency, insect pests or poor management practices. Zinc deficiency will also lead to button shedding

 

Immature nut fall

Infected nut

Button Shedding

Management:

1. High acidic soil could be overcome by adding lime and high alkaline soil could be managed by adding gypsum.
2. The recommended dose of fertilizer schedules and proper time of application are important to minimize the button shedding.
3. Ensuring sufficient irrigation during summer and drainage during winter will lead to a sustainable yield.
4. Apply 0.5 ml of NAA (Planofix) mixed in 1 litre of water on the inflorescence. This prevents button shedding.
5. Soil application of $ZnSO_4$ of 25kg/ha

Crown Chocking:

This disorder caused due to boron deficiency. The leaves of the palm become shorter and crinkled. The leaflet show severe tip necrosis and fail to unfurls. The fronds exhibits chocked appearance.

Management

Application of borax @ 50g per palm at half yearly interval during February –March and September- October along with recommended fertilizers will control this disorder.

Nut splitting

Nut splitting is mainly due to boron deficiency. One of the earliest symptoms in boron deficiency on coconut palm is leaf wrinkling and manifested as sharply bend leaflet tips, commonly called “hook leaf”. Leaves have a serrated zigzag appearance. Newly emerging spear leaves failure to open normally. In a chronic stage, multiple unopened spear leaves may be visible at the apex of the canopy. The inflorescence and nuts become necrotic.

Management:

Application of borax /sodium tetraborate @ 0.2 % (2g/litre water), 75-100 ml per seedling and 15-20 g per plam to control nut splitting

Barren Nuts

The occurrence of nuts without or with imperfectly developed kernel is known as ‘barren nut’,'Seedless' or 'Imperfect' nuts and it is a common phenomenon in coconut which is as ancient as the cultivation of the coconut. Till about the fourth month, no marked differences are noticeable between a normal and a barren nut. It is possible to identify these nuts with some difficulty from the fourth month of development onwards, when they are observed lagging behind in external development. About the seventh month, the signs of barrenness become more conspicuous. At this stage, these nuts are generally identified from the normal ones by their peculiar colour, irregular shape and their reduced size and lighter weight.

The most common feature of the barren nut is the frequent splitting of the shell during the period of development. Sometimes the barren nuts show the cracks at the apical end of the nut

Management:

- The production of barren nuts can be reduced by checking the crop load and thinning of nuts.
- Application of 1 kg of murate of potash and 200 g of borax per palm in addition to the regular recommended dose of fertilizer will correct this problem.

There is also a popular belief that application of common salt reduces the production of barren nuts.

Physiological disorder in Rubber

Brown bast – Taping panel dryness (TPD)

A physiological disorder, mainly due to intensive tapping. High yielding clones are more vulnerable.

Symptoms

Partial drying up of tapping cut (initial symptom) with the outer latex vessel drying up first (No production of latex).

Light brown discoloration of the attacked portion (Hence TPD is also known as brown bast) Tumors can be seen on the panel area. Drying up entirely and cessation of latex flow

Management:

- Remove affected tissues and Rest the trees without tapping from 3 to 12 months,

Low frequency tapping is also recommended and Proper manuring

Physiological disorder in Coffee

Kondli or Stem Wasting: This disorder id due to toxicity of Copper. A constriction of the main stem, tendency towards lean and lanky growth and the main stem snaps off at the constricted portion.

Management: Avoid application of copper fungicides to nursery seedling especially in inclement weather during June-august

Physiological disorder in Tea

Tea yellows

The tea yellow is caused due to deficiency of Sulphur. Leaves of sulphur deficient bushes turn yellow are reduced in size, the internodes are short and the entire plant appears shrunken. Under severe deficiency, leaves may curl up and their edges and tips turn brown. Axial buds produce dwarf yellow leaves

Management: Application of Ammonium sulphate to correct this problem or foliar spray of $CaSO_4$@1-2%

Physiological disorder in Cocoa

Zinc Deficiency

- Chlorosis of the leaves.
- Vein- banding.
- Mottling & crinkling with wavy margin.
- Younger leaves become narrow and sickle shaped.
- Twigs shows shortened internodes or rosette

Management: Spray 0.3% Zinc Sulphate as foliar application

Iron Deficiency

- Darker green veins in younger leaves against a paler green background.
- Green tinted veins against pale yellowish white background and tip scorching Narrow marginal and tip scorching in older leaves

Management: Spray 1% aqueous Ferrous Sulphate solution repeatedly until the deficiency is corrected

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HARMONIZING CROP HEALTH: HARNESSING BIO-PESTICIDES, BIO-FUNGICIDES, AND BIO-NEMATICIDES FOR SUSTAINABLE AGRICULTURE

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Abstract

The adoption of bio-pesticides, bio-fungicides and bio-nematicides in India aligns with the country's efforts to promote sustainable agriculture, reduce chemical residues in crops, and safeguard the environment and human health. Regulatory bodies like the Central Insecticides Board and Registration Committee (CIBRC) play a role in evaluating and approving bio-pesticides for use in the Indian market. Farmers, agricultural extension services, and researchers work collaboratively to implement integrated pest management strategies that incorporate bio-pesticides alongside other approaches for effective and eco-friendly pest and disease control.

Bio-pesticides are an environmentally friendly and sustainable alternative to chemical pesticides, and bio-nematicides specifically target plant-parasitic nematodes, which are a significant challenge in Indian agriculture. These bio-pesticides contain living organisms or natural compounds that help manage nematode populations and reduce their damage to crops.

Bio-pesticides used in India:

1. **Neem-based Products:**
   - **Neem Oil:** Extracted from neem seeds, neem oil contains azadirachtin, a compound with insecticidal properties. It's used against a variety of pests, including aphids, caterpillars, and whiteflies.
   - **Neem Cake:** The residual material left after extracting neem oil is processed into neem cake, which is used as a soil amendment and a nematicide.

2. **Bacillus thuringiensis (Bt):**

   Bt is a soil-dwelling bacterium that produces proteins toxic to specific groups of insects, such as caterpillars and larvae of certain beetles. It's effective against pests like the diamondback moth and cotton bollworm.

3. **Trichoderma spp.:**

Trichoderma-based products are used as bio-fungicides. They help control soilborne diseases by colonizing plant roots and preventing the establishment of pathogenic fungi.

4. **Pseudomonas fluorescens:**

This bacterium produces antibiotics that inhibit the growth of pathogenic fungi and bacteria. It's used as a bio control agent against various soil borne diseases.

5. **Verticilliumlecanii:**

This fungus is a natural enemy of many sap-sucking insects like aphids, whiteflies, and mealybugs. It's used as a biological control agent against these pests.

6. **Beauveriabassiana:**

This fungus infects and kills various insect pests, including aphids, whiteflies, and beetles. It's widely used in organic farming to manage pests.

7. **Azadirachtin Formulations:**

Apart from neem oil, formulations containing azadirachtin extracted from neem seeds are used as insect growth regulators. They disrupt insect development and molting.

8. **Bio-fertilizers:**

While not strictly bio-pesticides, certain bio-fertilizers like rhizobacteria and mycorrhizal fungi have been found to induce plant resistance against pathogens, indirectly contributing to disease management.

9. **Marigold Extracts:**

Marigold extracts have been shown to have nematicidal properties, making them useful in managing plant-parasitic nematodes.

10. **Trichogramma Wasps:**

These tiny parasitoid wasps are released to control insect pests like borers and caterpillars by parasitizing their eggs.

Bio-nematicides used in India:

1. **Pochoniachlamydosporia:**

Pochoniachlamydosporia is a fungus that parasitizes nematode eggs and females. It's used as a biological control agent against root-knot nematodes and cyst nematodes.

2. **Paecilomyceslilacinus:**

This fungus is known to parasitize and kill plant-parasitic nematodes, including root-knot nematodes and cyst nematodes.

3. **Trichoderma spp.:**

Some Trichoderma species have been found to have nematicidal properties. They can help suppress nematode populations in the soil through their antagonistic activity.

4. **ArbuscularMycorrhizal Fungi (AMF):**

While not strictly bio-nematicides, AMF can form symbiotic relationships with plants and enhance their resistance to nematode infestations by inducing systemic resistance.

5. **Plant Extracts:**

Neem extracts and marigold extracts have been explored for their nematicidal potential. These plant-derived compounds can interfere with nematode development and reduce their numbers.

6. **Chitinase-Producing Bacteria:**

Certain bacteria, like Bacillus spp., produce chitinase enzymes that can degrade the chitin in nematode cuticles, leading to their death.

7. **Vetiver Grass (Chrysopogonzizanioides):**

Vetiver grass is used as a biological barrier around crops to manage nematode populations. Its roots release allelopathic compounds that deter nematodes.

8. **Oil Cakes:**

Oil cakes derived from plants like neem and pongamia are used as soil amendments. They release natural compounds that have nematicidal properties.

Bio-fungicides are essential tools in sustainable agriculture, helping to manage fungal diseases without the environmental impact of chemical fungicides. In India, where agriculture plays a crucial role in the economy, the use of bio-fungicides has gained traction. These bio control agents offer effective disease management while minimizing the harmful effects on ecosystems and human health.

Bio-fungicides used in India:

1. **Trichoderma spp.:**

Trichoderma species are versatile bio fungicides used to manage a wide range of soil borne and foliar fungal diseases. They compete with pathogenic fungi for resources and release enzymes that break down pathogen cell walls.

2. **Pseudomonas fluorescens:**

Pseudomonas-based bio fungicides are effective against diseases like damping-off, root rot, and wilt. They produce antimicrobial compounds that inhibit the growth of pathogenic fungi.

3. **Bacillus subtilis:**

Bacillus-based bio fungicides are used against fungal diseases like powdery mildew and gray mold. They produce antifungal metabolites that target pathogens.

4. **Trichodermaviride and Trichodermaharzianum:**

These specific Trichoderma species are known for their efficacy against diseases like Rhizoctoniasolani and Sclerotinia spp.

5. **Gliocladium spp.:**

Gliocladium-based bio fungicides are used to suppress soil borne pathogens and protect plant roots from diseases like damping-off and root rot.

6. **Bacillus pumilus:**

This bacterium produces volatile organic compounds that inhibit the growth of fungal pathogens. It's effective against diseases like early blight and gray mold.

7. **Streptomyces spp.:**

Streptomyces-based bio fungicides produce antifungal compounds that can control a variety of fungal diseases.

8. **Neem-based Products:**

Neem extracts, including neem oil and neem cake, have fungicidal properties and can help manage fungal diseases like powdery mildew and rust.

9. **Beauveriabassiana:**

While primarily used as an insecticide, Beauveriabassiana also has potential as a bio fungicide against certain fungal diseases.

10. **Azadirachtin Formulations:**

Azadirachtin, a compound found in neem, not only acts as an insect growth regulator but also has antifungal properties.

The application doses of common bio-pesticides used in India:

1. **Trichoderma spp.:**
    - **Seed Treatment:** Use around 5-10 grams of Trichoderma powder per kg of seeds before sowing.
    - **Soil Application:** Apply 2-5 kg of Trichoderma powder per acre in the planting holes or through drip irrigation.
    - **Foliar Spray:** Mix 10-20 grams of Trichoderma powder in 10 liters of water and spray on the foliage.
2. **Pseudomonas fluorescens:**
    - **Seed Treatment:** Use around 10-20 grams of Pseudomonas powder per kg of seeds before sowing.
    - **Soil Application:** Apply 2.5-5 kg of Pseudomonas powder per acre in the planting holes or through drip irrigation.
    - **Foliar Spray:** Mix 20-25 grams of Pseudomonas powder in 10 liters of water and spray on the foliage.
3. **Bacillus subtilis:**
    - **Seed Treatment:** Use around 10-20 grams of Bacillus subtilis powder per kg of seeds before sowing.
    - **Soil Application:** Apply 2.5-5 kg of Bacillus subtilis powder per acre in the planting holes or through drip irrigation.
    - **Foliar Spray:** Mix 20-25 grams of Bacillus subtilis powder in 10 liters of water and spray on the foliage.
4. **Neem-based Products (Neem Oil and Neem Cake):**
    - **Neem Oil:** Mix 2-5 ml of neem oil per liter of water for foliar spray. For soil drench, mix 50-100 ml of neem oil in 10 liters of water and apply to the root zone.
    - **Neem Cake:** Apply 500-1000 kg of neem cake per acre as a soil amendment during land preparation.
5. **Azadirachtin Formulations:**
    - The application rates of azadirachtin formulations can vary widely. Follow the manufacturer's instructions on the product label for proper dosages.

The application doses of common bio-fungicides used in India:

1. **Trichoderma spp.:**
   - **Seed Treatment:** Use around 10-20 grams of Trichoderma powder per kg of seeds before sowing.
   - **Soil Application:** Apply 2.5-5 kg of Trichoderma powder per acre in the planting holes or through drip irrigation.
   - **Foliar Spray:** Mix 10-20 grams of Trichoderma powder in 10 liters of water and spray on the foliage.
2. **Pseudomonas fluorescens:**
   - **Seed Treatment:** Use around 10-20 grams of Pseudomonas powder per kg of seeds before sowing.
   - **Soil Application:** Apply 2.5-5 kg of Pseudomonas powder per acre in the planting holes or through drip irrigation.
   - **Foliar Spray:** Mix 20-25 grams of Pseudomonas powder in 10 liters of water and spray on the foliage.
3. **Bacillus subtilis:**
   - **Seed Treatment:** Use around 10-20 grams of Bacillus subtilis powder per kg of seeds before sowing.
   - **Soil Application:** Apply 2.5-5 kg of Bacillus subtilis powder per acre in the planting holes or through drip irrigation.
   - **Foliar Spray:** Mix 20-25 grams of Bacillus subtilis powder in 10 liters of water and spray on the foliage.
4. **Gliocladium spp.:**
   - **Soil Application:** Apply 2.5-5 kg of Gliocladium powder per acre in the planting holes or through drip irrigation.
5. **Azadirachtin Formulations:**
   - The application rates of azadirachtin formulations can vary significantly. Follow the manufacturer's instructions on the product label for proper dosages.
6. **Neem-based Products (Neem Oil and Neem Cake):**
   - **Neem Oil:** Mix 2-5 ml of neem oil per liter of water for foliar spray. For soil drench, mix 50-100 ml of neem oil in 10 liters of water and apply to the root zone.

- **Neem Cake:** Apply 500-1000 kg of neem cake per acre as a soil amendment during land preparation.

Products containing *Trichoderma spp.*

The application doses of common bio-nematicides used in India:

1. **Pochoniachlamydosporia:**

Apply Pochoniachlamydosporia as a soil treatment at a rate of 10-20 grams per plant or 2.5-5 kg per acre.

2. **Paecilomyceslilacinus:**

Apply Paecilomyceslilacinus as a soil treatment at a rate of 10-20 grams per plant or 2.5-5 kg per acre.

3. **Trichoderma spp. (Nematicidal Strains):**

Apply Trichoderma nematicidal strains as a soil treatment at a rate of 2.5-5 kg per acre.

4. **ArbuscularMycorrhizal Fungi (AMF):**

While not bio-nematicides, AMF can enhance plant resistance to nematodes. Apply AMF inoculants following manufacturer's recommendations.

5. **Vetiver Grass (Chrysopogonzizanioides):**

Establish a vetiver grass barrier around the crop area. The spacing and density of the grass will depend on the specific situation.

6. **Plant Extracts (Neem, Marigold):**

Apply neem extracts or marigold extracts as soil amendments or through foliar sprays following recommended dosages.

As the demand for sustainable agricultural practices continues to grow, the utilization of bioagents is becoming increasingly important. By embracing these natural allies, farmers can achieve effective pest and disease management while preserving the environment, promoting biodiversity, and securing the future of agriculture.

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IMPROVED PRODUCTION TECHNOLOGIES FOR HYBRID SUNFLOWER FOR BLACK COTTON SOILS (VERTISOLS) OF SOUTHERN TAMIL NADU

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Introduction

World sunflower area accounts for 20 million hectares and production around 30 million tonnes. Major cultivating countries are Russia (5.41 million hectares), Ukraine (3.69 million hectares), India (2.16 million hectares), Argentina (1.89 million hectares) USA (1.06 million hectares) and China (1.05 million hectares) occupying about 68 % of the total world sunflower acreage. The average productivity of sunflower in India is very low of 615 kg/ ha as compared to other major producers.

In India, sunflower is cultivated in around two million hectares (10 % of the world sunflower area) and production is around one million tonne (4 % of the world sunflower production). The major producers of sunflower are Karnataka (54.86%), Andhra Pradesh (20.83%) and Maharashtra (14.58%). According to the market sources, 70% of the crop is produced in Rabi (November – March) season, and remaining 30% in Kharif (June – September).

The productivity of sunflower in Tamil Nadu is 1240 kg/ha which is higher than the national average of 615 kg/ha. About 68 % of the crop is raised under irrigated conditions. For the past five years sunflower is a crop of choice for farmers in Trichy, Erode, Karur, Dindigul, Tirunelveli, Villupuram and Cuddalore regions.

Soil and Climate

The black cotton soil belongs to the order of Vertisols occupy an area of 4,98,000 ha in Ramanathapuram, Tuticorin, Tirunelveli and Virudhunagar districts of Tamil Nadu. The soils are mostly rainfed with cotton, chilly, millets, pulses and oil seed crops. The soil comprises of poorly drained to slightly alkaline very deep drained with slow permeability. The soil pH is 7.5-8.5 and the soluble salt content is within the permissible limits. The cation exchange capacity of the soil is 35 - 45 c mol (p^+) kg^{-1}. The soil is low in available nitrogen (N) and medium in available phosphorus (P) and high in available potassium (K). The available Zn, Fe, Cu and Mn are comparatively low.

The climate of the area is semi arid tropical monsoonic type. The major rainy season is north - east monsoon with 55 per cent total rainfall, followed by summer with 20 per cent, south west with 18 per cent and winter with 7 per cent. 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 700 mm. The moisture regime of the study area is 'ustic' and the temperature regime is 'iso hyperthermic'.

Improved Production Technology (IPT) for Hybrid Sunflower

Tamil Nadu - Irrigated Agriculture Modernization and Water bodies Restoration and Management (TN-IAMWARM) project which promotes scientific cultivation of Sunflower to improve productivity levels and to ensure better commodity price for domestic sunflower growers.

The following major criterias for adoption as IPT

- ✓ Short duration (90-105 days)
- ✓ Use of hybrid seed
- ✓ Field preparation with ridges and furrow 60cm apart
- ✓ Adoption of wider spacing 60 x 30 cm
- ✓ Split application of recommended fertilizer dose
- ✓ Spray borax @ 0.2% (2g/l of water) at ray floret opening stage and seed filling and /or gently brushing the two capitulums facing each other.
- ✓ Timely management in plant protection measures with suitable pesticides for preventing the major pest and diseases.

Farmers find sunflower as a highly profitable crop, especially in black soils of Southern districts of Tamil Nadu where the crop is largely cultivated under rainfed and irrigated conditions during late kharif/rabi season. Due to its short duration, it ideally is sown more between September and November. Sunflower also scores favourably against the traditional cultivated crops like Ragi Jowar, Bajra, Castor and Pulses during the late Kharif /early Rabi season due to following advantages

1. Selection of right hybrid

Selection of the right sunflower hybrid is critical as the final income is dependant on both grain and oil yields. As not all hybrids available in the market maximise both grain and oil yields, farmers need to be cautious while choosing the hybrids. In this aspect, it is appropriate to mention that some of the hybrids like Rasi Hybrid, Cauveri-50, Nuviseed, PAC-36, PAC-8699 and PAC-1091 provide both high grain and oil yields. These hybrids, have potential to yield upto 12 quintals/acre with oil content of >40%, under right growing and management conditions.

2. Time of Sowing and Duration of Hybrid

Farmers need to give very careful consideration to the time of sowing and based on which hybrids of right duration are to be selected. Predominantly, the farmers in southern districts like Viruthunagar, Tirunelveli and Thoothkudi of Tamil Nadu traditionally either keep the land fallow or take up pulses or green manure crop with the start of the first rains and then take up sunflower starting from September to mid of November. Farmers in southern districts have realised higher yields by sowing the crop during these months. Longer duration hybrids (>95 days) are to be sown in the early season while medium-short duration hybrids (85-95 days) give better results, if sown later.

3. Plant Nutrients

Better yields in sunflower can only be realised by applying integrated recommended dosage of fertilisers. Particularly, of importance are, application of FYM / Composted coir pith @ 12.5 t/ha, biofertilizer like Azophos @ 2 kg/ha with soil test based nitrogen, phosphorous, potash (Normal recommended dose as 60:90:60 kg NPK/ha) and micronutrients like sulphur and boron. Foliar application of Borax @ 0.2 % at ray floret opening stage, Salicylic acid (100 ppm) and nitrobenzene (50 ppm) at vegetative stage and flowering stage improving plant health and increasing grain yields, also help in improving grain weight and oil content.

4. Irrigation/rainfall

Soil moisture, if available in adequate measure, during critical stages of vegetative growth, flowering and seed setting enhances grain and oil yield. For effective water management the crop should be irrigated immediately after sowing followed by life irrigation on 5 DAS and pre flowering, flowering and pod filling stage.

5. Weed management

Pre emergence application of Pendimethalin 2 l / ha followed by hand weeding at 45 DAS help in better establishment and healthy plants.

6. Pest and Disease Management

Recommended preventive measures and usage of right hybrids provide protection to many of the common pests and diseases in Sunflower. Preventive sprays of pesticides before the first 50 days prevent attack by Heliothes and infestation of Alternaria. Outbreak of viral diseases can also be prevented by sowing the crop after July and by controlling sucking pests like thrips with timely spray of systemic insecticide in the first

40 days. Farmers are suggested to refer to package of practices recommended by local agricultural universities or information provided by the seed companies. When compared with

other competing crops in similar maturity groups, Sunflower is indeed very profitable. Farmers would get maximum benefits from this crop by following the scientific cultivation practices already explained above.

Results from Field trials

Under Tamil Nadu - Irrigated Agriculture Modernization and Water bodies Restoration and Management (TN-IAMWARM) project, filed trials were conducted in black soils for maximizing the yield of sunflower in Sankarankovil, Kuruvikulam, Vasudevanallur, blocks of Tirunelveli and Thoothukudi district of Tamil Nadu. The farmer groups were identified and trained by the agricultural scientists from the Agricultural College and Research Institute (TNAU), Killikulam, Vallanad, Thoothukudi (Dt). The latest improved production technologies were transferred through theory and practical field trainings. Totally 83 demonstrations were carried out. The hybrid seeds varities *viz.*, Rasi, Nuzivved, Kaveri-50 were sown. The farmers were instructed to adopt the improved production technology (IPT) as explained above. In improved production technology (IPT), the range yield of hybrid sunflower seed was 2385-2504 kg / ha over the conventional method (1685 -1935 kg / ha). The per cent increase yield was 23-25 % over the conventional method of cultivation.

Success story

Myself B. Rajagopal, S/o. Balakrishnasamy, Alamanayakkarpatti village, Kuruvikulam block, Tirunelveli district. I have vast experience in cotton, rice and sunflower cultivation for the past fifteen years. Under TN-IAMWARM Project, the scientists of Agricultural College and Research Institute, Killikulam approached me to carry out the improved production technology for sunflower in the ensuing season. They gave scientific package of practices of Sunflower. Accordingly, the field was prepared

with ridges and furrows. The seed was dibbled in the side of the ridges with a spacing of 60 x 30 cm. 10 packets of Azospirillum mixed with 25 kg FYM and 25 kg of soil and applied on the seed line. The sunflower hybrid Cauvery-50 seed used for this demonstration plot. Pre emergence herbicide flouchloralin @ 2 litres/ha was applied on five days after sowing followed by one hand weeding on 45 DAS. The recommended dose of fertilizers as 60:90:60 kg NPK/ha were applied as per the schedule. Bio-fungicide was also used for plant protection. Due to adoption of improved production technology, the demo plot recorded the increased head size, higher seed weight and seed setting percentage. I was realized the sunflower yield of 2550 kg/ha over conventional method of Sunflower cultivation. The higher yield was due to adopting of wide plant spacing, split application of N & K, maintenance of weed free environment up to the critical period and use of bio-fungicide.

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DRONES: TO BATTLE CROP PESTS

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Abstract

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have advanced significantly in the last several years. According to www.Dronedeploy.com, drone technology is being used for various purposes across seven continents, 160 countries, and 25 million acres of land. Crop health monitoring is a key component of precision agriculture and it includes irrigation, fertilization, pesticide sprays, and crop harvesting on time. The agriculture community has positively accepted the drone technology in the era of labour shortage as well as the tremendous importance of precision agriculture. The use of drones for spraying pesticides is a promising alternative to manual spraying. For augmentative biological management, which depends on the widespread deployment of natural enemies for timely pest control, drones may prove to be an incredibly helpful tool. One possible use for drones in pest control is the release of sterile insects. This paper discusses the use of drones for pest management.

Introduction

Crop health monitoring is a key component of precision agriculture, and it includes irrigation, fertilisation, pesticide sprays, and crop harvesting on time. Furthermore, crop monitoring and making appropriate decisions to maintain crop health is critical. The primary cause of the decline in global food production is biotic stress brought on by diseases and pests, which are well known to cause irreparable harm. Pests and diseases are expected to cause losses of over 37%, according to the FAO (Cao, 2015). It is very challenging to control invasive pests in India because more than 80% of farmlands fall into the small and marginal (1 ha) category and also labour availability and technical manpower are extremely limited, particularly in India. Whenever a field is sprayed, pests simply move their feeding to the nearby fields. Drones are gaining popularity in the context of smart farming and useful for on-site detection of problems and immediate implementation of corrective measures in order to complete the task. Drones, also known as unmanned aerial vehicles (UAVs), have become more and more common as a result of their ability to operate quickly and their wide range of potential uses in a variety of real-world scenarios.

Agricultural Drone

Drones are semi-automatic devices that are moving steadily in the direction of being fully automatic. Planning for agriculture and gathering related spatial data have a lot of potential with these devices. Although there are some inherent limitations, this technology can be used for effective data analysis. Drones were initially developed as a military tool and were known by various names, including Unmanned Aerial Vehicles (UAV), Miniature Pilotless Aircraft, and Flying Mini Robots. It is used today in a variety of industries, including business, infrastructure, farming, security, insurance claims, mining, entertainment, telecommunications, and transport. Small unmanned aerial vehicle (UAV) use in agribusiness is expanding quickly in the present (Ramirez and Galvez, 2019 and Giacomo *et al.*, 2018).

Types of drones

There are three types of drones following (Amitkumar *et al.*, 2022)

1. Fixed-wing drones: Fixed-wing drones have a stiff (non-movable) wing, a fuselage (the main body of the aircraft), and tails. A motor and propeller act as the propulsion system for these drones. They have the advantage of being able to fly at higher speeds for longer periods of time, which allows them to travel through a variety of possible habitats (such as jungles, deserts, mountains, and oceans). These drones can't hover and must take off and land using a runway or launcher, which only serves to exacerbate this disadvantage.

2. Rotary wing drones: Due to their rotary or propeller-based propulsion systems, these drones are referred to as rotatory wing drones. Unlike fixed-wing drones, these can hover, fly in all directions, both horizontally and vertically, and have excellent mobility. Because of their characteristics (pipelines, bridges), they are the best drones for surveying hard-to-reach locations. They experience a lift akin to helicopters because of the rotor blades' constant rotation.

The drawbacks of these, though, include their slow speed and short range.

3. LTA & tethered systems drones: They are challenging to manage, and agriculture hardly ever uses them.

Application of drones in insect pest management

1. Drone mediated remote sensing

Drone-based remote sensing technologies offer several advantages that make them attractive for use in precision insect pest management. Sensing drones likely allow the coverage of vast areas than handheld, ground-based devices. Particular biotic stresses, such as insect pest infestations, bring about physiological plant responses, lead to changes in the plants ability to perform photosynthesis and thus leads to changes in leaf reflectance spectral range. Drone can be equipped with an RGB (red green blue) sensor for aerial remote sensing, which is a multispectral sensor with between 3 and 12 broad spectral bands, or a hyper-spectral sensor with hundreds of narrow spectral bands. It is need to note that with remote sensing, not the pests themselves are detected, but patterns of canopy reflectance that are indicative of insect pest-induced plant stress. Hence**,** field observations to confirm the presence of specific insect pest remain necessary (Keller and Shields, 2014).

2. Drone mediated precision application of insecticides

New types of drones that can be purchased as commercial drones and are equipped with crop dusters and/or spray equipment are currently being developed in many parts of the world. Combining precision pesticide application with precision monitoring may lead to fewer overall sprays, which would reduce the development of pesticide resistance, lower pesticide use, and increase the presence of natural enemies on farms.

3. Release of natural enemies

Drones could be an extremely useful tool for augmentative biological management, which relies on the widespread deployment of natural enemies for prompt pest control. They may distribute the natural enemies precisely where they are needed, which may increase the biocontrol agent's efficacy and reduce the cost of distribution. For the purpose of eradicating the European corn borer, *Ostrinia nubilalis* (Lepidoptera: Crambidae), a pest of maize and a forests pest, eastern spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae), Martel *et al.* (2021) released the egg parasitoid *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) as drone mounted dispensers. They discovered that *Trichogramma* released by drone increased the parasitism of spruce budworm eggs, and that there were no differences in parasitism between *Trichogramma* releases by drone and conventional ground releases made with Trichocards.

4. dLocust: long-range drone for mapping vegetation and detecting locusts

The drone would have a range of approximately 100 km while gathering information about the locations of green vegetation and processing this imagery as a map on board. In turn, the map would direct ground survey teams to locations for up to 5 km of additional inspection using a rotary drone. If sizable infestations were discovered, a control drone could safely and successfully spray the locusts before they congregate into swarms. The administration and use of dLocust would fall under the purview of national locust centres. In a few years, the integration of dLocust with ongoing survey work done by national teams on the ground will improve the effectiveness and promptness of Desert Locust monitoring and early warning, resulting in a decrease in the frequency, duration, and intensity of devastating plagues as well as an improvement in food security and livelihoods.

5. Drone mediated sterile insect technique (SIT) and mating disruption

The release of sterile insects is one potential pest control application for drones. Drone-dispersed sterile bug programmes have been successful in reducing codling moth populations in New Zealand, Canada, and the USA. Additionally, the Mexican fruit fly in citrus and the pink bollworm in cotton have been successfully controlled in the USA by sterile insects released by drones during trial operations. It's possible that drone release of the sterile insects will be less expensive and quicker than ground release, resulting in SIT becoming a more popular pest control method (Gary and Gardiner, 2005).

Advantages of drones in agriculture pest management

- High payload, extended flight time, and increased speed
- Strong, long-lasting, and time-saving
- Access to remote areas
- Ability to land vertically and vertical take-off
- Fly backward and forward while hovering
- Low labour requirement

Disadvantages of drones in agriculture pest management

- High costs
- Complexity in data collection, analysis, and interpretation

- Only appropriate for large-scale spraying
- Cannot be used in unfavourable weather conditions
- Needs skilled labourers to operate

Conclusion

Pesticide delivery using drone technology is very efficient for a variety of crops. Even though the operational and delivery parameters have been tailored for a particular crop or a particular pest/disease, some fine tuning is still necessary to increase the effectiveness. Due to the lack of ultralow volume pesticide formulations on the market, the same optimised concentration of conventional pesticides was used in drone technology. Therefore, there is a critical need to create novel nano formulations that are both cost-effective and environmentally safe in order to increase the effectiveness of drone technology.

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PRE-BREEDING: UTILIZING THE CROP WILD RELATIVES FOR BROADENING OF GENETIC BASE

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Abstract

Green Revolution marked a significant increase in global food production, transforming India from a net importer to an exporter. However, contemporary challenges like population growth and climate change demand genetically enhanced crop cultivars. To overcome those challenges, pre-breeding is an alternative among available breeding methods. This approach enhances genetic diversity and making crops resilient by identifying desired traits from wild types and incorporating them into ergonomically useful forms. This article explores pre-breeding concept, necessity, and distinctions from conventional breeding and also highlighting its pivotal role in sustainable agriculture.

Concept/Introduction

Pre-breeding or germplasm enhancement or developmental breeding is a forward-thinking strategy it explores the genetic diversity in wild and underutilized plants were harboring traits like disease resistance and environmental tolerance. Unlike traditional methods, which were focusing on established crops, pre-breeding taps into the vast genetic resources of overlooked species. It enriches the genetic pool, fostering the development of resilient, high-yielding crop cultivars. This approach involves collaborative efforts encompassing germplasm screening, gene identification, hybridization, and the creation of gene-enriched plant populations suitable for diverse agro climatic conditions (Figure 1). In addition, pre-breeding was bridging the gap between genetic resources and modern varieties. It produces material rich in novel genes were readily crossing with cultivated varieties

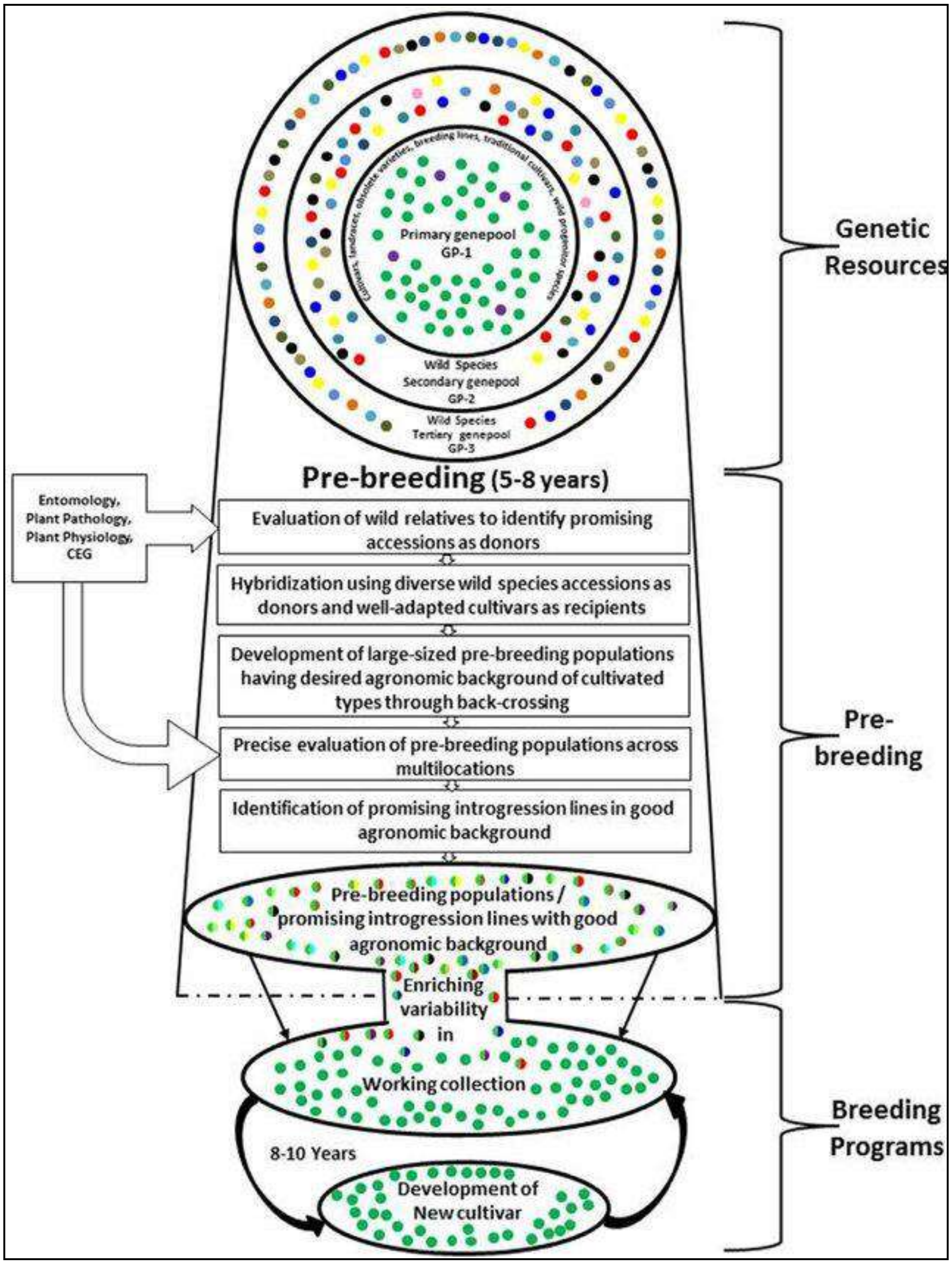

Figure: Pre breeding as a gap between germplasm and breeding of new cultivars

Strategic use of pre-breeding addresses the climate change, emerging pests and/or disease, and nutritional demands which enhancing global food security.

Need of pre breeding

There is a large gap between germplasm collection and modern plant breeding activities, this gap need to be filled via pre breeding activities. In recent days, genetic variability is almost diminishing. For long-term objectives, pre-breeding of field crops for India must be carried out in close cooperation with plant breeding entities, gene banks, and advanced and applied research institutes. Through these partnerships, it will be ensured that the targets are selected to meet the demands of environmental policies and climate adaptation, including modified crop production systems, expanded cultivation areas, enhanced water and nutrient use efficiency, increased resistance to pests and diseases, and increased production demands combined with market-specific quality requirements (Meena *et al.*, 2017).

Difference between pre breeding and conventional breeding

Sr. No.	Pre breeding	Conventional breeding
1	It aims identify and incorporate novel traits from wild or un adapted germplasm into breeding programs.	It aims improve existing varieties through controlled crosses and selection.
2	It often involves wild or underutilized relatives, exploring diverse gene pools.	It primarily utilizes existing germplasm within the same species or closely related species.
3	Typically a longer process due to the need to introgress novel traits from distant relatives.	Can be relatively quicker as it works within known germplasm and existing breeding programs.
4	Higher risk due to potential incompatibility and linkage drag when introgressing novel traits.	Lower risk as it works within the genetic background of existing varieties, minimizing uncertainties.
5	May involve advanced molecular and genomic tools for trait identification and introgression.	Utilizes traditional breeding methods, but may also incorporate some modern molecular tools for marker-assisted selection.

Successful examples of pre breeding

1) Latin American Maize Project (LAMP): In this project 12 countries (Argentina, Bolivia, Brazil, Colombia, Chile, U.S., Guatemala, Mexico, Paraguay, Peru, Uruguay and Venezuela) along with Hi Bred International company evaluated 15000 accessions of maize. Maize breeders can access these material for their breeding programs.

2) Hierarchical Open ended Population Enrichment (HOPE) system: This method were firstly used by Kennenberg (1970) in Corn. This system provides source of inbred lines from different genetic background of crops.

Conclusion

Pre breeding strategy that exploit the genetic base of crop provides a best way to widen the genetic base of crop. These crop wild relatives are the treasures for valuable traits such as disease resistance, nutritional attributes and many more. Through pre breeding it is possible to add these features into ongoing breeding programs. This approach can greatly contribute to tackle the problem of increasing population and climate change

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INTRODUCTION TO DRY FLOWER

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Abstract

The technology of drying flowers is the skill of preserving them, ensuring ease of handling and lasting beauty. Any section of an ornamental plant can be dried and preserved by considering a few essential factors. Contemporary methods are employed to dry plant parts while preserving their color and quality. These dried components find applications in decorating candles, making soap, crafting paper, arranging flowers, and more. To enhance the marketing of dried ornamental plant material, it requires increased emphasis on standardization, advanced production techniques, and improved marketing strategies.

Key words: Dry Flower technology, flowers

Introduction

FLOWER... we all know that flower is ornamental part of any plant. Flowers are associated with humans' life since ages. We use flowers to decorate our homes, office and express our sentiments. But fresh flower is expensive and have constrained lifespan. The beauty of flower is lost

DEHYDRATION TECHNOLOGY OF FLOWER AND FOLIAGE IS STANDARDIZED BY DR J.C. BHUTANI AT NBRI, LUCKNOW.

due to microbial activity and biochemical changes and can only be retained for few days by using post-harvest management technique. Even when post-harvest management technique is used flower life is only extended by few days. And solution to this problem could be production of everlasting flower. Production of everlasting flower by drying them is not new and we been doing it for hundreds of years.

Dry Flowers Technology

Dry flower technology is preserving the aesthetic value of fresh ornamentals by eliminating moisture from them. The word flower in dry flower does not only include flower but ornamental parts of plant like pods seeds leaf fruit bark etc.… Approximately 80% of ornamentals can be dehydrated and incorporated into floral presents. Dried ornamental plant parts, being cost-effective, are often valued for their enduring and appealing aesthetic.

History of dry flower is 5 decades old and britishers were first to introduce dry flower in India mainly Calcutta. Egyptians used to keep dry flower in tomb for fragrance. Dry flowers are facile to manage and have qualities like novelty, longevity, eco-friendly, flexible, everlasting and are assessable all year round.The industry of dry flower in India is growing 15%annually. While dry flower solely adds 71% of total export. Approximately 50 companies oversee the export of flowers.. Situated in Tuticorin, Kolkata, Mumbai. Ramesh flower limited of Tuticorin (T.N.) have 50% share of total dry flower export. The item exported from India includes: Lotus pods (over 10 million pieces), Camellia, Dahlia, Bell cups, Marigold, Jute flowers, Wood rose, Wild lilies, Paper flower. The benefits of dry conditions are plentiful, as they are readily available and persist consistently throughout the year. Additionally, they are easy to manage and cost-effective.

Dehydration of Ornamentals

Dehydration or drying of ornamentals includes various methods by which artificial heat is applied to remove moisture from plant part. The basic principles of dehydration are removing moisture from desired part by maintaining its original shape and colour.

Drying methods are:

1. Air drying
2. Sun drying
3. Press drying
4. Embedded drying

5. Oven drying
6. Microwave drying
7. Water drying
8. Freeze drying
9. Skeletonization

PRE-DRYING :

- As immature follower tends to loosed their shape quickly. The flower should be collected as they come to maturity.
- Collection from the field should be done one or two days after irrigation.
- Collection should be made under bright sun, their should be no accumulation of dew drops.
- Harvested Plant part should be with long stem
- Harvest with sharp knives.
- Chop the unnecessary materials like dead and diseased part or extra foliage
- Grade and make bundle, flower of same kind in a bundle and flowers with big head are dried alone.
- Flowers with weak stem should be wired using florist wire

AIR DRYING

Also known as the "Upside Down" or "Hang and Dry" method. In this method flower of one kind are bundled together and hanged in well-ventilated room away from direct sunlight. The color of flower is lost in this method. Drying takes 2-3 weeks.

Suitable flowers: helichrysum, Limonium, statice

SUN DRYING

With the help of sun moisture from ornamental plant is removed. Generally, takes 3-4 days. The disadvantage of the method is that the color of dried product is inferior.

- Suitable flowers: zinnia, marigold, pansies and chrysanthemum

PRESS DRYING

Drying of ornamental part (flower, leaves) while pressed between newspaper, books, bloating paper etc. .in this method original shape of flower is lost. Complete drying takes 5-10 days.

- Suitable flowers: thuja, hibiscus, marigold, *Lantana camera*, euphorbia, ixora, mussenda

EMBEDDED DRYING

To overcome drawbacks of above-mentioned method embedded drying is used in this method flower or ornamental parts are entrenched in desiccant. Generally used for delicate flowers.

Desiccant

They are generally material with 0.02mm-0.2mm particle size. The dessicant should be available easily, cheap, less adhesive, must hold the original shape of the sample and must readily absorb the moisture.

OVEN DRYING

The container with flowers or flowers embedded with desiccant are kept. In hot air oven. Temperature is maintained between 45-60 C for two hours to three days depending upon the plant material to be dried.

- Suitable flowers: helipterum, chrysanthemum, gerbera

MICROWAVE DRYING

Quickest method of drying, the flowers is kept in microwave along with small cup of water to avoid excessive drying. Time required for dehydration is 5-10 minutes. This method of drying maintains fresh look of flowers.

- Suitable flowers: roses, chrysanthemum, gerbera

WATER DRYING

The stem of flowers is kept in few inches of water and kept in warm dark room. The drying takes 7-10 days.

- Suitable flowers: hydrangea, yarrow, bells of Ireland, celosia

FREEZE DRYING

In 1813 at Royal Society of London, William Hyde Wallaston first practiced freeze drying. In the process flowers are freeze up to -35C. By eliminating the water, the flowers dry up with life freshness and retain better integrity and are more durable.

- Suitable flowers: roses, carnation.

SKELETONIZATION

Skeletonizing implies, lacy arrangement of dried ornamentals by eliminating all tissues only leaving the "skeleton" or veins of leaves.

Skeletonization is best achieved in heavy textured or velvety leaves.

- In this method Boiling of leaves with 1-quart water and 2 tablespoons of lye (hot NaOH) for 40 min is done.
- Then the ornamentals are dipped in cold water and pulp is scrapped of gently.

DRY FLOWER STORAGE AND PACKAGING

Dry ornamentals should be shielded from direct sunlight and provided with adequate ventilation. Dried material is prone to moisture absorption and shape loss, so it should be promptly stored in moisture-proof containers. Adding silica gel at the container's base helps absorb moisture effectively. Sturdy packaging, such as cardboard boxes, thermos-cool packing, and poly or wax paper-lined cartons, is employed to ensure safe storage and transport. These materials safeguard the flowers and are suitable for extended storage and long-distance shipping.

MARKETING OF DRIED ORNAMENTAL

To successfully market dried ornamentals and achieve profitability, it is essential to comprehend multiple factors, including economic aspects, consumer appeal, and logistical considerations. This includes factors such as warehousing, distribution, and sales facilities.

This sector get least attention; therefore, both consumer and producer are at loss, whereas middleman is earning the huge profit.

FUTURE THRUST

In the future, the industry should prioritize standardization, market identification, modern drying techniques, and education to promote sustainability and provide consumers with eco-friendly, attractive, and long-lasting floral options. This will benefit both producers and consumers, reducing reliance on middlemen and enhancing overall profitability.

CONCLUSION

In conclusion the art and science of this industry with its rich history and significant growth, offers a lasting way to enjoy the beauty of ornamental plants and flowers. Various drying methods, both traditional and modern, provide options for preserving the aesthetic value of flowers. Proper harvesting, handling, and storage are essential to maintain quality. The marketing of dried ornamentals needs more attention, with a focus on standardization, advanced production techniques, and improved marketing strategies. Education and training are vital to raise awareness and adapt to consumer preferences.

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ORGANIC CERTIFICATION

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Introduction

The important aspect in modern era of organic farming is certification programme which consists of standards(rule), inspection (checking whether the rules are implemented) and certification (judgment). Organic farming can be distinguished from other methods of sustainable agriculture by this certification programme. The standards define what can be labeled "certified organic" and sold commercially as such. Certification in organic agriculture generally refers to independent third-party certification.

Certification

A third part implies it is not done by either the producer (first party) or the buyer (second party) the system includes farm inspector and audit trails (checking of records).

Certificate is valid only if it is done by accredited certifying agency. certification by an agency includes

1. Certification attested by the certification manager
2. Inspection done by an inspector
3. Adopting standards attested by the quality control manager

From a commercial perspective it is not enough that product is produced organically, what is equally important is that it should be certified as such. In India, APEDA, an apex organization under Ministry of Commerce, Govt. of India has formulated a National Programme for Organic Production (NPOP). APEDA has developed National Standards for organic export. The scopes of these standards are:

1. Lay down policies for development and certification of organic products.
2. To facilitate certification of organic products confirming to the National Programme containing the standards for organic production.
3. Institute a logo and prescribe its award by accrediting bodies on products qualifying for bearing India organic label.

Certification being expensive, technical and time-consuming other schemes such as Internal Control Systems (ICS), Participatory Guarantee Systems (PGS) and Producer Companies (PC) are being viewed as better options to be promoted in the country.

Global Certification Bodies:

1. 468 organizations offer organic certification services throughout the world.
2. Most certification bodies are in Europe (37%), followed by Asia (31%) and North America (18%). The countries with the most certification bodies are the Japan, USA, Germany and China.
3. Forty per cent of these certification bodies are approved by the EU; 32 per cent have International Organization for Standardization 65 (ISO65) accreditation and 28 per cent are accredited under NOP (National Organic Programme, United States).

Purpose of Certification

It is a marketing tool for exports.The entire production chain from the producer u up to the importer has to be inspected by independent and neutral bodies Coertification bodies) that are operating according to specific guidelines.exporter and The advantages of certification agency are that it acts as a trust building system between farmers and customers, helps in authentication of the product, enables transparency and strengthens the position of the primary producer and helps in market promotion of product.

Certification-Tasks of the Growers -Producers

In order to certify a farm, the producer is typically required to start number of new activities in addition to normal farming operations. is and what is Study the organic standards which cover in specific detail what not allowed for every stage of farming, including storage, transport and sale.

1. Farm facilities and production methods must comply with the standards. This may involve modifying facilities, sourcing and changing suppliers, etc. Records like detailed farm history and current set-up, day to day farming, soil, plant tissue and water analysis etc. should be kept and available for reference.

2. An annual production plan detailing everything from seed to sale, seed sources, field and crop locations, manuring and pest control activities, harvest methods, storage locations etc. will have to be submitted.

3. The field must meet basic requirements of being free from use of prohibited substances (synthetic chemicals, etc.). Annual on-farm inspections are required, with a physical tour, examination of records, and face to face interview. A conventional farm must adhere to organic standards during transition, often, three years.

4. Transitional crops are not considered fully organic. The transition period could be minimized if a farm already growing without any chemicals and other procedures of organic farming.

Accreditation Agencies

- Under NPOP, the mandate of the accreditation agencies includes, among others, the prescription of a package of practices for organic products within their jurisdiction and accreditation of certification agencies.
- The inspection and certification charges to be levied by the certification agencies are to be fixed by the accreditation agencies.
- On the basis of the mandate given by the NPOP, the accreditation agencies have issued detailed regulations covering, among others, standards, packages of practices and procedures for accreditation of certification agencies for their mandated products.

SYMBOL FOR ORGANIC CERTIFICATION:

Guidelines for Organic Certification

1. General Requirement for Certification
2. Application for Certification
3. Review of Application
4. Scheduling of Inspection
5. Verification during Inspection
6. Group Certification Standard
7. Continuation of Certification
8. Tamil Nadu Organic Certification Department (TNOCD) Standards for Organic Certification

1. **General Requirement for Certification**

❖ A registered operator shall Comply with National Programme for Organic Production (NPOP) norms and shall adhere to the National Standards for Organic Production (NSOP) and TNOCD general standards for organic agricultural production, animal husbandry production, honey, wild collection, processing, packaging, storage, labelling and transport standards.

❖ Prepare, implement, and update annually an organic production plan and submit to Tamil Nadu Organic Certification Department (TNOCD) every year.

❖ Permit on-site inspections with complete access to the production and handling operation, including non-certified production and handling operation, areas, structures, offices by the Organic Certification Inspectors and other higher officials of TNOCD and also officials of APEDA whenever required.

❖ Maintain all records applicable to the organic operation for not less than 5 years after creation of such records and allow authorized representatives of TNOCD, State or Central Government officials of accrediting agency access to such records during normal working hours for review and copying to determine compliance with NPOP norms and TNOCD Standards.

❖ Pay the prescribed fees charged by TNOCD within stipulated time.

❖ Operator shall inform the TNOCD in case of any

a) Application, including drift, of a prohibited substance to any, production unit, site, facility, livestock, or product that is part of an operation and

b) Changes in certified operations or any portion of a certified operation that may affect the organic integrity in compliance with standards of NPOP and TNOCD.

2. **Application for Certification**

A person seeking organic certification of production or handling operation shall submit application for registration in the prescribed format in triplicate. The application shall include the following information

1) An organic production or handling system plan,
2) All information requested in the application shall be completed in full i.e. name, addresses, details of contact person, telephone number of the authorized person etc.,
3) The names of organic certification body to which application is previously made and outcome, non-compliance noted if any, copy of such records and reason for applying shall be given.
4) Any other information necessary to determine the compliance with the standards specified.
5) The prescribed registration fee, one-time inspection fee, one-time travel cost shall be paid by the operator along with the application form. The other prescribed fees shall be paid by the operator as notified by TNOCD during the course of certification process.

3. **Review of Application**

1) Application shall be scrutinized.
2) Any information required shall be communicated to the operator and operator shall submit the requested information immediately.
3) Application without prescribed fee shall not be reviewed.
4) After review of application decision shall be made by TNOCD on acceptance/ rejection of the application.
5) The rejected application shall be returned to the applicant citing reasons for rejection along with the fees enclosed.
6) Fee paid for the applications accepted by TNOCD shall not be refunded at any circumstances.
7) An initial onsite inspection shall be fixed and communicated to the operator after registration or shall be noted in the registered copy of application itself.

8) An applicant can withdraw the application at any time but the fees paid shall not be refunded.

4. **Scheduling of Inspection**

- Initial field inspection shall be fixed at a reasonable time so that the operator can demonstrate compliance or capacity to comply with the standards while conducting inspection of land, facilities and activities. Such initial onsite inspection shall be delayed up to six months from the date of registration so as to give time for the operator to comply with required standards including record keeping.
- All onsite inspection shall be conducted only in the presence of operator or an authorized representative of the operator who is knowledgeable about the operation. However, this requirement does not arise in the case of unannounced / surprise inspections.
- There shall be one annual inspection and additional inspection shall be fixed based on the risk assessment carried out during initial inspection.

5**. Verification during Inspection**

1) During the field inspection, the OCI shall verify the compliance or the capacity to comply with the NPOP standards and TNOCD standards.
2) Verification of information on organic production plan submitted by the operator and practical implementation of the standards.
3) OCI shall ensure that the prohibited substances/ materials are not used and in case of suspicion the OCI, shall draw samples of soil, water, wastes, seeds, plant tissues, plant, animal and processed products.
4) The samples shall be tested in NABL accredited ISO 17025 laboratories. The operator shall bear the cost of samples sent for analysis.
5) During onsite inspection the OCI shall conduct interview with the person responsible for the organic production system to confirm accuracy of information gathered during inspection and completeness of inspection, observation gathered during the onsite inspection. The inspector shall also collect other required information as well as issues of concern.
6) After inspection the OCI shall prepare checklist and inspection report and obtain signature of the operator or his representative.

7) A copy of the check list and inspection report shall be sent to the concerned operator and Evaluator.
8) Inspection reports shall be evaluated by the evaluator within reasonable time and any additional information required shall be addressed to the operator.
9) In case of any non-compliance to the prescribed standards an explanation shall be called from the operator and sanctions shall be imposed if required.

6. Group Certification Standards

General Requirement

This system applies to farmer groups, co-operatives, producer groups, contract production and small-scale processing unit.

1) The producer group shall have similar production system and within the same geographical proximity.
2) Farmers holding four hectares and above can be part of group but has to be inspected individually. The total area of such farm shall be less than 50% of total area of group.
3) Processor an exporter may be a part of the same group but they shall be inspected annually by TNOCD.

Constitution of Group

1) Group shall have a legal status or structured organization
2) The group shall maintain a documented Internal Control System (ICS)
3) The responsibilities of the group shall be delegated to individual members/committee for carrying out specific activities.
4) The group shall develop an internal quality system manual comprising of implementation of internal control system and assessment of risk.

Internal standards for group certification

1) Internal standards shall be prepared in local language under the framework of NPOP standards
2) The internal standards shall include definition of production unit, method of dealing with part conversion, parallel production, period of conversion, production norms for entire production unit, harvest and post-harvest procedures.
3) The IQS shall include buying procedure, trading procedure and processing procedure for the group.

Granting of Certification

1) TNOCD shall issue Scope Certificate or Certificate of Registration, Transaction Certificate and Product Certificate to the eligible operators.
2) The issue of certificate shall be based on the decision taken by the certification committee.
3) Scope Certificate

Denial of Certification

1) If the Organic System of operation does not comply with the Standards, the operator shall be intimated about denial of certification stating the reasons for such action with non-conformities noticed and time limit for submission of correction.
2) Upon receipt of such reports the operator shall correct the noncompliance and submit the action taken report to the TNOCD.
3) TNOCD shall ensure the correction carried out by the operator before issuing certificate.
4) Operator with another certification body willing to come under TNOCD certification shall submit a new application form to TNOCD along with the notification of issue of non-conformities issued by the previous certifier.
5) TNOCD upon receipt of such application shall verify the correction carried out onsite and supporting documents. Any records required shall be received from the, CB previously registered or from APEDA.
6) TNOCD shall issue written notice to the operator for denial of certificates in case of operator failing to respond to the notification of non-compliance.
7) A notice of denial of certification shall inform the operator about the reasons and applicants right to reapply for certification or file an Appeal to the Appeal Committee.

7. Continuation of Certification

1) To continue certification the operator shall renew registration by paying fees for renewal.
2) An updated annual report for production or handling operation shall be submitted by the operator.
3) An updated corrective action for minor non-conformities previously identified shall be submitted by the operator.
4) TNOCD after receipt of renewal application for continuation of certification shall scrutinize the application and verify the facts.

Fair trade

All the operators shall perform their operation with social justice, they shall not employ child labour, and shall protect rights of women, smallholder, traditional agriculture and indigenous people's rights.

Appeal

- Registered operator may appeal against the notice of denial of certification, proposed suspension or revocation to the appellate authority (Director, TNOCD).
- An appeal shall be made within the time period mentioned in the notification or within 30 days from the date of receipt of the notification, whichever occurs later. The appeal shall be considered filed on the date of receipt in the office of Director, TNOCD. The decision of the appellate authority shall be final.

Conclusion

The organic certification system through assures the quality of the produce for the consumer is very cumbersome and expensive for the poor farmers. Organic agriculture provides a sequel of environmental services in addition to producing safe food.

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FASCINATING FACTS OF UNDERUTILIZED FRUIT CROP: WATER APPLE

Article ID: AG-VO4-I01-18

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Introduction

Our country with varied, but favourable agro climatic conditions yields an extensive range of tropical and temperate fruits. Fruits are unquestionably called as protective food as they are very rich sources of vitamins, minerals, antioxidants and phytochemicals. It comprises a huge range of water content, ranging between 80 to 90 percent with a small quantity of carbohydrate, fat, protein, salt and sugar and also rich in fiber. There are relatively large numbers of native and underutilized fruit crops, which are being used by the limited populations. In India the utmost common underutilized fruits are Karonda (*Carissa carandas*), Jamun (*Syzygium cumini*), Ber (*Ziziphus mauritiana*), Lasora (*Cordia myxa* L), Phalsa (*Grawia subinaequalis*), Bael (*Aegle marmelos*), Water apple (*Syzygium aqueum*), Malay apple (*Syzygium malaccense*) and Rose apple (*Syzygium jambos*) etc. Hence, this article is mainly highlighting on the cultivation aspects, nutritional value, traditional medicinal uses and other standards for one of the underutilized fruit crop, Water apple.

Water apple, botanically known as ***Syzygium aqueum*** comes under the family **myrtaceae.**

Common Names: Panneer Naval, Water apple, Watery rose apple, Water Cherry, Java apple, Bell apple and Bell fruit.

Habitat

This is a tropical fruit and native to South East Asia. This is evergreen tree with a dense, spreading crown and growing up to 12 meters in height. The tree requires heavy rainfall and survives in moist tropical lowlands at altitudes of 1200 - 1600m from sea level. Branches grow at 1 m height in short trunk. Leaves are oblong to elliptic with very short petioles.

Soil type and climate

It grows vigorously in poor, alkaline soils, though it prefers better conditions. It prefers a light, porous, well-drained soil that is rich in organic matter with reliable water supply. They are tolerant to a wide range of soil types, but they do best in slightly acidic soil with a pH between 5.5 & 6.5. If soil is too alkaline, add sulfur or organic compost to reduce the soil pH. Avoid planting in poorly drained or water logged soil. It grows best in climates that have a substantial dry season, but only in locations where they have ready access to water. As water apple is a tropical fruit tree 25-32 ^{o}C temperature range is desirable for better growth rate, higher yield and quality produce.

Propagation

This tree is typically propagated by air layering. It can also be propagated by cuttings, budding and grafting. Although seeds can be planted, they do not store and lose their viability quickly hence must be planted immediately. Some fruits have 1 or 2 (rarely up to 6) viable but recalcitrant seeds. Seedlings do not come through true to type and the juvenility period can be 3-

7 years. Polyembryony is occasionally detected throughout the genus. Most commonly the seedless forms are grown, so these can be air layered and may start fruiting in half the time of seedlings. Cuttings can also be successful. Budding on well-matched related species (*Eugenia javanica, E. densiflora*) has also been used with success.

Planting

Water apple is an evergreen tree and can be planted both in spring i.e. February -March and the monsoon season i.e. July-August. Prior to planting, land should be ploughed well enough to remove any weeds and other materials like stones and rocks and dig suitable pits (1 x 1 x 1 m) for planting water apple. The ideal row to row distance for planting is 7 – 8 m and for plant to plant is 5 – 6 m. This will accommodate about 100 - 130 trees in one acre land.

Manures and Fertilizers

The pits are filled with mixture of 75% top soil and 25% well rotten farmyard manure or compost. The water apple trees are generally not manured. An annual dose of about 19 kg farmyard manure during the pre-bearing period and 75 kg per tree for bearing trees is considered.

Irrigation

Constant water supply is needed to maintain soil moisture content which is essential for this crop. Avoid any water stress especially during its growth. Drip irrigation could be the best selection while a combination of mulch and basin is also a promising method of irrigation for moisture conservation. Avoid water stagnation at tree basin for a long time.

Intercropping

Commercial growers can earn additional income by growing other vegetable crops, herbs, leguminous crops or flower crops as intercrop in between the water apple plants during initial years at rainy season.

Flowering and fruiting

Flowering season is February – March. 3 – 7 flowers are loosely arranged in clusters terminally. The calyx has 4 fleshy and persistent sepals curved inwards, and the corolla has 4 white-yellow petals. Fruits are often seedless, but sometimes have 1 – 4 small seeds. It's a small bell shaped fruit with red, pink or green colour thin skin, spongy and fragrant with an aromatic flavor which is edible for human consumption. Fruits are watery and mature during May – June. It can able to flower and fruit two or three times in a year.

Harvesting and yield

Seedling trees commence for bearing fruits when about 7 – 8 years old, while layered trees can able to bear fruits in 3 – 4 years. Fruits ripen in stages 35 - 45 days subsequently anthesis. Harvesting the fruits is in mid-summer in sub-tropical areas, but twice a year in the tropics. A single tree bears 18 - 21 kg of fruit. In general water apple, trees could be grown for fruit production for more than 30 years. Harvesting is done by handpicking as the fruits are extremely sensitive. After picking they have a short shelf-life at ambient temperature, limiting the possibilities for commercial exploitation. The fruits are chill-sensitive, hence it is not possible to store for long time at cold storage. Storage of fruits in a cloth bag in a cool place or pre-cooling at 10-12 ^{o}C should be done for extending shelf life.

Plant Protection: Controlling pest and diseases in any fruit orchard is essential for better yield.

Leaf eating caterpillars (Slug caterpillar, Hairy caterpillar, Leaf webber, Leaf Miner and semilooper)

Leaf eating caterpillars are effectively controlled by spraying Chloropyriphos 20 EC or Quinalphos 25 EC or Phosalone 35 EC 2.5 ml / lit of water.

Fruit flies

Fenthion 2 ml / lit or malathion 2 ml / lit of water spraying will control the pest. Ploughing the inter spaces will expose the pupae. Set up pheromone trap with methyl eugenol 1 ml in 1 litre of water + 1 ml of malathion solution will attract and kill the female insects. Take 10 ml of this mixture per trap and keep them in 10 different places in one acre between 6 a.m. and 8 a.m.

Scales

After pruning, the trees should be sprayed with Phosphamidon 40 SL or Methyl demeton 25 EC @ 2 ml/lit. During pruning, all the affected materials should be collected and burnt.

Mealy bug

Spraying of Chlorpyriphos 20 EC 2.5 ml / lit or Monocrotophos 36 WSC 1.5 ml / lit will give control over the pest. Similarly, release of Australian ladybird beetle, *Cryptolaemus montrouzieri* @ 10/tree will be a very effective bio-control measure.

Anthracnose

The fungus incites leaf spots and fruit rot. Affected leaves show small scattered spots, light brown or reddish brown in colour. Affected fruits show small water soaked, circular and depressed lesions. Ultimately, the fruits rot and shrivel. Spraying with Dithane Z - 78 @ 0.2% or Bordeaux mixture at: 4:4:50 concentrations shall check the disease.

Uses and composition

Nutritional Profile of Water apple

100 grams of water apple fruits contain:

Carbohydrate: 169.6 mg

Crude Protein: 158.19 mg

Fat : 0.29 mg

Fibre: 1.37 mg

Vit C : 13.08 mg

Calcium : 0.64 mg

Potassium: 8 mg

Ash: 81 mg

Uses

The water apple is a traditional medicinal plant with numerous bioactive compounds distributed in all parts of the plant. These comprise phenolic compounds, tannins, flavonoids, terpenoids and also essential oils. *S. aqueum* extracts and their isolated compounds showed multiple beneficial biological effects such as antibacterial, antifungal, antidiabetic, analgesic, antimalarial, antioxidant, anti-inflammatory, and anticancer activities.

The leaves are eaten raw or dried. The unripe green fruits are eaten raw as well as used to make pickles, jelly, syrup and sauces. In Malaysia and Indonesia, Water apple fruits are eaten in fruit salad and the fruits are also preserved by pickling. Water apples have high water content and helps in keep the body hydrated during hot weather condition. The flesh of the fruit is typically white or pink with mild sweet and sour taste. The fruits are rich in antioxidants which help to protect the body against oxidative stress. It has high fiber content which aids in digestion and prevents constipation problem. It maintains healthy heart by regulating the blood pressure.

Water apple has an adequate amount of Vitamin A and C which helps to prevent the impairment from the oxidative stress produced from the poor diet, anxiety and pollution. It also decreases the dryness of the skin and reduces the wrinkles. It also possesses a sufficient amount of potassium. It improves the strength of muscles and decreases the muscle pain which is due to the low level of potassium.

Water apples support and boost the immune system of our body. It also has a property that may help to lower the blood sugar level for diabetic patients. The bark of the tree also used in herbal medicines. It is very well grown in orchards, gardens and parks as an ornamental as well as fruit tree.

Conclusion

Currently, due to better consciousness and desire about health and nutrition, people are exploring more and more nutritional choices. Water apple is one such fruit getting attention in Indian fruit markets. Underutilized fruits have tremendous potential for introducing a variety of new products for commercial and nutritional importance and in turn finding their uses in the human diet for high nutritive value. Though water apple is having outstanding medicinal properties, its cultivation and processing are inadequate. Hence, research and development effort, awareness to farmers and possibility for the cultivation and processing must be given due consideration.

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IMPORTANCE OF MULBERRY AS A FODDER CROP

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Introduction

In general mulberry is using as a food to silk worms, leftover stalks after silkworm feeding are commonly used as forage to cattle. Supply of nutrients by traditional fodders are insufficient to the livestock. It is very necessary supplement of nutrient rich fodders like mulberry, Moringa, sweet potato for balancing the nutrition diet of livestock and also reducing the cost of animal feed. Mulberry contain the higher values of protein, digestibility, mineral content is the reason to keep mulberry as a fodder crop. Mulberry contain an average of 10-20% crude protein, 7-11% total sugars, 15-18% minerals, crude fibre- 8-14%, carbohydrates- 7-13%, Iron- 5-10%, NDF- 9-12%, ADL- 2.5-7.9%, ascorbic acid- 150-300 mg/100gm and it is also contain vitamin B, folic acid, vitamin D. It is also drastically increases the protein and fat content in milk of cattle and also increases the weights of sheep & goat.

Agronomic practices of mulberry cultivation

Soils

Mulberry is suitable to all type of soils, preferably grown in loamy and acidic soils with P^H range of 6.2 to 6.8

Land preparation

Ploughing of land by 2-3 times with cultivator followed by planking and levelling are require for good tilth.

Rainfall: optimum rainfall range between 600-2500 mm for good yield. Growth is affected under low rainfall conditions.

Temperature: Ideal temperature of mulberry growth is 18-30^{o}c, mulberry can also survive the extreme temperatures of ≥ 48 ^{o} and ≤0^{o}c.

Relative humidity: 65 to 80 %

Varieties: Kanva-2, S-13, S-34, vishala, viswa etc...

Propagation: Mostly propagated by stem cuttings and rarely by seeds

Spacing: 60×60 cm or 90×90 cm

Time of planting: Best season for planting is rainy season or at the time of onset of monsoon, avoid planting during summer and winter months

Fertilizers: Application of Farm yard manure @20-25 tons/ha at the time of land preparation, recommended dose of inorganic fertilizers are 300: 150:150 kg NPK/ha

Weed management: Regular weeding and hoeing is require for controlling the weed growth, aeration and crop growth.

Irrigation: once in 10 days irrigation is require if no rains received in the season, mulberry is not tolerant to the extreme drought conditions. Drip irrigation is very best for efficient water management

Forage management: harvesting should be done at 3-4 months after planting, thereafter cutting interval is in between 6-8 weeks

Ratio of feeding mulberry stalks to livestock

- For cows an average of 15-20 kg mulberry stalks per day can be recommended to the cows
- For sheep and goat 4-5% on dry weight basis of body weight of the animal can be recommended
- For poultry birds mulberry leaves can be included up to 7-9% of total feed ratio for increasing quality of eggs

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REVOLUTIONIZING AGRICULTURE: HARNESSING NANOTECHNOLOGY FOR SOIL HEALTH AND CROP

Article ID: AG-VO4-I01-20

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Abstract

This article explores the pivotal role of nanotechnology in addressing soil health concerns for sustainable crop production. As farmers increasingly focus on higher yields, soil health tends to be neglected. The integration of nanotechnology in soil science offers solutions, with applications ranging from nano fertilizers and biosensors to carbon sequestration and nano pesticides. Nano fertilizers, discovered in 2009, reduce pollution, enhance crop yield, and decrease the need for fertilizers. Nano biosensors enable precise monitoring of soil conditions, aiding in timely fertilization and pest management. Nanoparticles contribute to efficient carbon sequestration, while nano pesticides offer pest-specific solutions with reduced environmental impact. Additionally, nano particles enhance soil structure, influencing soil strength positively. Embracing nanotechnology in agriculture promises environmentally friendly solutions, contributing to a sustainable and technologically advanced future.

Key Words: Nanotechnology, Nano fertilizers, Nano biosensors, and Nanoparticles.

Introduction

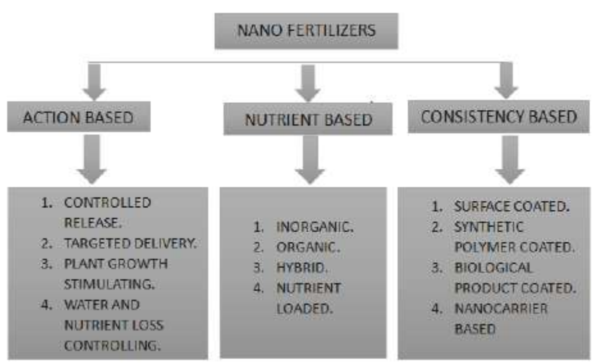
Soil health is the basic factor for successful crop production. Nowadays the farmers are obsessed with higher yield and hence they failed to think about the soil health. By applying nanotechnology in soil science, the soil health can be prevented from deterioration. Nano particles are made into nano fertilizers, nano pesticides, nano biosensors etc., which helps in getting higher yield and ecofriendly. By using nano particles in carbon sequestration, atmospheric carbon content can be reduced which in turn reduces the chance of global warming. By enhancing the soil structure through nano particles, the soil will be saved from deterioration (Ghidan and Antary, 2020).

Applications of Nanotechnology in Soil Science

1. Nano fertilizer

The nano particles (NPs) that contain macro and micro nutrients and are supplied to crops in a controlled and smart manner are called as nano fertilizers (Neme *et al*., 2021). It was discovered by Ramesh Raliya, an Indian in 2009. This enormous discovery leads to bio revolution. It reduces the soil pollution and helps in increasing the crop yield. It reduces the necessary of fertilizers by half. Viruses and dust present in volcanic ash, ocean, biological matter are naturally occurring nano particles. The macro nutrients and micro nutrients can be made into nano structures and encapsulated into nano fertilizers. Nano fertilizers can be applied as both foliar spray and basal drench.

Types of nano fertilizers



(Nongbet *et al*., 2022)

2. Nano biosensors

Nano biosensors are sensitive detectors which are portable and contains biological and chemical agents. Nano biosensors are made from carbon nanotubes, nano wires, quantum dots based nano materials and nano particles. These are used to sense the fertilizers, herbicides, pathogens, moisture and soil pH. The assimilation of nano particles into biosensors highly helps in increasing its sensitivity and makes it effective in various environmental conditions. They are cost effective portable, instant results, easy to use and occupies less space (Abobatta, 2018).

In agriculture, it detects the time of fertigation, which enables the farmers for the timely application of fertilizers and reduces the damage. It provides the entire data about the soil such as moisture content, nutrient availability etc., which helps the farmers in successful crop production. It mainly helps in early detection of pest and pathogens; this greatly helps farmers in timely application of specified pesticides instead of broad-spectrum pesticides. The nano biosensors are used to detect the difficulties of crop precisely which greatly helps in the timely intervention of farmers for a successful yield (Huang *et al*., 2021).

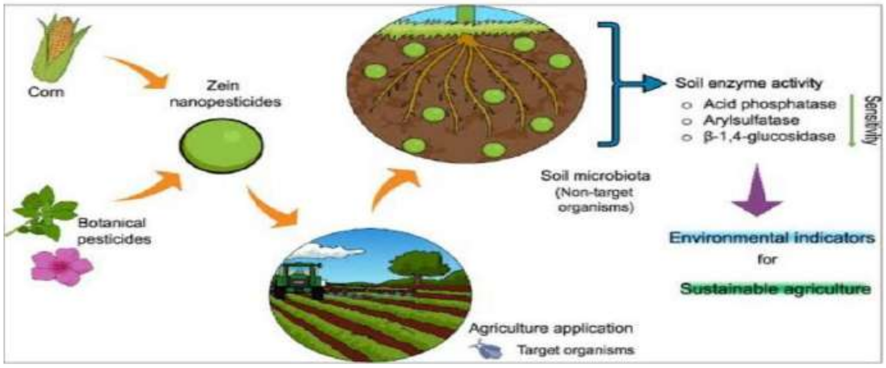
3. Nano particles in carbon sequestration

Nano particles can be used in carbon sequestration to improve its efficacy and reduce the cost. Since the nano particles are having more surface area to volume ratio their capability of absorbing Carbon dioxide is high. Nano materials like carbon nano tubes considerably inflate the efficiency of capturing carbon dioxide. Use of nano particles results in timely monitoring, direct air capture and catalytic conversion which is highly necessary in carbon sequestration. Silica based nano particles mainly mesoporous silica nano particles can be applied for carbon sequestration due its varied qualities. As carbon nano tubes are compatible with every other carbon capture method it is easier to be adopted for carbon sequestration (Wang *et al*., 2021).

4. Nano pesticides

Nano pesticides comprise of nanoparticles encapsulated as nanomaterials, nano capsules or nanoscale emulsions. They are of smaller size and sharper surface which makes them interact with the cell directly. IT is pest specific. It reduces the pesticide usage by half and does not harm the soil. It minimizes the runoff by controlled supply of pesticides. Nano pesticides maintain a stability which protects the ingredients from varied environmental conditions, they are more virulent against pest as they are smaller and quickly absorbed by plants and pests. They also can be customized according to the crop and pest (Asif *et al*., 2021).

The size of nano pesticides ranges from 1 to 200 nm. Some examples of nano pesticides are aqueous dispersion of nano-permathin, novaluran and β-cypermethrin. Titanium oxide, Copper and silver are most preferred nano particles to be used for nano pesticides among metals. Titanium is most effective which shows better antimicrobial and antifungal activity.



Fate of nano pesticides in soil (Paradva and Kalla, 2023)

5. Nano particles for soil structure enhancement

Soil is a three dimensional medium whereas soil particles, water and air between the pores comprises to form its structure. By improving the bond strength of the soil particles and changing the pore fluid, nano particles enhance the soil structure. Due to tiny structure of nanoparticles, they can easily diffuse into the pore space thus influences the soil strength. Some usual nano materials that are used in enhancing the soil structure are carbon nano tubes, colloidal silica, bentonite and laponite (Krishnan and Shukla, 2019).

Conclusion

Nanotechnology plays an important role in soil science as well as agriculture, which paves way for technological and somewhat ecofriendly environment. Their benefits are enormous. Above applications of nano technology in soil science reduces the negative impact of agrochemical products in environment. The applications of these technology into daily life depends on the knowledge and awareness among the people. Not only in soil science nano technology brought a tremendous revolution in many fields by helping in the development of the products through conventional methods that are hardly possible to be developed.

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SOIL PLANT ATMOSPHERE CONTINUUM

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Introduction

Water is one of the most common and most important natural resources on earth. It is essential for the existence of life and for the vegetation that is totally dependent upon water availability. It is crucial for the physiology and metabolism of plants. Water and life is integral components of Earth. Water transport and exchange through soil, vegetation, and the atmosphere typically constitute the largest hydrologic output in most terrestrial ecosystems. The soil properties and plant activity affects the partitioning of rainfall into evapotranspiration, runoff and deep percolation which impact regional scale water budget and balance. Transpiration is tightly linked to the carbon cycle through the simultaneous exchange of CO_2 and water via a stomatal pathway. Because of this fundamental role in our living world, water movement through the soil-plant-atmosphere continuum (SPAC) remains a subject of active research in hydrology, plant and agricultural sciences.

SPAC (Soil Plant Atmosphere Continuum)

All components of the field environment i.e. soil, plant and atmosphere, form a physically unified and dynamic networking system in which various water flow processes occur independently. This unified system is called the Soil-Plant-Atmosphere-Continuum or SPAC which was proposed by Huber in 1924. The fundamental principle of SPAC is water moves from higher total water potential to regions of lower total water potential at a rate depending on the hydraulic resistance of the medium. The low water potential of the atmosphere, and relatively higher water potential inside leaves, lead to a diffusion gradient across the stomatal pores of leaves, drawing water out of the leaves as vapor. Water lost at the surface of cells is replaced by water from the xylem, which due to the cohesion-tension properties of water in the xylem of plants pulls additional water molecules through the xylem from the roots toward the leaf.

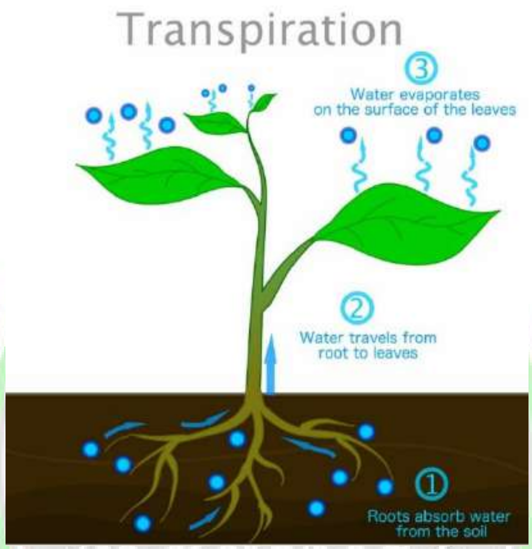

Fig -1: Processes involving SPAC in plants

Soil – Water Status

The water status in soils can be defined in terms of

1. the amount of water in a given soil (on a mass or a volume basis), i.e. gravimetric or volumetric soil-water content, and
2. the forces acting on the water in the matrix, i.e. soil-water potential.

Many processes in the soil-plant-atmosphere continuum are influenced by the amount of water, including gas exchange with the atmosphere, diffusion of air and nutrients to plant roots, soil temperature and hence the activity of microorganisms, and the rate at which dissolved (agro)chemicals are transported through the root zone.

Soil – Water Status: Importance

- The soil-water content tells little about the amount of water available to plants.
- A sandy soil may be saturated at a water content that is near the wilting point for a loamy soil.

- Soil water content is also not sufficient to explain the movement of water in soils.
- When sandy soil is brought in contact with a loamy soil of equal water content, water will move from the sand to the loam.

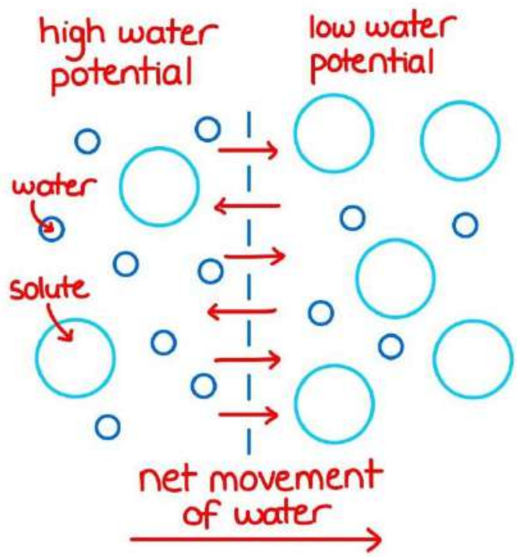

Fig -2: Movement of Water along Water Potential

Soil – Water Content

Soil-water content or soil-moisture content can be expressed in various ways. The gravimetric soil-water content w (kg kg^{-1}) is expressed relative to the mass of oven-dry soil according to:

$$w = \frac{M_w}{M_s}$$

where

M_w is the mass of water (kg) and

M_s is the mass of the solids, i.e. the mass of the oven-dry soil (kg).

By convention, oven-dryness is reached after drying a sample at 105 °C till constant weight.

It is often desirable to express soil-water content on a volume basis. The volumetric soil-water content θ (m^3 m^{-3}) is the volume of water per bulk volume of oven-dry soil:

$$\theta = \frac{V_w}{V}$$

where

V_w is the volume of water (m^3) and

V is the bulk volume of oven-dry soil (m^3).

If bulk density ρ_w(Mg m^{-3}) is known, θ can be calculated as

$$\theta = \frac{\rho_b}{\rho_w} w$$

where ρ_w is the density of water (Mg m^{-3}).

Soil – Water Potential

The primary forces acting on water held within a soil are:

- Matric forces result from interaction of the solid phase with the liquid and gaseous phases, including binding to soil solids and interfacial curvature.
- Osmotic forces owing to differences in the chemical composition of the soil solution.
- Forces induced by gravitation, air pressure and hydrostatic pressure.
- Mechanical forces exerted by unsupported solid material on the soil water in case of swelling soils.

These different forces allow us to partition total soil-water potential ψ_s into different components:

$$\Psi_s = \psi_{sz} + \psi_{ss} + \psi_{sm} + \psi_{sp} + \psi_{sa}$$

where

ψ_{sz} is the gravitational potential,

ψ_{ss} the osmotic potential,

ψ_{sm} the matrix potential,

ψ_{sp} the hydrostatic or pressure potential, and

ψ_{sa} the air pressure potential.

The **gravitational potential ψ_{sz}** is determined solely by the elevation of the point of interest relative to some arbitrary reference point (e.g. the soil surface). It is the energy per unit volume of water needed to raise a body against the gravitational pull from a reference level to the point of interest. Above the reference point, it has a positive value, and below the reference, it is negative.

The **solute or osmotic potential ψ_{ss}** is determined by the presence of solutes in soil water, which lowers its potential energy and its vapor pressure. Given that the pressure potential at a water level free of solutes is zero, it is always negative. It is the energy per unit volume of water when solutes identical in composition to the soil solution at the point of interest in the soil are added to pure, free water at the elevation of the soil. The effects of solute potentials are negligible unless diffusion barriers, like soil-plant root interfaces and soil-water-air interfaces – when water evaporates, salts are left behind – exist.

The **matric potential ψ_{sm}** results from the combined effects of adsorptive forces and capillarity within the soil matrix. It is the energy per unit volume of soil needed to transfer an infinitesimal quantity of water from a reference pool of soil water at the elevation of the soil to the point of interest in the soil at reference air pressure. The dominating mechanisms determining the matric potential include

(1) adhesion of water molecules to solid surfaces due to short-range London-van der Waals forces and extension of these effects by cohesion through H bonds formed in the liquid,

(2) ion hydration and binding of water in diffuse double layers (osmotic effect),

(3) capillarity caused by liquid-gas and liquid-solid-gas interfaces interacting with the irregular geometry of soil pores. In unsaturated soil, the matric potential is always negative and as the matric potential is decreasing, so is soil-water content.

The **hydrostatic pressure potential ψ_p** is defined as the water pressure exerted by the overlying unsupported water (i.e. saturating the soil) on the point of interest in the soil. It is positive below a water table and zero at or above the water table. The air pressure potential ψ a is defined as the change in potential energy per unit volume of water when the soil air pressure is changed from the pressure of the reference state to the pressure of the soil. For most practical cases, the air pressure potential is negligibly small.

In swelling soils, the **matric potential ψ_m** is divided into an overburden or **envelope pressure potential ψ_b** due to the weight of overlying unsupported solids, and the **wetness potential ψ_w**, which is the matric potential at zero external air pressure and zero envelope pressure. Since the effects of all forces other than gravity and solutes interact with each other, the soil physics committee of the International Soil Science Society (ISSS) grouped all components except ψ_v and ψ_s into the tensiometer pressure potential ψ_{tp} (Bolt, 1976).

The soil-water potential is the total potential minus the gravitational potential and is thus the result of the inherent properties of the soil-water itself. It is typically measured with devices such as **piezometers**, **tensiometers** and soil **psychrometers**.

Water flow inside roots:

The function of plant roots is dual - they anchor the plant to the soil matrix and they absorb water and nutrients from the soil. Water and macro- and micro-nutrients preferentially enter the root through small root hairs that are located on root epidermal cells and from the differentiated regions of fine root tips. Water traverses this single-cell epidermal layer to reach the cortex.

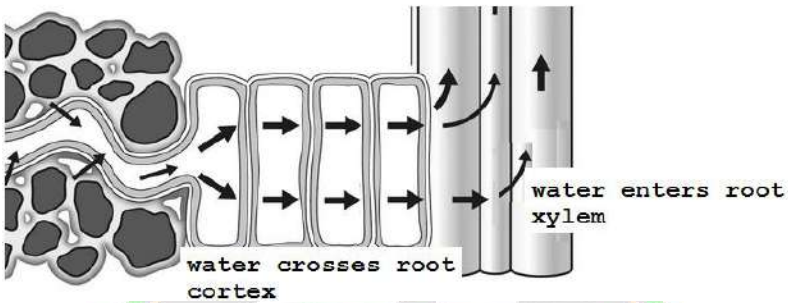

Fig -3: Water flow from root hairs to xylem

In the cortex, water travels through two pathways:

- it may move through the Apoplast (i.e. continuum of cell walls and other remaining spaces outside of living cells) or
- through the Symplast (i.e. the protoplasm of cells surrounded by narrow cytoplasmic connections, the plasmodesmata and surrounded by a plasma membrane).

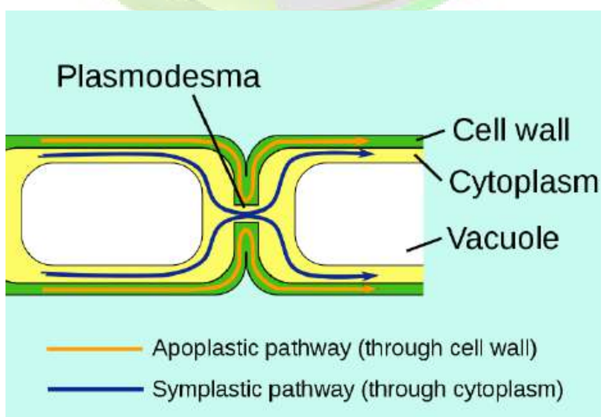

Fig -4: Apoplastic and Symplastic Pathway

At the endodermis, the cell wall or apoplastic pathway for water movement is blocked by the Casparian strips. In such cases, water must pass through the lateral walls and enter the cytoplasm of endodermic cells to continue its movement across the root. Here it is mandatory to enter a cell's cytoplasm (symplast). In the remaining part of the pathway, water can travel through both the apoplast and symplast. After crossing the endodermis, water can enter into xylem elements. Water passes through the pericycle, a single layer of parenchyma cells that surrounds the vascular bundle before entering into the xylem.

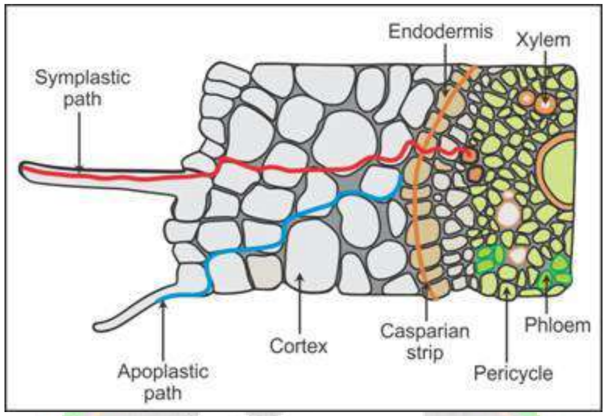

Fig -4: Movement of water from the soil to xylem

Water flow from roots to leaves

The water-conducting elements of vascular tissue are highly thickened and lignified tracheids and xylem vessels. They act as network of long slender tubes connected from which water is taken in ascending ways from the roots up to small veins in the leaves. At the veins ends, the water is released from xylem into surrounding tissues. The water is carried by mesophyll cells to stomatal pores into the atmosphere as water vapor. This physiological process is called transpiration. Transpiration loses water from leaves into the air.

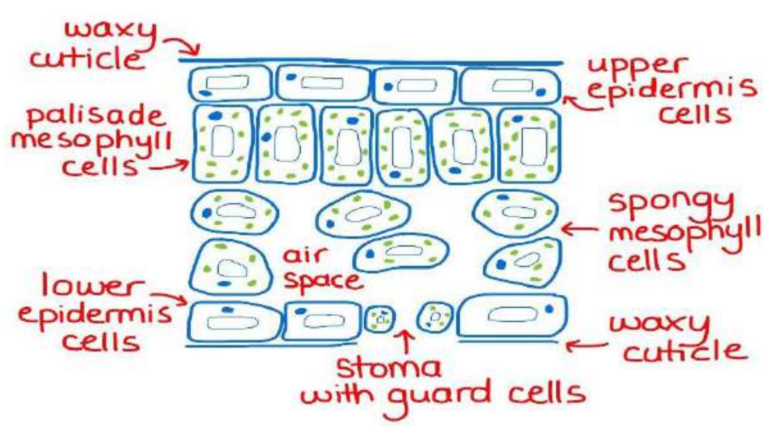

Fig – 5: Water movement from mesophyll cells to the outer environment

Transpirational Pull

The physiological process which can be determined as the force functioning against the direction of gravity in plants due to the continuous processes of transpiration in the plant body is referred to as the transpiration pull. It can also be characterized as the pulling forces produced inside the xylem tissue supporting the upward movement of water into the xylem vessels. The transpiration pull can also be explained as a suction force used to drag the water from the roots in an upward direction to the leaves of the plant. The quantity of water received by the plant leaves is utilized for photosynthesis and the excess portion of water is discharged into the surrounding atmosphere in the form of vapors through the opening in the leaves called stomata.

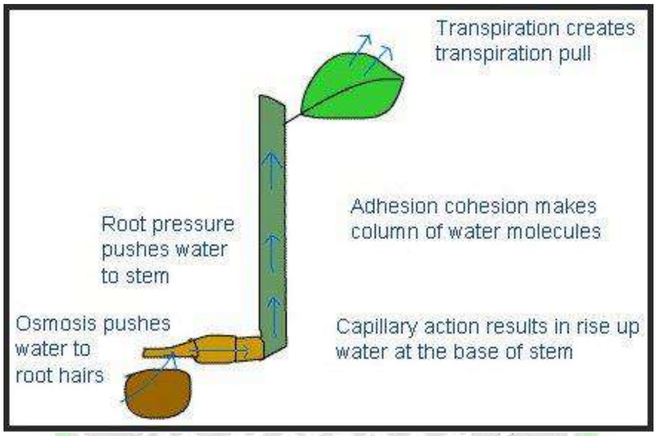

Fig – 6: Water movement through various mediums (SPAC)

Evapotranspiration and consumptive use

Evapotranspiration is a term used to represent the sum of evaporation and plant transpiration from the earth's land surface to the atmosphere. They are considered as combined term. Evaporation accounts for the movement of water to the air from the soil surface, plant canopies and water bodies. Transpiration accounts for the subsequent loss of water as vapor through stomata in plants. Consumptive use is the total amount of water taken up by vegetation for transpiration or building of plant tissue in addition to the unavoidable evaporation of soil moisture, snow, and precipitation which is associated with vegetational growth.

Orders of magnitude of water potential in SPAC

- The total potential difference between soil moisture and the atmospheric humidity can count for 10MPa and in arid climates can even exceed 100MPa.
- The potential drop in soil towards the root may vary from less than 100 kPa to several 100s of kPa.

- In the roots, the potential drop is generally somewhat greater than soil to roots.
- In the xylem from roots to leaves, the potential drop is likely to be lower than a few 100kPa.
- The total potential drop between the soil and leaves is of order to 1-3MPa.

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SARCOPTIC MANGE AND ITS THERAPEUTIC MANAGEMENT IN PET RABBITS

Article ID: AG-VO4-I01-22

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Introduction

Raising rabbits as pets is increasing day by day as they make great pets for city dwellers and are the third most common animals that the people are preferring to raise next to dogs and cats. This is because they require little space, crepuscular, vegetarian and not much attention is required as of dogs and cats. Rabbits are very much prone to skin infections and Mange infestation is very commonly noticed in rabbits and highly contagious. Mites induce several skin conditions in rabbits such as psoroptic, sarcoptic, and notoedric mange of which Sarcoptic mange is most commonly noticed and is highly contagious ectoparasitic infestation. It is caused by *Sarcoptes scabiei*, which is distinguished by presence or absence of pruritis, morphology of mite and distribution of lesions and if left untreated may cause significant morbidity and economic losses. It is of zoonotic importance; affecting dogs, cats and humans causing a transient itching dermatosis. Sarcoptic mange generally spread by direct skin contact or through contact with environment. As it is a deep burrowing mite in epidermis causing intense itching, pruritis, pyoderma, crust formation, scare production, thickening and wrinkling on skin of affected areas, it also affects the health apart from damage of skin tissues by loss of blood or body fluids, cause allergic reactions and secondary bacterial infections.

Clinically, mite infestation is characterized by pruritis, alopecia at ears, nose, feet, areas around genitalia and in prolonged illness, the animal become emaciated and may even die due to cachexia. Microscopic examination of skin scrapings is an appropriate method for diagnosis of mites. Completely relying only on clinical signs to confirm the infestation is not recommended. The avermectin group of drugs includes ivermectin, abamectin, doramectin, eprinomectin and selamectin can be used to treat rabbits that are naturally infected with scabies. Among these acaricides, ivermectin given orally or, parentrally, has been reported to be effective in treatment of scabies.

Treatment

Treatment with initial dose of ivermectin @400 µg/kg bwt SC and at weekly intervals for four weeks is advised. Multiple doses of ivermectin is advised because the mite eggs are resistant

Fig.1&2 White indurated dry crusts and scabs on the ears, nose, periocular and paws region

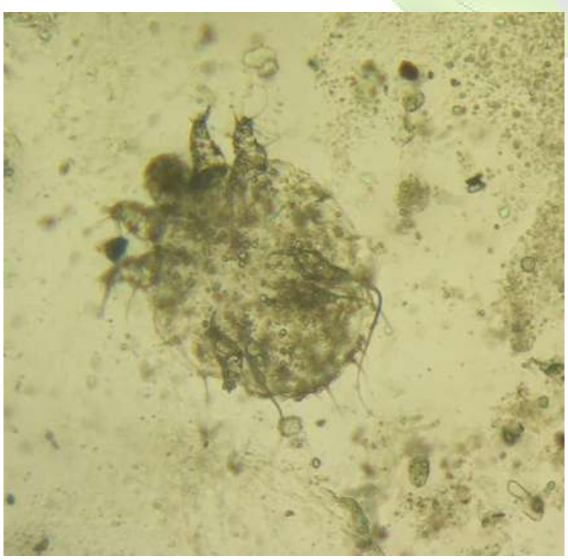

Fig. 3&4 Skin scrapings showing Sarcoptes Spp., mite under microscope to acaricidal products and thus multiple treatments at various intervals are required to ensure presence of active drug during the time of hatching. Skin scrapings should be collected and examined before giving the dose of ivermectin on subsequent weeks.

. Supplementation of vitamins and minerals with ivermectin augments the parasitological and clinical recovery in rabbits as it reduces the drug induced stress and also prevent deficiencies because of anorexia. Moreover, the age old practices of using benzyl benzoate, carbamates, sulfur-based compounds and paraffin oil may be used also for mange treatment. Diluted benzyl benzoate is used as a topical treatment of scabies to decrease the severity of skin irritation. Cleaning of cages with flame gun or locally available flame appliances yields good results and prevents recurrence.

Therefore, to conclude treatment with ivermectin, topical application of benzyl benzoate, and supplementation with multivitamins and cleaning of cages of rabbits could effectively control mange in rabbits.

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FARMERS RIGHT IN INTELLECTUAL PROPERTY RIGHTS

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Introduction

India is a pioneer in developing explicit legal provisions to recognise and protect farmers' rights. The legal regime related to farmers' rights in India has been developed as a response to the developments under international law. Farmers' rights have become a part of Indian legal system through statutory frameworks related to plant variety protection and biodiversity. These two statutes have come into force as India's response to obligations under two international treaties – Agreement on Trade Related Intellectual Property Rights, 1994 and Convention on Biological Diversity, 1992. Farmers' rights regime in India involves mainly two statutes - the Protection of Plant Varieties and Farmers' Rights Act, 2001 and the Biological Diversity Act, 2002. While the former addresses farmers' rights directly, later deals with some of the key aspects of farmers' rights. The legal recognition of farmers' rights in India has been criticised on various grounds including conceptual and implementation aspects.

Fig.1 PPVFRA

2. THE EMERGENCE OF FARMERS' RIGHTS IN INDIA

(a) Protection of Plant Varieties and Farmers Rights Act (PPVFR), 2001

This is the main law in India dealing with Farmers' Rights. The Act emerged from a process of enormous debate and could be passed after about five revisions were made to the draft. The PPVFR Act (Figure 1). initially emerged as a result of the demands of the seed industry for breeder's rights. A chapter on Farmers' Rights was added to the Act due to pressure by NGOs.

Agriculture was generally excluded from IPR protection in India and there was no legal system of Plant Breeders' Rights or Farmers' Rights for decades. 'Common heritage' or the principle of free exchange based on the view that the major food plants of the world are not owned by anyone and are a part of our human heritage governed genetic resources. Farmers were free to use, share and exchange seeds and since breeders could not acquire plant variety protection, there was no system of benefit sharing or compensation.

The initial demands for IPRs in agriculture arose with the change in policy that allowed private sector entry into the seed sector with the New Seed Policy of 1988. The Seed Association of India, formed in 1985, first actively promoted the need for plant breeders' rights in India.

TRIPs allows countries to establish 'effective sui generis' systems, but many developing countries are implementing even higher standards than the minimum requirement, such as UPOV 1991. For plant breeders' right in India, the government formulated a draft of a bill to grant PBRs in 1993/94. The bill provided for plant breeders' rights through provisions based on UPOV.

The bill was opposed both by NGOs and industry and with this impasse the government began the process of revising the draft. The Ministry of Agriculture prepared a second draft in 1996 and a third one in 1997. The third draft added the words 'Farmers' Rights' in the title and was labeled the Plant Variety Protection and Farmers' Rights Act.

NGOs, however, criticized both of the bills for not providing adequate protection to farmers. NGOs claimed that benefit sharing was vague under the bill, there were no farmer's representatives in the Authority, and there was no system for registering farmers' varieties. The process of accommodating the interests of various actors began with another draft introduced in Parliament in 1999 (Protection of Plant Varieties and Farmers Rights Bill) and sent to a Joint Committee of Parliament (JPC). The Joint Committee traveled across the country gathering the views of NGOs, industry, scientists and farmers lobbies on the bill. Incorporating the demands of various actors, the Joint Committee redrafted the bill in 2000 and the new version was introduced in Parliament. The Joint Parliamentary Committee's main revision was the inclusion of a separate chapter on Farmers' Rights. In 2001, the bill was passed and made into a law. The final version of the bill was largely accepted by the major stakeholders.

One can categorize nine rights accorded to farmers under The Protection of Plant Varieties and Farmers Rights Act, 2001 (PPVFR) (Bala Ravi, 2004):

1. **Rights to Seed:**

The farmer's right to save and exchange seed has been one of the major demands of the farmers' right movement. India's Act aims to give farmers the right to save, use, exchange or sell seed in the same manner he/she was entitled to before the Act. However, the right to sell seed is restricted in that the farmer cannot sell seed in a packaged form labelled with the registered name.

2. **Right to Register Varieties:**

Farmers like commercial breeders can apply for IPR over their varieties. The criterion for registration of varieties is also similar to breeders (distinctness, uniformity, stability) but novelty is not a requirement. The ability to gain IPR type rights over farmers' varieties is a unique aspect of India's law. Farmers' variety is defined as 'a variety which has been traditionally cultivated and evolved by farmers in their fields; or is a wild relative or landrace of a variety about which the farmers possess common knowledge'. The plant breeder's right granted on farmers' varieties provides the exclusive right to produce and market the seed of registered varieties.

3. **Right to Reward and Recognition:**

The Act provides for establishing a National Gene Fund. Through the National Gene Fund, farmers that have played a role in conservation of varietal development of plants can be recognized and rewarded. The fee collected from breeders who are required to pay for benefit sharing is to be deposited in the National Gene Fund. The money collected under the National Gene Fund can be used for support and reward farmers engaged in conservation. The Act provides this general provision to promote conservation but does not provide further specifications regarding the method. The Authority set up under the Act is left with the task of operationalizing this right.

4. **Right to Benefit Sharing:**

The Act proposes the setting up of a centralized National Gene Fund through which benefit sharing would be facilitated. The Authority is required to publish the registered varieties and invite claims for benefit sharing. The Act states that any person or group of persons or firm or governmental or non-governmental organization can submit its claim of benefit sharing. The rewards from the gene fund can only be given to a farmer/community who can prove that they have contributed to the selection and preservation of materials used in the registered variety.

5. **Right to Information and Compensation for Crop Failure:**

Section 39 (2) of the Act provides that the breeder must give information about expected performance of the registered variety. If the material fails to perform, the farmers may claim for compensation under the Act. This provision attempts to ensure that seed companies do not make exaggerated claims about the performance (yield, pest resistance) to the farmer. It enables farmers to apply to the Authority for compensation in case they suffer loses due to the failure of the variety to meet the targets claimed by the companies.

6. **Right to Compensation for Undisclosed use of Traditional Varieties:**

In cases where it is established that the breeder has not disclosed the source of varieties belonging to a particular community, compensation can be granted through the Gene Fund. Any NGO, individual or government institution may file a claim for compensation on behalf of the local community in cases where the breeder has not disclosed traditional knowledge or resources of the community.

7. **Right to Adequate Availability of Registered Material:**

The breeder is required to provide adequate supply of seeds or material of the variety to the public at a reasonable price. If after three years of registration of the variety, the breeder fails to do so, any person can apply to the Authority for a compulsory licence. Compulsory licenses revoke the exclusive right given to the breeder and enable third parties to produce, distribute or sell the registered variety.

8. **Right to Free Services:**

The Act exempts farmers from paying fees for registration of a variety, for conducting tests on varieties, for renewal of registration, for opposition and for fees on all legal proceedings under the Act.

9. **Protection from legal infringement in case of lack of awareness:**

Considering low literacy levels in the country, the Act provides safeguards against innocent infringement by farmers. Farmers who unknowingly violate the rights of a breeder shall not be punished if he/she can prove that they were not aware of the existence of breeder's rights.

(b) Biological Diversity Act

The Biological Diversity Act, 2002 (hereafter 'Biodiversity Act') is another important statute significant to farmers' rights in India. The Biodiversity Act was enacted with the purpose of complying with the Convention on Biological Diversity, 1992. The Biodiversity Act does not address farmers' rights explicitly. Nevertheless, two important aspects of farmers' rights are dealt with under the Biodiversity Act. They are access to biological resources and fair and equitable sharing of benefits arising out of the use of biological resources. While the PVP Act is silent on the issue of access, this is one of the important objectives of the Biodiversity Act. Therefore, the Biodiversity Act is the major statutory framework in India applicable to the issue of access to plant genetic resources. Access to biological resources or knowledge (this includes plant genetic resources and knowledge) is regulated under the Biodiversity Act through a license mechanism. This means, prior approval from the National Biodiversity Authority is required to access biological resources and knowledge.

Equitable sharing of benefit is another important area where the Biodiversity Act is linked to farmers' rights. The Biodiversity Act makes it a mandatory duty of the National Biodiversity Authority to ensure that the terms and conditions subject to which approval is granted secure equitable sharing of benefits. The Biodiversity Act also provides that the benefit sharing arrangement shall be in accordance with mutually agreed terms and conditions between the person applying for approval, local bodies concerned and the benefit claimers.

Implementation Issues: An Analysis

The presence of the Biodiversity Act makes the legal and institutional framework addressing farmers' rights in India complex. The complexity is particularly apparent in the case of access and benefit sharing. A brief comparative analysis of two statutes could reveal that there is overlapping and differences between these two statutes. This might lead to obscurity at the level of implementation and realisation of farmers' rights also. Most importantly, there are three issues relevant to farmers' rights in this regard.

a) First, it is most likely that access to plant genetic resources will be regulated under the Biodiversity Act in accordance with mutually agreed terms with the participation of all stakeholders.
b) Second issue is related to the difference in the scope of benefits. It is already noted that the PVP Act envisages only monetary benefits.
c) Third issue is related to the difference in the ways in which monetary benefit is to be dispensed. The PVP Act does not provide any direct rights in this regard by providing that monetary compensation is to be deposited in the Gene Fund. At the same time, the Biodiversity Act, to some extent, recognises the right of the claimers to receive monetary compensation directly.

A probable solution to these overlapping and conflicting regimes is an effective co-ordination between two statutory frameworks. This could be facilitated by a new regulation or guideline on access and benefit sharing by the central government by incorporating all relevant norms such as prior informed consent, mutually agreed terms and an expanded list of benefits. The impediment of socio-economic conditions of farmers and local communities could be addressed by envisaging a pro-active role for statutory bodies to ensure that relevant norms are followed in meaning and spirit.

(c) Rights and Benefit Under UPOV Act For Farmers

As per Section2 (l) farmer's variety can be defined as a newly developed variety, wild relative, or landrace variety that is possessed by a farmer as a common knowledge, or a variety that has been cultivated traditionally by farmers on their fields. Whereas the wild race and traditional variety are possessed by the farmers as a result of being passed on to them by the past generation, a new farmers' varieties are based on diverse sources, and build on landraces and local varieties from farmers. The rights and benefit that a farmer can avail under the UPOV act are as followed:

1) Right to register their new variety
   a) Under the UPOV act, the farmers have been granted the right to register their new variety of plant breeds developed on their field and avail all the other protection like any other breeder. For such a farmers variety to be registered a farmer has to furnish a declaration stating that the genetic or the parental material required for the development of the variety has been acquired by the farmer lawfully. Apart from the declaration stated above

for a farmer to be able to protect its plant variety under the UPOV Act, the variety must comply with the 3 test that is:

b) **Distinctiveness**: when variety shows even one essential characteristic that can help distinguish it from the other known variety commonly available in the world at the time of application, it is said to be a distinct variety.

c) **Uniformity**: when even on continuous propagation of the variety, the variety does not show sufficient uniformity in its essential characteristic it is said to be uniform.

d) **Stability**: when the essential character remains the same even after repeated propagation it is said to be stable.

2) Benefit for preserving wild variety and get award
3) Farmers to get compensations if an EDV does not perform properly
4) Right claim compensation for contribution
5) By a mutual agreement between the corporate and research institute
6) By filling a claim with the UPOV Authority
7) Protect available for innocent infringement
8) Prior authorization for making an EDV from a farmers variety
9) Certain fee exemption

Conclusion

Legal regime in India relating to farmers' rights consists of two major statutes – the Protection of Plant Varieties and Farmers' Rights Act, 2001 and the Biological Diversity Act, 2002. The Protection of Plant Varieties and Farmers' Rights Act, 2001 addresses farmers' rights directly. The rights of farmers provided under this Act are registration of farmers' variety, right to claim compensation for default seeds purchased from breeders, benefit sharing and recognition of traditional rights of farmers. The Biological Diversity Act, 2002 is linked to farmers' rights as it regulates access and benefit sharing. This Act provides norms of prior informed consent and mutually agreed terms for accessing biological resources in India. These norms are crucial for farmers' rights as it facilitates fair and equitable sharing of benefits arising from the use of plant genetic resources. The existence of more than one statutory framework makes farmers' rights in India a subject of 'regime complex'. There are several overlapping areas between the existing statutory regimes. For instance, both the Protection of Plant Varieties and Farmers' Rights Act and the Biological Diversity Act deal with benefit sharing. However, the scope of benefit sharing is significantly different under these two statutes. While the Plant Variety Protection Act talks only about monetary compensation, the Biological Diversity Act provides a number of benefits other than monetary compensation.

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AMARANTHUS CAUDATUS THE FOXTAIL GRAIN AMARATH –A PROMISING PSEUDOCEREALS

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Introduction

The foxtail amaranth (*Amaranthus caudatus* L.) having 2n = 32 is one of the most popular species of domesticated amaranths. It has been cultivated for a long time as a multipurpose pseudocereal of high nutritive value, as a vegetable and as an ornamental plant . It belongs to the group of grain amaranths, along with Amaranthus cruentus . The plant residue after grain harvest may be fed to livestock or used for thatching. A. caudatus is most recognizable for its striking flowering panicles that can reach up to 90 cm (35.4”) long. The colour of these highly dense flowering panicles ranges can be black, red and more commonly white. The red varieties of A. caudatus are due to a high content of betacyanins.

Botanical description of amarathus caduatus

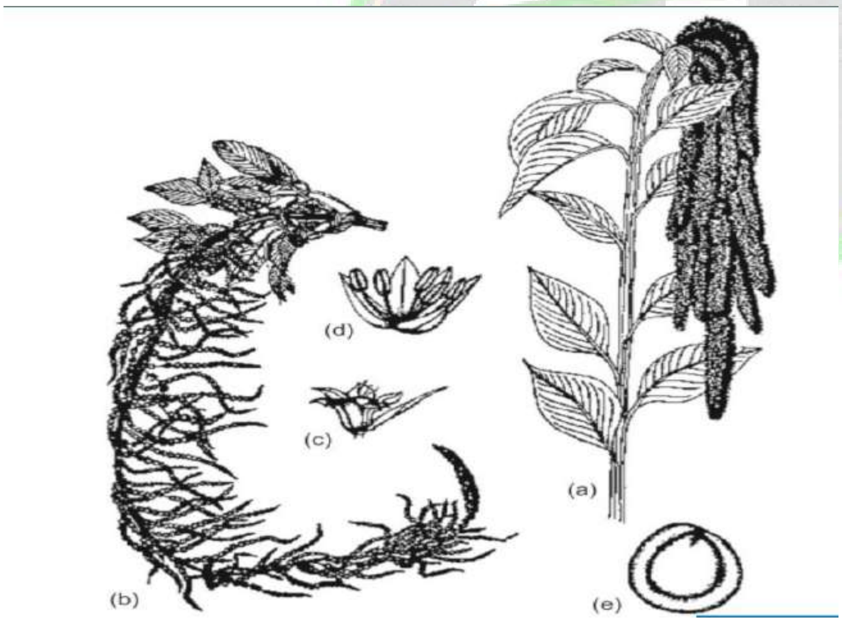
Habitat: Native to the Andes region in South America. It grows between 1 to 2.5 meters, reaching maturity in 4–6 months (or up to 10 months in highland regions). It is having loam and loam-sandy soils with rich organic matter and good drainage. Soil pH is 6-7 but can tolerate up to 8.5.

Habit: *Amaranthus caudatus* is an annual herbaceous plant, meaning it completes its life cycle within one year. It grows as a herb, with a relatively short life span. It is erect, reaching up to 1.5 meters in height.

Root: Amaranth has a primary root with deeper spreading secondary fibrous root structures. It has well-developed root system that aids in nutrient absorption and anchoring.

Leaves: Surface of leaves glabrous or ± sparingly pilose along the margins and lower surface of the primary venation. Petiolate are Long-petiolate, with petioles up to about 8 cm but not longer than the lamina. Lamina Shape has broadly ovate to rhomboid-ovate or ovate-elliptic. Dimensions is 2.5-15 x 1-8 cm. Apex of Obtuse to subacute at the mucronulate tip. Base is Shortly cuneate to attenuate below.

Inflorescence: Inflorescence is called as glomerule. The inflorescence is in the form of a large panicle, which varies in terminal or axial position, color, and sex. The tassel of the inflorescence can be either erect or bent and varies in width and length between species.



Flowers: Male and female flowers are intermixed throughout the spikes. Deltoid-ovate, pale-membranous, acuminate, with a long, pale or reddish, rigid, erect arista formed by the yellow-green or reddish stout, excurrent midrib. The longest bracts may be up to twice as long as the perianth . Male Flowers are Oblong-elliptic, 2.5-3.5 mm, acute, aristate. Female Flowers are 1.75-2.5 mm, broadly obovate to spathulate, distinctly imbricate, abruptly narrowed to a blunt or sometimes faintly emarginate, mucronate tip. Stigmas are 3, approximately 0.75 mm, erect or flexuose.

Calyx: The passage mentions that flowers in Amaranthus have three to five tepals. Tepals are structures that cannot be clearly differentiated into sepals and petals, and they often look similar. The number of tepals can vary among species.

Corolla: In many wind-pollinated plants, including some Amaranthus species, the corolla may be reduced, inconspicuous, or absent.

Androceuim: Filaments are almost completely fused and 5-toothed at the apex with entire or deeply lobed teeth . Anthers are 1-2-locular, meaning they have one or two compartments. They usually dehisce (open) by one or two slits.

Gynoceuim: ovary is superior and unilocular, indicating that it has a single chamber. Ovules are usually solitary, sometimes two to numerous. They can be erect to pendulous, and the placentation is basal. The style is described as very short or obsolete to long and slender. Stigmas are capitate (simple or penicillate) or up to 2-3 (-6) and long and slender.

Fruit: Irregularly rupturing capsule. Alternatively, it may be less frequently circumscissile, rarely a berry, or crustaceous.

Seed: Black, shiny. 2-2.5 mm long, ovoid-globose, circumscissile (splits open at maturity).

POLLINATION: Each panicle is self-pollinating. Grain type is cross pollination

CENTRE OF ORIGIN : Central and South America.

RELATED SPECIES:

Amaranthus caudatus var. caput-medusae .

Amaranthus tricolor.

Amaranthus palmeri.

USES OF AMARANTHUS CADUATUS :

1**. Food Source:**

In India and South America, Amaranthus caudatus is used as a source of food. Known as kiwicha in Peru, its seeds are flavorful, highly nutritious, and do not contain saponins (unlike quinoa).

2. **Culinary Uses:**

- The seeds of foxtail amaranth can be used in various recipes and preparations.
- They produce a crunchy, nutty "popcorn" when heated and can be used as a snack or in sweets.

- The seeds can be used in cold cereals with milk and honey, or as a "breading" on chicken or fish.
- The grain can be ground into flour, rolled into flakes, "puffed," or boiled for porridge.
- The flour can be blended with other cereal flours to enhance their nutritive value, providing higher protein, better amino acid balance, and increased vitamin content.
- Foxtail amaranth can be used in bakery specialties.

3. Traditional Uses in Ethiopia:

In Ethiopia, foxtail amaranth seeds are considered a famine food during scarcity and are combined with teff to make injera flatbread in times of abundance.

4. Food Coloring:

The plant contains pigments that can be used for food coloring.

5. Edible Greens:

Young leaves and stems of foxtail amaranth can be boiled and consumed as greens, similar to spinach.

6. Livestock Feed:

After grain harvest, the stover (the residual plant material) can be fed to livestock.

7. Ethnomedicinal Applications:

All parts of foxtail amaranth have ethnomedicinal applications. The plant has been reviewed for its potential health benefits, including anti-diabetic, anti-hyperlipidemic, anti-atherogenic, and cardioprotective properties.

8. Widespread Cultivation:

Although not reported in statistics, various amaranths, including foxtail amaranth, may be among the most widely grown vegetable crops in the humid tropics.

FODDER VALUE OF CADUATUS:

GREEN FODDER: *Amaranthus caudatus* get well established after every 2 to 4 weeks on the growing condition , with a focus on the nutrient-rich leaves as the primary fodder source, while that the stems, though less palatable. The maximum yield of amaranth green mass (245.5 t/ha) and the yield of dry matter (62.5 t/ha) was obtained in the phase of wax maturity..

Nutritive value: A. caudatus is high in dietary fiber and minerals such as iron, magnesium and manganese. Its frequent consumption could help to reduce hypertension and cholesterol.

Palatability: While some livestock, notably horses, may show reluctance to consume *Amaranthus caudatus*, animals like goats, sheep, rabbits, and poultry generally find it palatable, especially in its young, leafy stage. Amaranthus caudatus leaves are rich in nutrients, including protein, vitamins, and minerals

Toxicity: It was concluded that the low concentration of saponins in amaranth seeds and their relatively low toxicity guarantee that amaranth-derived products create no significant hazard to the consumer.

Hey and Silage: Typically grass or legumes, that is cut, dried, and then stored for later use as animal feed. The nutritional composition of amaranth silage can include proteins, fibers, vitamins, and minerals.

Advantages of Amaranthus Caudatus

- High nutritional content, including proteins, vitamins, and minerals.
- *Amaranthus caudatus* is adaptable to various climates and soil conditions, making it a versatile and cosmopolitan plant.
- The plant has culinary versatility, with its seeds used in various recipes, including snacks, cereals, and as a breading on chicken or fish.
- Various parts of the plant have ethnomedicinal applications, contributing to potential health benefits, such as anti-diabetic and cardioprotective properties.
- Its cosmopolitan distribution allows for widespread cultivation and utilization in different regions, contributing to food security.
- In times of scarcity, the seeds of Amaranthus caudatus are considered a famine food in regions like Ethiopia.
- The plant has potential as a forage crop, producing a large amount of biomass with high protein content.
- Amaranthus caudatus requires little fertilization, contributing to its ease of cultivation.
- Once established, foxtail amaranth is drought-tolerant, providing resilience in varying environmental conditions.

Limitations of amaranthus caudatus

- In some regions, Amaranthus caudatus may exhibit invasive tendencies, competing with native vegetation.

- Certain species within the Amaranthus genus, including some varieties of A. caudatus, may be considered weeds in agricultural settings.
- Seed shattering during harvest can be a challenge, as it may result in loss of seeds and affect overall yield.
- Effective management practices are needed to control potential weediness and optimize cultivation practices.
- While the absence of saponins in the seeds is an advantage for consumption, it may limit certain industrial uses where saponins are desired.
- Seed yields of grain amaranths, including Amaranthus caudatus, can be variable, influenced by factors such as climate and cultivation practices.

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BROWN TOP MILLET – AN UNDERUTILIZED RARE MILLET

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Introduction

Brown top millet *(Urochloa ramosa)*) is small-seeded annual grass cultivated as grain crop, primarily on the marginal lands in dry areas in temperate, subtropical and tropical regions. It is increasingly receiving attention of the scientific community. The scientific literature based on brown top millet has been found scanty. According to the few studies available energy ranges from 338.0 kcal to 368.62 kcal. The, crude fiber and fat content of BTM is 71.32 gm, 8.06–16.08%,1.89 gm, respectively. Protein is between 11.64% and 10.72%. Brown top millet contains phytochemicals such as flavonoids, quinones, tannins, and resin. There is galore scope for development and standardization of value added products made from brown top millets such as ready to eat foods (cookies, bars, deserts, etc) and ready to cook foods (idli mix, poha, etc) in which the millet can be used in combination with other cereal grains. Thus, brown top millet holds great potential in alleviating food and nutrition insecurity. It has good nutritional value. It can be used for the prevention and management of several non-communicable diseases. In order to make this smart food popular among farmers and consumers, systematized studies in the field of agriculture, nutrition, toxicology, naturopathy and biomedical sciences need to be done and documented properly. From ancient times BTM has been used in many forms such as forage, staple food or in many traditional dishes. An e-repository can be made of the traditional Indian foods made from BTM to popularize its use among the younger generations (Figure 1).

Common name	Brown top millet
Scientific name	*Urochloa ramosa*
Chromosome no.	2n = 8
Origin	Africa
Family	Poaceae
Name of the inflorescences	Panicle
Duration of the crop	70-80 days

Fig. 1. *Urochloa ramosa*

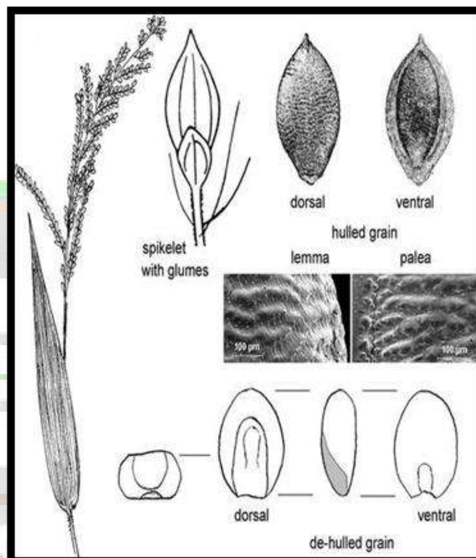

Fig. 2. Grains of *Urochloa ramosa*

Distribution

The domestication of brown top millet probably occurred in South India, in the Deccan, and it spread during prehistory outward to other parts of India. Charred grains identified as *"Brachiaria ramosa* type" have been recovered from most Neolithic South Indian sites where systematic archaeo-botanical work has occurred. On these sites brown top millet has a high ubiquity and relative frequency. Dating the time of domestication is complicated by the fact that little archaeobotanic work has been carried out on early Neolithic or preceramic period (Mesolithic sites); however, the evidence suggests that this crop, along with other South Indian crops (i.e., *Macrotyloma uniflorum*, *Vigna radiata* and *Setaria verticillata*), developed from indigenous wild populations around the beginning of the third millennium BCE. During this period, local millets and legumes were incorporated into an agro-pastoral system, part of the ash-mound culture of the southern Neolithic of India, which employed both mobile cattle pastoralism and small-scale crop cultivation. Brown top millet spread out from the Deccan to Tamil Nadu in the south and Gujarat in the north by the end of the second millennium BCE. Small quantities of the grain have also been found from Chalcolithic (late second–early first millennium BCE) sites in Odisha (Orissa) in the east and some sites in the Ganges plains, however, the number of grains recovered does not suggest cultivation and may represent wild plants. Over time, brown top millet has seen reduced use, although it was still present at the site of Paithan in Maharashtra up to the seventh century CE.

Its gradual reduction in use can be attributed to Brown Top Millet displacement by alternative, more productive millets, including the African millets (*Sorghum bicolor*, *Eleusine coracana*), as well as foxtail millet *(Setaria italica*) that probably contributed to this. Today brown top millet is a relict cultivar but one with some important ritual uses.

Cultivation practices

Browntop millet is drought-hardy and heat tolerant, but can also be planted in low areas that get flooded. The shadow tolerant nature of browntop millet makes it distinct from other crops. The shade loving crop grown often as cover crop well even under perennial trees Maximum cultivation happens in both the kharif & rabi seasons in areas that receive more than 800 mm of rainfall. The crop can be grown Sea level up to 8,000 ft.

Land Preparation

Ploughing with a mould bould plough will help to plough soils deeply and to conserve moisture. Green manuring involved distributing dhanica seeds. To improve the soil's fertility and condition, a dhanicha crop was added after one month, also with 2 MT of FYM, which was spread

Seed Rate & Seed Treatment

The seeding rate for browntop millet will depend upon the seedling method. For line sown crop 4-5 kg/ ha and for broadcasting seed rate @ 10-12 kg/ha is recommended for the healthy stand and better yield. Treating the seeds with carbendazim or thiram @ of 2 g/kg before sowing is highly recommended to manage the seed borne diseases.

Varieties

BTV1/ 2/ 3/ 5/ 6/ 9/ 10 & 12 are the promising varieties of Brown top millet that gives assured yields under optimal conditions.

Soil

It grows best in sandy loam soils with a pH 5-6.5 under full sun. Browntop millet grows in rocky, shallow soils from It is adaptable to almost all upland soil, but does not grow well in water- restricted, droughty conditions.

Time and Method of sowing

Browntop millet can be planted from mid-April until mid-August in most locations, though later plantings will result in lower yields. Whereas, in rainfed conditions farmers sow seeds with the onset of monsoon. Recommended spacing is 45 X 15 cm. Plant population in rainfed conditions is 1.35 lakh/ha and in irrigated conditions is 1.5-1.8 lakh/ha.

Cropping System

Browntop millet + pulses in 4:1 row ratio is recommended cropping system for major growing areas of India.

Fertilizers and manures

Farm yard manure (FYM) should be incorporated @ 10 T/ ha one month before sowing will improve the yields significantly. The suggested fertilizer dosage per hectare is 40:20:20 kg of nitrogen, P205, and potassium. When planting, all of the fertilizer should be incorporated into the soil. After 25-30 DAS and if irrigation facilities are available, half of the nitrogen should be top dressed in standing crops.

Weed Management

To manage weeds, it is best to plant in a well-tillaged field, weed-free bed with narrow row spacing. Chemical weed control options are limited. Up to 25- 30 days after sowing, the field should remain weed- free. The weeds in the field of browntop millet can be controlled with just two weedings. In a line-sown crop, 4 weeding may be done using a hand or wheel hoe

Diseases/ Insect Pest & Management

Generally the diseases and insect pests infect the browntop millet are of lesser importance.

Water Management

Like other millets, irrigation is not necessary for browntop millet. However, if a prolonged dry spell occurs, 01-02 irrigations must be administered at the critical stages. It is always preferable to drain the field of extra water after a heavy storms.

Harvesting

Harvesting will be done at the physiological maturity. It is cut from the ground level with the help of sickles and stacked in the field for about a week before threshing. Threshing is done by trampling under the feet of bullocks. The grains should be dehusked before consumption.

Nutritional and health benefits

Millets have unique nutrient composition which is good for physical and mental health. They have high fiber and vitamin content, low simple carbohydrates. Brown top millet is high in nutrition and has high energy content; 100 grams of BTM contains 338 Kcal of energy, 71.32 g of carbohydrate, 8.98 g of protein, and 1.89 g of fat. It is a rich source of natural fiber i.e., Consumption of dietary fiber has long been associated with health benefits like bowel movement, and maintenance of normal blood cholesterol and glucose levels. Further, it is rich source of micro nutrients such as **iron, calcium, potassium, magnesium, zinc, phosphorus, and B group Vitamins**. Therefore, BTM may serve as budding grain for therapeutic diets. The fiber content i.e., 12.5 gm per 100 gram (Indian Institute of Millets Research (IIMR), 2022) and fiber helps to detoxify the body by removing the waste from the intestine. Millets have low glycemic index (GI). Because of the low GI, millets help in gradual increase in the post-prandial blood glucose levels. This is particularly helpful for patients suffering from impaired glucose tolerance as well as diabetes.

BTM contains good amount of minerals. It has significant levels of magnesium which is 94.5 mg/100 gm. Magnesium is a vital mineral which aid in increasing the efficiency of insulin and glucose receptors by supporting many carbohydrate digesting enzymes, which manages insulin action and it also helps to reduce the pressure on blood vessels (BTM is gluten free and an excellent choice for people suffering from celiac disease. BTM contain 276mg per 100 gm phosphorous. Phosphorous is involved in the structure of every cell in the body, forming the mineral matrix of bone essential component in molecule i.e., adenosine triphosphate (ATP).

Besides fiber and minerals, millets are also rich in health-promoting phytochemicals like polyphenols, liganins, phytosterols, phyto-oestrogens, phytocyanins, phenolic compounds, tannis and flavonoids like, anthocyanins, carotenoids, and tocopherols. They are natural antioxidant that protect the phospholipid membrane around heart, nerves, muscles, and red blood cells from the attack of free radicals and thus prevent carcinogenesis, and aging. Carotenoids are reported to prevent cardiovascular diseases like atherosclerosis, maintain normal functioning of immune system, and retina of eyes. These also function as, immune modulators and detoxifying agents. BTM being rich in secondary metabolites (phytochemicals) can help to reduce the risk for gastric ulcers and colon cancer.

Conclusion

The comparison of macronutrients and micronutrients of different millets and staple cereals with the browntop millet (in percent), BTM contains 8.98 gm/100 gm of protein which is higher than protein of rice, wheat, sorghum, Proso millet, finger millet, little millet, barnyard millet and Kodo millet. Fat content of BTM is 1.89 gm/100 gm which is much higher than fat content of rice, wheat and sorghum. 71.32 gm/100 gm is the carbohydrate content of BTM that is higher than wheat, sorghum, pearl millet, proso millet, finger millet, little millet, barnyard millet and foxtail millet. Crude fiber value of BTM is 8.06 gm/100gm which is higher than rice, prosomillet, littlemillet, foxtail millet and kodo millet. The energy value of BTM is 1414 kj/100 gm which is greater than energy value of wheat, sorghum, prosomillet, finger millet, barnyard millet and foxtail millet. Calcium content of BTM is 28 mg/100 gm which is higher than calcium content of rice, pearl millet, proso millet, little millet and barnyard millet. Iron content of BTM is 8.86 mg/100 gm which is higher than iron content of all the millets and staple cereal grains i.e., rice and wheat. So we can increase the production of the crop and increase the productivity and create the awareness of that millet and consume it we get good healthy life.

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BUCKWHEAT: A PROMISING PSEUDOCEREAL

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Introduction

Buckwheat is botanically called *Fagopyrum esculentum* is a Pseudocereal, Growing buckwheat is popular because of its triangular, black or gray seeds. Along with being a pharmaceutical plant that yields rutin, it can also be grown as a companion crop, a cover crop, a source of buckwheat honey, and a green manure crop. Not a true cereal, buckwheat is a member of the Polygonaceae family. But the buckwheat grain is a dry fruit, just like cereals like wheat, corn, and rice, which are members of the grass family.

Orgin and Distribution

It is thought that buckwheat originated in central and northeastern Asia, and it was most likely grown in China in the fifth and sixth century. In the fourteenth and fifteenth centuries, it was brought to Europe via Turkey and Russia; in the seventeenth century, it reached North America. The amount of buckwheat produced worldwide peaked in the early nineteenth century and has since decreased. It has averaged almost 2.7 million tonnes over the last five years (1995–1999), with China and the former Soviet Union contributing 58 and 34% of the world's production, respectively. Brazil, Poland, the United States, Japan, Canada, France, Bhutan, the Republic of Korea, and South Africa are further significant producers.

Types and Cultivars

While there are at least 15 species of buckwheat in the genus *Fagopyrum*, only two are used for food or feed. The other species, wild buckwheat (*F. cymosum*), is mostly found as a tetraploid and is occasionally used as a green vegetable or as fodder for cattle. The common buckwheat (*F. esculentum*), tartary buckwheat (*F. tataricum*), and perennial buckwheat (*F. cymosum*) are the three main species of buckwheat. Another name for common buckwheat is *F. saggitatum*, and *F. kashmirianum* is the name for a type of tartary buckwheat. All agree, however, that the diploid variety of perennial buckwheat is the ancestral form of both tartary and common buckwheat. In the Himalaya region of India and China, eastern Canada, and occasionally mountainous eastern United States, tartary buckwheat is grown. Because of its limited resistance to cold, it is cultivated at higher elevations where there is a higher chance of frost damage. The seeds have a greenish tint, and the goods derived from them have a slightly bitter flavor. It is mostly utilized as feed, or in a blend of buckwheat and wheat flour, and is frequently utilized as a rutin source.

Plant and Seed Morphology

The tall, herbaceous, broad-leaved buckwheat plant can reach a height of 0.70 to 1.5 meters.

Fig. 1. Buckwheat- *Fagopyrum esculentum*

It can achieve full maturity in less than ninety days and contains several branches in addition to its primary stem. With the exception of the nodes, the stem is often hollow, succulent, and grooved. The stems and branches have a green to red tint before they mature, and they turn brown after that. The plant has a shallow taproot that lateral roots branch off of. Its roots make up only 3-4% of the plant's dry weight, which is a smaller amount than those of cereals.

Flowering:

Buckwheat flowers in an unpredictable manner. Common buckwheat blossoms are flawless yet lacking something. Although they lack petals, the calyx is made up of five sepals that resemble petals and are often white but can also be pink or red. Dense clusters of flowers are found at the tips of branches or on short pedicels that emerge from the leaf axils. Common buckwheat has plants bearing one of two types of flowers. The pin-type flower has long styles, or female parts, and short stamens, or male parts, and the thrum-type has long styles and short pistils. The pistil consists of a one-celled superior ovary and a three-part style with knoblike stigmas and is surrounded by eight stamens. At the base of the ovary are glands that secrete nectar. Because self-incompatibility prevents self-fertilization, common buckwheat plants are typically sterile. In most cases, cross-pollination between pin and thrum flowers is required for seed development. Leaf-cutter bees and honey bees are efficient pollinators. Both seed set and seed yield are increased. The triangular, dry fruit 0011 (achene) of buckwheat, measuring 4–9 mm in length, is composed of an embryo, spermoderm, endosperm, and hull.Small seeds typically have convex sides, but large seeds typically have concave sides. The hull might have a solid or mottled appearance and be shiny, gray, brown, or black. It might have lateral furrows and be smooth or rough. The hulls make up 17–26% (or 30–35%) of the weight of the kernels in tartary buckwheat. Compared to tetraploids, diploid cultivars typically have a thinner hull.

Structure of Kernel:

The buckwheat kernel's hull, spermoderm, endosperm, and embryo are all made up of many layers, as shown by scanning electron microscopy. The hull's epicarp, fiber layers, parenchyma cells, and endocarp are arranged from outside to inside. The spongy parenchyma, the inner epidermis, and the outer epidermis make up the spermoderm. The endosperm is made up of a subaleurone endosperm that contains starch granules encased in a proteinaceous matrix and an aleurone layer that is 10–15 micrometers thick. The two cotyledons of the embryo protrude through the starchy endosperm. Under the kernel surface, the terminal segments of cotyledons are frequently parallel.

Nutrient composition:

Table 1 Proximate composition , on a dry-weight basis, and selected mineral profile of three dehulled buckwheat cultivars (Mazza G.,1988)

Assay	*Cultivar*								
	Mancan (± SD)			*Manor (+ SD)*			*Tok yo(+ SD)*		
Moisture (g per 100g)	16.2	±	0.9	10.1	±	0.2	10.9	±	0.1
Protein3 (g per 100 g)	14.2	±	0.6	14.6	±	0.3	11.9	±	0.4
Crude fiber (g per 100g)	1.57	±	0.30	1.21	±	0.03	1.57	±	0.10
Ash (g per 100 g)	1.85	±	0.01	1.66	±	0.01	1.39	±	0.01
Lipidsb (g per 100 g)	2.6	±	0.3	2.2	±	0.3	2.1	±	0.2
Carbohydratesc (g per 100 g)	79.8	±	1.6	80.3	±	0.8	83.0	±	1.1
K (mg per 100g)	440	+	0.005	419	+	0.009	407	+	0.005
P (mg per 100g)	359	±	0.018	347	±	0.003	262	±	0.016
Mg (mg per 100 g)	214	±	0.002	201	±	0.012	195	±	0.010
Ca (mg per 100 g)	18	±	0.74	180.5	±	10.6	220.5	±	6.5
Fe (mg per 100 g)	2.5	±	0.18	21.4	±	0.3	21.2	±	0.9
Zn (mg per 100 g)	2.3	±	0.04	22.0	±	1.6	22.8	±	1.1
Mn (mg per 100 g)	1.0	±	0.02	10.0	±	0.5	10.2	±	0.4
Cu (mg per 100 g)	0.03			3.74	±	0.1	4.3	±	0.2

Functional value:

Because of the presence of rutin, common buckwheat and its constituents are considered functional foods in Japan. It is well known that rutin makes blood vessels more elastic, which keeps the arteries from hardening. Chinese medicine claims that the leaf and stem of tartary buckwheat can be used as an adaptogen, heal ulcers, help with hemostasis and hypertension, and enhance vision and hearing. Tartaric buckwheat eating is said to help with gastrointestinal issues in Nepal. Buckwheat consumption has been linked to the management and prevention of hypercholesterolemia. The protein in common buckwheat is responsible for this effect; it functions similarly to dietary fiber and has a greater hypocholesterolemic action than soy protein isolate. Because buckwheat protein extract is poorly digestible, it lowers blood estrogen levels, which delays the development of breast cancer in rats. It also causes a reduction in body fat. Because bioactive peptides from buckwheat pollen stimulate lymphocytes' immune systems, they may function as an immunomodulator to boost immunity and treat cancer. It has been suggested that buckwheat flour has physiological activity in the management of diabetes, hyperglycemia, hyperlipemia, and cardiovascular disease. Clinical results show that 75 diabetic individuals receiving tartary buckwheat biscuits experienced a drop in blood sugar. Fagopyritols are a class of phytochemicals found in buckwheat bran that function as an insulin mediator and may be useful pharmacologically in the management of noninsulin-dependent diabetic mellitus (NIDDM). When combined with vitamin C, rutin from buckwheat shields the endothelium and stops ascorbic acid from oxidizing. As a result, rutin and fagopyritols together can significantly aid in the prevention of diabetes.

Products

Buckwheat is useful in many ways. It is utilized to produce alcoholic beverages, with the liquor made from tartary buckwheat having purported health benefits. It's utilized to make vinegar in China. Many nations also use common buckwheat as a source of nectar for making honey. As a green manure crop, buckwheat can help revitalize low-productivity soil. Because the plant germinates quickly and forms a dense canopy that keeps broad-leaved weeds under control, it has been employed as a smother crop. It serves as a cover crop and food for deer, wild turkeys, and other birds, among other species. Buckwheat flour typically has a dark color because it contains hull particles. It is mostly sold as prepackaged mixes in North America, where it is mostly used to make buckwheat pancakes. Buckwheat flour is typically combined with flours such as wheat, corn, rice, oat, or soybeans, along with a leavening agent, in these mixtures. Additionally, buckwheat is combined with rice, corn, or wheat to make ready-to-eat breakfast items, porridge, bread, and pasta products. It is also combined with vegetables and spices to make kasha and soup mixes.

Buckwheat flour is mainly used in Japan to make Teuchi Soba, or hand-made buckwheat noodles, and soba or sobakiri, or buckwheat noodles. These goods are made at home or in soba shops using a blend of wheat and buckwheat flours. Because of its availability and binding qualities, wheat flour is employed. Soba is either mechanically or manually manufactured.

Both techniques include combining wheat and buckwheat flours with water to create a stiff dough that is either passed between sheeting rolls and sliced into long strips or kneaded and rolled into a thin sheet (1.4 mm) with a rolling pin. The product can be dried, sold fresh, or cooked right away.The majority of buckwheat in Europe is ground into groats, which are then eaten with fresh or sour milk, porridge, cabbage rolls, and meat products (particularly hamburgers). Many dumplings are filled with buckwheat groats, cottage cheese, sugar, peppermint, and eggs. Buckwheat flour is combined with yeast, wheat flour, or rye flour to make fried specialized items such biscuits, bread, and other confections. Western Europe is producing and selling an extruded, high-nutrient breakfast product made of corn and buckwheat. This food has 8% soluble fiber and over 14% protein. Poland and the former USSR have also created comparable items.

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CONCURRING REPRODUCTIVE DYSFUNCTION IN FISHES USING STRUCTURAL BIOINFORMATICS: A WAY FORWARD

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Introduction

Aquaculture, the farming of aquatic organisms, has emerged as a vital sector for meeting global demands of protein rich food and ensures food security. Within four decades, aquaculture production has surpassed the capture fisheries, and today, more than half of the fish destined for human consumption are farmed globally. The global total fish production is estimated to reach about 177.8 million metric tonnes (MMT) in 2020 (FAO, 2022). The primary goal of domestic aquaculture is to provide a consistent and abundant supply of healthy, fresh fish for human consumption. Success of aquaculture requires good quality fish seed in sufficient quantity. But culturing continuously in captivity leads to reproductive failure in many commercially important fishes. Our prime focus in this situation is to avoid reproductive failure and to produce viable fishes. This is only possible with successful breeding of fish in hatcheries by following SOPs. Captive breeding of fishes not only supplies seed for farming but also ensures a continuous generation of fish stocks,reducing the need for capturing wild fish and helping to alleviate overfishing pressures on natural population The key to reproductive success in captivity is endocrine manipulation.

Hormonal Control of Reproduction

Fish reproduction is a complex process that is regulated by a set of endogenous and exogenous signals, which acts along the hypothalamic–pituitary–gonadal (HPG) axis.The hypothalamus delivers certain specific signals to pituitary gland, which results in the release the hormones that directly affects the gonads. The reproductive processes in fishes are processed through a sophisticated complex network of signals and receptors, ensuring the successful coordination of mating, gamete release, fertilization, and the development of offspring. Hormonal signals stand at the forefront of this intricate system. In vertebrates, Gonadotropin-releasing hormone (GnRH) is the major hypothalamic neurohormone that regulates reproduction. Gonadotropin-releasing hormone (GnRH) is a pivotal player in fish reproduction, originating from the brain and stimulating the pituitary gland to release gonadotropins. The gonadotropin hormones such as luteinizing hormone (LH) and follicle-stimulating hormone (FSH), govern the production of sex hormones and the maturation of gametes, thereby regulating the timing of spawning or mating. Furthermore, sex hormones like estrogen and testosterone, produced in the gonads, guide secondary sexual characteristics, enhance reproductive behavior, and facilitate the development of gametes. The GnRH receptor is a G protein-coupled receptor (GPCR) which belongs to rhodopsin-like receptor family. When GnRH hormone binds to its receptor, it triggers a chain of intracellular events that ultimately lead to the release of gonadotropins from the anterior pituitary gland. The GnRH receptor is essential for the control of reproductive cycles, sexual maturation, and the timing of spawning in fish.

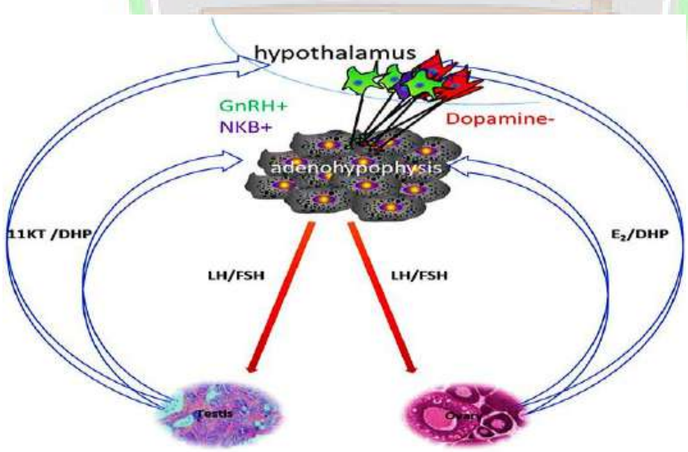

Fig.1 Schematic diagram displaying HPG axis in fish and the potential regulatory signals conveyed by hypothalamic neurons to pituitary cells, leading to the gonads (HPG axis)

Reproductive Dysfunction

When fish is cultured in captive conditions, chances of reproductive failure increase due to lack of adaptability to the new environment. In this case, it fails to undergo a normal gametogenic cycle in captivity. This leads to a wide range of adverse effects on the reproductive health of cultured organisms and can be called "reproductive disfunction". Reproductive dysfunction may persist in different ways, including reduced fertility, altered spawning behaviors, abnormalities in gonadal development, disruptions in hormone regulation, physical deformities in reproductive organs, skewed sex ratios, and even interference with parental care behaviors. The study of reproductive dysfunction in fishes is crucial for understanding the health of aquatic ecosystems and addressing conservation and management concerns related to fish populations and fisheries sustainability.

The lack of gametogenesis of European eel *Anguilla anguilla*; the lack of maturation and ovulation in the meagre *Argyrosomus regius*; and the failure of breeding and spawning of F1 generation sharp snout sea bream *Diplodus puntazzo* and Senegalese sole; milt release in Asian catfish *Clarias batrachus* are some examples for reproductive dysfunction in culture condition. European and Japanese eel *Anguilla japonica* males remain immature and fail to undergo spermatogenesis in captivity. In some cases, captive-bred fish species may exhibit reduced egg production compared to their wild counterparts. Factors such as stress, suboptimal environmental conditions, and dietary deficiencies can contribute to this reproductive dysfunction. More often, captive environments disrupt hormonal balance, affecting reproductive success. Hormonal manipulation techniques, such as the use of GnRH agonists (GnRHa), are often employed in aquaculture to induce spawning and mitigate reproductive dysfunction.

GnRH Receptor Analogues Used in Aquaculture

GnRH receptor analogues are synthetic compounds engineered to replicate the effects of natural GnRH. These analogues find applications in aquaculture and fisheries management, where the goal is to regulate reproduction and enhance breeding practices. GnRH agonists and antagonists serves as the prime examples of such analogues, with the former stimulates and the later inhibits the release of gonadotropins. By employing GnRH analogues, fisheries, and aquaculture professionals have the means to synchronize spawning in farmed fish, manipulate gender ratios, and delay sexual maturation, among other uses. Earlier crude pituitary extract containing gonadotropins was used.GnRHa creates a positive impact as compared to the use of gonadotropin preparations. GnRH and its agonists, being compact decapeptides, do not elicit an immune response.

By stimulating the release of the body's own gonadotropins, GnRHa helps restore the disrupted endocrine processes responsible for the failure of captive fish to undergo final oocyte maturation (FOM), ovulation, and spawning. It also doesn't carry any diseases as it remains in pure form. GnRH have structural similarity and hence it can be used for a wide range of fish species. Ovprim, a synthetic GnRHa in combination with dopamine antagonist marketed by Syndel Laboratories in Canada and marketed by Agri.Vet. pharma of Glaxo India Ltd. in Mumbai, has proven to be highly effective in inducing spawning in fish. Another successful analog in this category is Ovatide, a synthetic compound launched by Hemmo Pharma in Mumbai. Ovatide has demonstrated efficacy in inducing reproductive processes in these fish species.

Structural Bioinformatics for Mitigating Reproductive Dysfunction

Bioinformatics is an interdisciplinary field of science that utilizes computational techniques for understanding biological data, especially when the data sets are large and complex. Structural bioinformatics is the branch of bioinformatics concerned with the analysis and prediction of the three-dimensional (3-D) structure of biological macromolecules including DNA, RNA and proteins. This branch is also called as “molecular modeling” in more general sense. Due to advancement in both hardware and software this field is becoming more accurate and hence gaining popularity. Currently, structural bioinformatics isbeing used regularly in the drug discovery process to save money and time. So, this technique can also be used to mitigate reproductive failures in commercially important farmed fishes.

For any drug development, the identification of a target is the first step. In this contest, GnRH receptors are the drug target. The amino acid sequence of the target is needed for structural prediction, which can be retrieved from the NCBI protein database. After getting target sequence, the sequence similarities among different species can be done using NCBI BLASTp tool. To know the functional domains available in the target sequence online servers like Interpro from Europian Bioinformatics Laboratory can be used. The 3-D structure of the target can be predicted by tools like AlphaFold online, available in the form of Google-Colab, or installed in-house, which can be used. For the identification of ligands or candidate drugs interacting with the target, free docking tools like AutoDock Vona developed by The Scripps Research Institute can be used. To analyse 3-D structures and docking results, freely available tools like UCSF-Chimera developed by University of California can be used.

This is a general procedure for identifying new drug candidates using structural bioinformatics. The same pipeline can also be used in case of fish GnRH receptors.

Literature review to identify target protein to be studied
Sequence retrieval
NCBI, /SWISS-PROT

↓

Similarity search
BlastP

↓

Prediction of physical and chemical property of protein
ProtParam tool

↓

Conserve domain prediction
InterPro - EMBL-EBI

↓

Secondary structure prediction
Sopma (secondary structure prediction method)

↓

Tertiary/ 3D structure prediction
AlphaFold2.ipynb - Collaboratory - Google Colab

↓

Structural visualization, comparison, and analysis
UCSF-Chimera

↓

Protein-ligand and protein-protein docking
Autodock Vina with UCSF-Chimera interface (for protein-ligand) and Cluspro, HADDOCK servers for protein-protein docking)

Fig.2 Flowchart representing the bioinformatic tools used to identify the drug

Conclusion

Reproductive dysfunction in fishes is a multifaceted challenge, influenced by various factors ranging from environmental stressors to genetic diversity. The development of drugs, particularly GnRH analogues, has provided innovative solutions to various problems associated with the captive breeding of commercially important farmed species. But many commercially important fishes still exist whose captive breeding technique has not been standardized. In this regard, structural bioinformatics can play a significant role. Currently, using various structural bioinformatic tools, the structure of drug targets can be easily predicted, and new drug molecules can be discovered. As we continue to explore this evolving field, the future promises novel approaches, greater environmental responsibility, and increased productivity, all contributing to the continued vitality of aquaculture and global fisheries.

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INNOVATIVE PLANT DISEASE DETECTION AND FORECASTING

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Introduction

"Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products" as defined by the FAO and IPPC. Pests can cause enormous crop loss worldwide. Damage can occur both in the field, from sowing to harvesting, as well as during storage. Major historical background of plant disease epidemics include the Irish Famine (1845) due to potato blight, and the Bengal famine (1943), caused by brown spot of rice. The science of plant pathology deals with the cause, biology, epidemiology, subsequent losses, and management of plant diseases. A secure food supply for future generations requires environmentally safe and sustainable production. Different types of pests and abiotic stress factors (e.g., deficiency of nutrients, drought) reduce the quantity and quality of agricultural and horticultural crops worldwide. Meanwhile, the intensive production of agricultural crops reduces soil nutrients and the maintenance of long-term environmental sustainability.

The main goal of modern agriculture is to reduce intensive fertilizer and pesticide use and decrease the heavy exploitation of natural resources (water, soil, energy). Therefore, the integration of digital innovations and technologies with traditional agricultural practices could be an option for more sustainable and secure crop/food production. This approach perfectly matches the aims and spirit of the Sustainable Development Goals adopted by all United Nations Member States in 2015. For instance, precision agriculture is a collection of agricultural practices that focus on specific areas of the field at a particular moment in time. The main goal of precision agriculture can be summarized as doing "the right thing, at the right time, in the right place". This is opposed to more traditional practices, where the various crop treatments, such as irrigation and the application of fertilizers, pesticides, and herbicides, are homogenously applied to the entire field, ignoring any variability within the field, and are often carried out according to calendar-based scheduling. It aims to achieve real-time, robust mapping systems for crop, soil, and environmental variables to produce management decisions. In addition to arable field production, precision agriculture has been successfully applied in viticulture, livestock production, and pasture and turf management. It has a vast range of uses, from tea production in Sri Lanka and Tanzania to sugar cane production in Brazil, rice cultivation in China and India, and sugar beet growth in Argentina, Australia, Europe, and the US. Although it is difficult to define the scope of the scale of benefits, when applying precision agriculture, a review of 234 studies was presented that proves an average of 68% profitability in all cases.

Precision agriculture tools

Precision agriculture tools have been in use for more than three decades now, by supporting farmers and farm managers in decision making at different spatiotemporal scales. Precision tools, such as sensors and mapping fields, allow farmers to better understand their crops at a micro-scale, reducing the use of natural resources and impacts on the environment. Although, in the beginning, precision agriculture was applied for the optimization of fertilizer use depending on soil variety across the agricultural field, its use has evolved into the use of automatic guidance of field vehicles and implements, autonomous machinery, product traceability, on-farm research, and software for agricultural management. With the recent scientific advancements, technological innovations, and legislative tools, it is now possible to achieve these strategic goals and increase sustainability in agriculture. An enlarged network based on the principles, techniques, and tools of precision agriculture at a regional, national, or even international scale could also represent a great step forward for small farms, easily providing information about what is happening in their fields and offering expert information about how to manage possible plant health risks and threats in a timely manner.

For some diseases, and specifically, for different insect pests, the monitoring of related attacks and population dynamics is essential for the determination of alert thresholds and intervention times. From a certain perspective, the application of epidemiological forecasting models can provide interesting results in controlling the spread and/or development of pests and diseases. Monitoring remains a key aspect for implementing and validating existing models or for calibrating epidemiological models when they are used in a new area, as well as for creating new models by understanding macro-phenomena and the dynamics of harmful organisms. Field scouting is necessary to provide initial inputs detected in the field for triggering some models, to keep the actual phytosanitary threats for a crop under control, and to carry out a timely verification of the efficacy obtained by several plant protection products, or the possible occurrence of pest resistance towards specific active substances.

Moreover, appropriate monitoring systems are also important, both to detect inoculum outbreaks and to follow their evolution, particularly for the diseases that cannot be controlled by direct methods, but for which the identification and localization of the affected plants are fundamental for limiting their spread (e.g., Esca disease in grapevines, as well as other trunk diseases, and root rots in different crops). The early detection of new outbreaks and phytosanitary emergencies related to newly introduced alien pests in a specific area (e.g., *Xylella fastidiosa* in olive trees in Europe, *Flavescence doree* in grapevines in northern Italy, or *Ralstonia solanacearum* in tomatoes in the Emilia-Romagna region of Italy) are the key scope of monitoring activities to apply the appropriate quarantine phytosanitary measures and/or evaluate, in real-time, the phytosanitary situation of a region or an area in a timely manner.

Sensing technologies

Several sensing technologies are used in precision agriculture, helping to monitor yield, the rate of fertilizer use, weed occurrence, insect abundancy, soil properties, water requirements, crop harvest readiness, and many other factors. The geographic information system is one of the advantages of modern technology, benefitting precision agriculture in many ways. It allows for analyzing and processing a large amount of data in a short time by providing uniform measurements for large areas in a digital form. This technology makes it possible to use only the optimal amount of fertilizer, which prevents wasting money and polluting the environment. For instance, crop yield monitoring is very important for farmers to consider future expectations. In this case, data (i.e., the amount and rate of harvest) obtained from site sensors are combined with a global positioning system (GPS) for the location of each data point, providing information to produce crop maps in a geographic information system (GIS). This map can later help to manage a site-specific program in future years. GIS is an essential technology for decision-making systems, generating various types of spatial and description data. Wireless sensor network

(WSN) technologies have become an essential part of precision agriculture because of recent advances in wireless communications systems. The use of WSNs allows farmers to increase efficiency, productivity, and profitability while reducing the negative effects of agricultural production on wildlife and the environment. Real-time data obtained by WSNs can contribute to lessening potential production risks, caused by the environment or humans and energy consumption, and help farmers to modify production strategies at any time, without using traditional manual or machinery-based methods. The transition towards sustainable agriculture requires cleaner crop production techniques based on WSNs. Wireless sensor technologies have mainly been deployed in greenhouses or gardens, rather than in actual fields. The data obtained from sensor nodes are wirelessly transmitted to a central base of data collection for a decision on relevant management measures like drip irrigation. However, a large-scale WSN experiment was also conducted in the Netherlands to obtain better crop production alongside the optimal use of resources.

Drones in agriculture

Drones in agriculture are promising tools to easily overcome several challenges, such as soil and field analysis, that farmers face during crop production and protection, allowing farmers to be aware of farm conditions from the beginning of the cropping cycle (i.e., generated data can be used to evaluate irrigation and nitrogen rate for crop growth). They can be useful to monitor the vegetative status of the crop through thermal sensors and allow for the adjustment of the irrigation rate, as well as to calculate the vegetation index and the crop health status. Unmanned aerial vehicles (UAV) are another tool of precision agriculture for monitoring purposes. Similar to drones, UAVs are aircraft with no onboard crew or passengers, most commonly used for the surveillance of crop Conditions, soil properties, water content and weed distribution. Differing from drones, which are remotely piloted by humans, UAVs have “automatic intelligence” that controls both flying activities and loading imaginary data, along with other information. UAVs with relevant sensors can deliver easy access to the field plots and difficult landscapes, while also enabling crop growth monitoring at lower operational costs. Another advantage of UAV technology is crop yield monitoring: multispectral imaging helps growers to predict the yield and consequently, the market value, of their crop. UAV-based sensing helps to monitor plant growth parameters, such as emergence or flowering, vigor, and leaf area index, and can use a wide range of technologies such as light detection and ranging (LIDAR), visible to near-infrared, and/or thermal imaging. Installed infrared, NVDI, or multispectral sensors on drones allows farmers to track crop health and take protective actions beforehand. Although UAV remote sensing technologies have some limitations, such as reduced flight time, meaning that they require more flights for covering larger areas and to meet strict aviation regulations, in addition to the lack of a standardized methodology for processing a high volume of UAV images, they can still benefit precision agriculture in many ways].

Internet of Things (IoT)

The Internet of Things (IoT) is another promising technology in terms of monitoring and control in a large-scale farming systems. It allows for better productivity and sustainability in many ways, such as, for instance, achieving better sensing and monitoring of production and obtaining a better understanding of the specific farming conditions (i.e., weather, environmental conditions, animal welfare; pest, weed, and diseases management). The more sophisticated and remote control of farm, processing, and logistics operations can be enhanced by actuators and robots (e.g., precise application of pesticides and fertilizers, robots for automatic weeding); these can also improve food quality with the control of environmental conditions during transportation. Thus, the IoT is offering novel opportunities beyond farming, benefitting food manufacturing as well.

Monitoring tools are more effective when used in combination with networking arrangements based on institutional agreements to monitor locusts, fall armyworm, and wheat rust diseases. The desert locust is a well-known invasive pest in the region between West Africa and India. The FAO Desert Locust Information Service (DLIS) operates an early warning system that collects locust-related data and produces monthly situation summaries and forecasts for each country. The recently developed eLocust3 tool records and transmits real-time data to the national locust centers. These data are used to assess the current situation, forecast infestation, and provide preventive control strategies for affected countries.

Wheat rust diseases are a major threat in almost all wheat-growing countries. The FAO cooperates with different countries to develop effective surveillance and early warning systems against rust diseases, and rusttracker.cimmyt.org is the web portal for global cereal rust surveillance and monitoring information. It provides up-to-date information on different features of wheat rust, such as incidence and severity, resistant cultivars, and the availability of interactive, database, and visualization tools.

Disease management practices

Disease management practices essentially rely on preventing the occurrence of disease and targeting critical stages of the pathogen in the disease cycle. Correct disease diagnosis is always essential to identify the right causal agent. Therefore, plant health treatments are usually applied based on correct disease forecasting models. The main diagnostic method of a plant disease remains the confirmation of Koch's postulates, starting from a symptomatic plant or organ to verify the hypothesis that the isolated pathogen is the actual cause of the disease. Based on artificial intelligence advances, analyzing and identifying images of the pest damage could greatly help farmers in diagnosing the disease or the insect pest in seconds, even without a connection to the Internet. Nuru is one of these tools helping many farmers in Africa to diagnose fall armyworm (FAW) in their fields. Specific image analysis software (e.g., Assess 2.0, Lamari APS Press) can also be used on pictures of affected organs or canopies, and it represents another useful tool for estimating disease severity on different vegetative organs by, for example, quantifying the size of chlorotic and/or sporulating lesions on grapevine leaves affected by downy mildew. The use of machine learning approaches for the diagnosis of plant pests is progressing rapidly.

An integrated disease control program aims at (i) eradicating or reducing the initial inoculum, (ii) reducing the effectiveness of the initial inoculum, (iii) increasing the host resistance, (iv) delaying the disease onset, and (v) slowing down the secondary cycles. It is crucial to accurately detect and identify pathogens to initiate preventive disease control measures. An essential factor in disease management is the early detection of pathogens, particularly in seeds, mother plants, and propagative plant material, but also in the early stages of the infection to avoid the introduction and further dispersal of the inoculum. On-site nucleic acid-based methods that can be performed with minimal equipment, rapidly, and at low cost, are receiving growing interest in plant pathology. Indeed, continuous advances in DNA-based detection methods have provided fast, sensitive, and reliable detection and quantification of fungal pathogens, when compared to culture-based identification methods. Most of these techniques rely on polymerase chain reaction (PCR) and real-time PCR (RT-PCR) assays, which have been extensively applied to plant pathology from the soil, water, air, and plant material. Moreover, PCR-based techniques provide highly specific assays that can discriminate between species isolates and genotypes.

Scientific development has been achieved by moving real-time PCR technology from the laboratory to the field using a portable thermocycler. Despite some successful applications, these technologies have not been widely adopted, as the portable thermocyclers are expensive, and the assays require laborious modifications to adapt DNA extraction protocols to the field conditions. Recently, the insulated isothermal PCR (iiPCR) POKIT system was introduced for sensitive and specific on-site detection of nucleic acid, and it is a relatively simple and inexpensive device when compared to thermocyclers.

Isothermal amplification detection methods have been developed to overcome the challenges of the use of PCR thermocyclers for possible on-site testing. As the name suggests, the isothermal amplification of DNA (or RNA) occurs at a constant temperature, which confers to some of these methods the potential for use in the field by means of portable instruments. Many reviews have fully described these methods for isothermal amplification.

Loop-mediated isothermal amplification (LAMP)

The loop-mediated isothermal amplification (LAMP) method has attracted much attention, as it provides a rapid, accurate, and cost-effective diagnosis of diseases. Numerous reports have been recorded to evaluate its efficiency in recognizing bacterial, viral, fungal, and parasitic diseases worldwide. In the initial phase of development, LAMP was applied to many kinds of pathogens causing food-borne diseases, and LAMP kits for detecting salmonella, legionella, listeria, verotoxin-producing *Escherichia coli*, and campylobacter have been commercialized. Recently, a growing interest in this method has been also observed in the detection of plant pathogenic agents, especially with the possibility of in-field application through portable devices. For instance, the LAMP method, combined with lateral flow strips or portable fluorometers, has been developed to enable the field detection of plant pathogens such as *Erwinia amylovora*, *Candidatus* Liberibacter asiaticus, *Erysiphe necator*, and *Phytophthora infestans* . More recently, handheld instruments have been made available for real-time isothermal detection. Most of these instruments consist of a simple heating block, with a testing capacity of eight standard 0.2 mL tubes, and usually include dual-channel fluorescence measurement to allow for the use of internal controls and multiplexed assays. Some of them also provide positional information through GPS, in addition to wireless connectivity via Bluetooth and Wi-Fi.

Phytopathology

Phytopathology can benefit from the use of affordable and robust on-site assays, as plantations can be distant from diagnostic laboratories; in particular, there can be a long interval of time between sampling and diagnosis, and in some cases, it would be highly recommended to perform testing at the sampling site (e.g., quarantine plant pathogens). On-site molecular testing requires not only a portable platform and suitable assay, but also a simple and robust alternative DNA extraction method that can be performed in the field. The preparation of a sample has traditionally been difficult and time-consuming. It is widely known that plant tissue samples require DNA extraction methods that are able to efficiently wash away any chemical compound and that can inhibit the DNA amplification reaction. However, isothermal assays were shown to efficiently detect plant pathogenic DNA from crude extract samples using simple and short sample preparation methods.

Decision support systems (DSSs)

Decision support systems (DSSs) represent the holistic vision of crop cultivation problems: they take into account and provide decision support for all of the key elements of the production chain, from strategic choices to tactical operations. These DSSs use sophisticated technologies and methods for analyzing data to produce simple and easy-to-understand decision support information in order to convert complex decision processes into simple decision support frameworks that can be easily and clearly used by farmers. A properly designed DSS is an interactive software-based system that helps decision makers to obtain useful information from raw data, documents, personal knowledge, and/or models in order to identify and solve problems, make informed decisions, and apply correct actions. DSSs can be as simple as a tool for processing data or as complex as an expert computerized system. DSSs collect, organize, and integrate all types of information required for producing crops; DSSs then analyze and interpret the information, and finally use the analysis to recommend the most appropriate action or action choices

Remote sensing

Remote sensing allows users to identify stressed plants, as well as soil characteristics of large areas, and also, by calculating different vegetation indexes, to obtain information on the crops' vigor for estimating crop yield. Other diagnostic tools, such as the molecular devices discussed, are crucial to accurately detect and identify pathogens to initiate preventive disease control measures. These can be used on a large scale by trained personnel and can cover a wide area to provide precise, timely, and accurate information about the presence and development of disease epidemics. Such information could be relevant to improve the precision of the entire platform and the quality of data provided.

There is, for instance, great variability in plant disease epidemics across areas and years, and such variability is closely related to the variability in weather conditions. Moreover, severe epidemics can occur in areas where the disease has not been traditionally considered a key problem. The combination of site-specific weather data, monitoring reports, and advice from a DSS enables growers to protect, for instance, their vineyards against downy mildew by modulating the frequency and timing of fungicide applications based on disease risk.

By providing real-time, holistic, and detailed information on the many aspects of crop status, the new-generation DSSs have been proved to be able to help farm managers to make informed decisions. In particular, they enable managers to rationalize the use of both natural resources, such as water, and technical inputs, such as plant protection products, and thereby implement a cropping system that is consistent with the principles of sustainable agriculture, including IPM, as acknowledged by the SUD in Europe. These new DDSs also enable managers to keep track of the rationale behind each management action undertaken during the cropping season. The innovative DSSs were designed to overcome the “implementation problem” previously encountered by most crop management DSSs. The key characteristics that define the new-generation DSSs is that they were purposely developed to avoid both technical limitations and a low rate of acceptance by users.

The actual availability of innovative tools and data management techniques, also leading to big data management and analysis requirements, allows us to think about an integrated system of digital collaboration that provides phytosanitary monitoring for one (or more) crops in a specific area, which is effective, rapid, objective, and repeatable in varied environmental contexts, and therefore suitable to provide appropriate support to the various phytosanitary control needs in a region or an area. This digital collaboration environment could be integrated into modern decision support system information, protocols, and guidance to allow trained personnel to carry out surveys and data collection, through information, alerts, and guidelines (photographic or video supported) provided by the system.

This supports the user in making decisions, increasing operational efficiency and reducing the possibility of making mistakes. It also makes it possible to share information or collected data with team members or organizations through the web platform in real-time. The aforementioned monitoring can be combined with the automation of the process, by means of the use of Internet of Things (IoT)-based technologies, to make the activity more precise, with a reduction in errors and implementation times, as well as costs. This approach could lead to a complementary monitoring system and enhancement of the forecast models, an aspect that will allow researchers to optimize and increase the information and alerts provided to the operator, guaranteeing a clearer and more thorough picture of the phytosanitary and physiological state of the plant.

The new generation of DSSs are now ready to serve as a platform able to (i) receive input, information, and data from many different sources and tools, and (ii) store them in a repository where appropriate models can analyze them in the most appropriate way (including big-data analysis), (iii) define decision supports, and (iv) provide information to the decision makers (i.e., growers, technicians, consultants, and policymakers) in a timely, clear, and easy to understand form. This can represent a step forward in the practical application of the Sustainable Development Goals adopted by the UN in 2015 . Innovative solutions described in this review are linked to at least eight different SDGs. The increased efficiency of warning system networks due to the integration of enhanced technologies will lead to a timelier application of pest control strategies, with a consequent reduction in food losses and increased food security (SDG 2), leading to a reduction in poverty (SDG 1). The enhanced quality of crop protection will engender a rationalization of, and thus a reduction in, the use of plant protection products, leading to reduced contamination of soil and water and thus, to the enhancement of clean water availability (SDG 6), as well as the protection of life below water (SDG 14) and life on land (SDG 15). Improved crop management will lead to improved food safety, and thus to improved health and well-being (SDG 3). A large-scale application of the presented solutions will provide improved learning opportunities (SDG 4) by making innovative tools more accessible to a large audience (e.g., students, farmers), while at the same time, ensuring more decent work and economic growth by providing information and knowledge (SDG 8).

Conclusion

Although precision agriculture is not exclusively a new idea, the main thread of this review was about its spirit and goals, with a particular emphasis on increasing awareness about the accessibility to innovative tools for all farmers. The main purpose of describing different monitoring and diagnostic tools and early warning and decision support systems in this review was to give insight into the possibility of using precision agriculture, not only at the field scale, but also at the regional scale to reach the goal of sustainability in agriculture. In the main topic, we also discussed problems of non-acceptance of technological solutions due to the lower budget of farmers. Using innovative applications at a regional scale will lower the cost and provide a more precise forecast for robust decision making.

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STATUS OF PHYTOPLASMA IN GLOBAL AND IN INDIA

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Introduction

Plant diseases are playing very crucial role in crop production and plant protection. These diseases are affecting the agricultural production and productivity causing losses of ~ 42 per cent. Many of the diseases are associated with several disease causing agents like fungi, bacteria, virus, phytoplasma and viroids. Among these, phytoplasma diseases are ruining all over the world. Phytoplasmas are plant pathogenic bacteria in the class Mollicutes and are formally called mycoplasma-like organisms (MLOs) (Doi *et al*. 1967). They are obligate intracellular prokaryotes, lack cell wall having triple lamellar layer with pleomorphic shape and are transmitted by insect vectors (leafhoppers, planthoppers, and psyllids). They infect hundreds of plant species worldwide, including many economically important crops, fruit trees, and ornamental plants. They are associated with more than 600 plant diseases worldwide with a noticeable impact on agriculture economics. In plants, phytoplasmas are localized exclusively in the sieve tubes where they multiply actively and move systemically within the host. The genome is small (680–1600 kb), when compared with their ancestral walled bacteria and lacks several metabolic pathways for the synthesis of compounds indispensable for their survival and multiplication (Oshima *et al*. 2013).

Phytoplasma

Phytoplasma is the name given to microscopic, plant pathogenic, cell wall-less prokaryotes of the class Mollicutes that were formerly known as mycoplasma-like organisms or MLOs. They are obligate parasites and have not been grown in axenic culture. Because of this, they have not been fully characterized and their pathogenic nature has not classically been confirmed. Until the plant-inhabiting pleomorphic mollicutes can be cultivated and characterized apart from their hosts, they are provisionally classified as *Candidatus* Phytoplasma, with species delineated by genome size and phylogeny as inferred by the nucleic acid sequence of the 16S ribosomal RNA. Wie *et al.* (2007) reported the classification of phytoplasma based on symptology and 16S rRNA sequence similarity with 97% phytoplasma sequence.

Why phytoplasma are threatening?

The symptoms produced by phytoplasmas are confused with the viral diseases and nutrient deficiency. These are having very wide and overlapping host range. Symptom production vary during changing environmental condition. Upto now there is no economically viable management practises because vector based management has causing problem of pest resurgence and pest resistance. Major problem is till now there is no development completely resistant genotypes. Problem of false positive results at the time of detection also becoming difficult. Ethical issues for development of transgenic plants and use of advanced CRISPR technology.

Global status of phytoplasma

The phytoplasmas infection was reported in 47 countries distributed among the five continents all over the world (Kumari *et al.*, 2019).

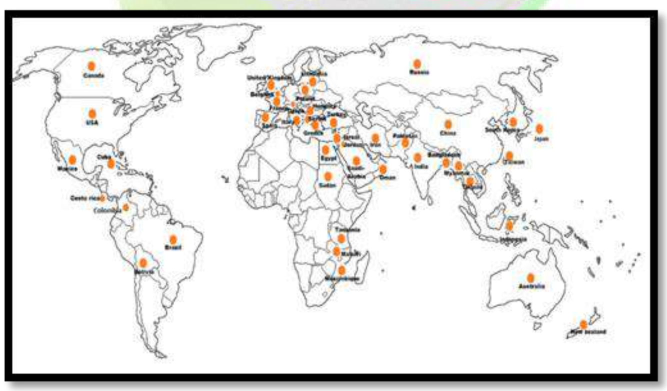

Fig 1. Global distribution of phytoplasma diseases

Among different phytoplasmal groups, aster yellows group (16SrI) are predominant across different genera followed by the peanut witches' broom (16SrII), clover proliferation (16SrVI) and "stolbur" (16SrXIIA) groups. Interestingly, among the four subgroups of aster yellows (16SrI-A, -B, -C, -X) infecting vegetable crops, the 16SrIB subgroup is the most predominant worldwide, whereas the subgroup 16SrI-C seems to be restricted to the Asian countries. In the Asian continent phytoplasma strains belonging to 10 ribosomal groups and 16 subgroups have been identified similarly to the detection in the American continent where strains belonging to 12 subgroups in 10 ribosomal groups have been identified. The 16SrIII is the most relevant group of phytoplasmas in the Americas, infecting 10 vegetable crop species after the aster yellows phytoplasma (16SrI), which infects 14 species. The group 16SrIII phytoplasmas appears to be restricted to South America (Argentina, Brazil, Chile, Costa Rica, and Bolivia) except for a report from Mexico, in tomato. Aster yellows and "stolbur" phytoplasmas are well established groups in the European continent where they are emerging as a serious concern for vegetable crops cultivations except for potato, which is infected by "stolbur" (16SrXII-A) phytoplasma.

Among worldwide distribution of phytoplasma, vegetables are highly susceptible to phytoplasmal diseases. Presence of phytoplasma in vegetable crops has a history of more than 85 years also in Africa and Australia where the tomato big bud disease was first described, however, reports of phytoplasma diseases on vegetable crops in Australia are limited; out of the seven phytoplasma groups (16SrI, 16SrII, 16SrIII, 16SrV, 16SrX, 16SrXI, and 16SrXII) reported from Australia, only three (16SrII, 16SrV, and 16SrXII) are infecting vegetable crops.

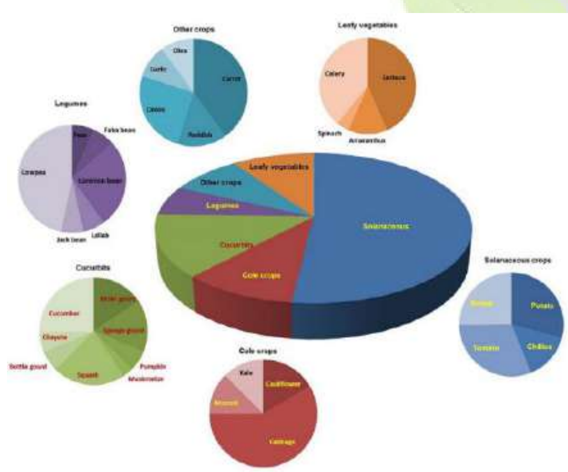

Fig 2. Distribution of phytoplasma diseases in different vegetable crops

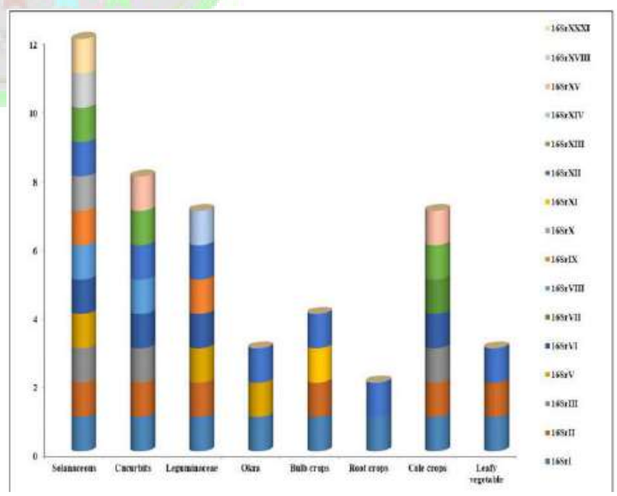

Fig 3. Various phytoplasma groups infecting vegetable crops

In the African continent three subgroups (16SrII-A, -C, and -D) are ubiquitous, infecting brinjal, tomato, chili, faba bean, and squash. Brinjal is infected with little leaf phytoplasma, big bud of tomato, tittle leaf of chilli and purple top roll of potato. Phytoplasma infection led to significant yield losses in brinjal (40%), tomato (60%), pepper (93%), potato (30–80%), and cucumber (100%) in different parts of the world**.**

A broad spectrum of genetic diversity has been observed among the vegetable-associated phytoplasmas based on their host range and insect vector specificity. Currently, sixteen ribosomal groups (16SrI, 16SrII, 16SrIII, 16SrV, 16SrVI, 16SrVII, 16SrVIII, 16SrIX, 16SrX, 16SrXI,16SrXII, 16SrXIII, 16SrXIV, 16SrXV, 16SrXVIII, and 16SrXXXI) and more than twenty one subgroups (16SrI-A, -B, -C, -X; 16SrII-A, -B, -C, -D, -E; 16SrIII-B, -J, -U, -Y; 16SrVI-A, -C, -D, -J; 16SrIX-C; 16SrXII-A, -B and 16SrXV-A) were reported to be associated with different vegetable species belonging to diverse botanical families including solanaceae, cruciferae, and cucurbitaceae.

Diversity of phytoplasma in India

Recently in India research work on characterization and management of phytoplasmas is being carried out very efficiently. Phytoplasmas are reported on various plant species in India including crops, fruit trees, ornamentals, sugarcane, grasses and weeds. So far more than fourty 16S rRNA sequences from different plant have been submitted in GenBank across the country. Phytoplasma diseases are the major constraints in profitable ornamental plants production and lowers its quantum, quality and gaining international importance because of unspecific symptoms, various losses and epidemiology throughout the world. Epidemics of these diseases have compelled withdrawal of many floriculture plant varieties from cultivation.

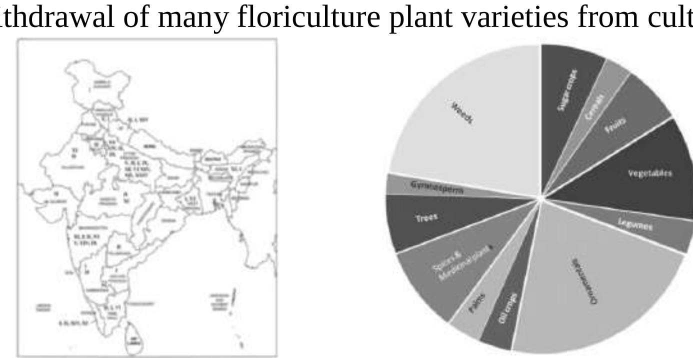

Fig 5. Phytoplasmal groups in India and infected plants

Phytoplasma cause diseases in several plant species in India and resulted in serious threat to the affected crop as a source of alternative host for the spread of phytoplasmas to other economically important plants and thereby chances of causing severe losses to a maximum level. So far, 34 phytoplasmas belonging to 7 groups have been identified on different plant species from all over India. The "*Candidatus* Phytoplasma asteris", "*Candidatus* Phytoplasma cynodontis", "*Ca*. Phytoplasma aurantifolia" and "*Ca*. Phytoplasma trifolii" belonging to 16SrI, 16SrII, 16SrVI and 16SrXIV group of phytoplasmas are the major group associated with different group of plant species reported to be infected with phytoplasma. Throughout India. Nucleotide sequence studies have shown that phytoplasmas infecting plant species in India are mainly belongs to 16SrI, 16SrII, 16SrVI, 16SrXI and 16SrXIV groups (Rao *et al.,* 2011).

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CONVENTIONAL FILTER AND ITS APPLICATION IN DAIRY INDUSTRY

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Introduction

Filtration may be defined as a process of separation of solids from a fluid by passing the same through a porous medium that retains the solids but allows the fluid to pass through. The solids are retained in the porous medium and form a layer called filter cake. The liquid that passes through the porous medium which is free from any solid particles is called as filtrate. The porous medium is known as filter medium. The driving force for the separation of the two phases may be gravity force or mechanical force. Pressure is created at the upstream or vacuum at the downstream to cause the flow of filtrate through the medium.

Filtration of milk is carried out to remove foreign matter from the milk to improve the aesthetic quality of milk. This may be removed either by filtration. During handling of milk on farm and its transportation, certain visible particles and dirt may gain access into the milk which may be removed by either filtration. Filtration equipment has been designed for both cold and warm milk. Since fluidity of warm milk is more, its separation process is more efficient. It also poses the risk of bacterial growth unless handled properly. When solid are present in concentration, i.e., not exceeding 1% separation from liquid very low w/v, the process of its is called clarification.

Principle of Filtration

The driving force for filtration is most often the pressure difference. In the beginning of the filtration process, filtrate flows easily through the medium with least resistance. The rate of filtration which is the ratio of filtrate volume and time of filtration is high in the beginning. But, as the filtration progresses, the layer of cake deposition upstream gradually increases. So, now the filtrate not only ought to pass through the medium, but also it should cross the layer of cake. Hence, there is a constant pressure drop across the medium and it increases with time. After certain time, the filtration virtually stops.

Filter Types used for Dairy Filtration

There are various types of milk filters available that are made with food-grade materials with a strong seam, evenly sized pores, and high wet strength. These provide reliable, consistent milk filtration. Common disposable milk filters include sock and sleeve filters and filter disks. Permanent filters with stainless steel mesh be used.

Sock and Sleeve Filters are used by producers milking with a pipeline. Both sock and sleeve filters are made with a folded sheet of milk filter fabric. The sock filter is closed at one end, while the sleeve type of filter is open at both ends. **Filter Disks** filter is used by producers who milk by hand or with buckets. They may be round or rectangular and don't provide a high filtration capacity. As a result, filter disks are not used as often as the other types.

Permanent Filters with Stainless Steel Mesh filter is designed to be used in the pipeline system. They are similar to disposable milk filters, but instead of being made of nonwoven fabric like disposable filters, permanent filters are made of stainless steel or plastic screens or mesh. Permanent milk filters are able to run continuously. Because of that, it's important that they are cleaned thoroughly and regularly to remove any trapped debris and maintains sanitary filtering conditions.

Milk filter may be classify based on applied pressure are pressure filtration, vacuum filtration and centrifugal filtration.

Plate and frame filter press (pressure filtration): In this type of filter grooved plates covered on both sides with filter medium alternate with frames in a rack. The assembly of plates and frames can be squeezed tightly together by a screw, hydraulic or pneumatic mechanism to form a liquid-tight unit. The filter medium also acts as a gasket, preventing leakage between the plates and frames. Both plates and frames are provided with openings at one corner and when the press is closed these openings form a channel through which the feed slurry is introduced. In addition, the hollow centre of each frame is connected by an auxiliary channel to this feed channel. The feed slurry enters the frames and the cake builds up in the hollow centre of the frames. The filtrate passes through the medium and on to the grooved surface of the filter plates from where it is removed via an outlet channel in each plate. Filtration is continued until the flow of filtrate drops below a practical level or the pressure reaches an unacceptably high level, due to the cake packing tightly in the frames. After filtration, washing of the cake may be carried out by replacing the flow of feed slurry with wash liquid. However, more effective washing is obtained by the use of special wash plates. These are arranged in the press so that every second plate is a wash plate. During filtration these wash plates act as filter plates. During washing, the outlets from the wash plates are closed and the wash liquid introduced on to their surfaces through a special inlet channel. The flow path for both filtration and washing when wash plates are used. The cake is removed manually after opening the press.

It is simple in design and operation, compact, flexible and can be used to handle a wide variety of types of slurry. It is relatively cheap initially. On the other hand labour costs and filter cloth consumption are high and washing of the cake is not always efficient.

Rotary vacuum filter drum

Consists of a drum rotating in a tub of liquid to be filtered. The technique is well suited to slurries, and liquids with a high solid content, which could clog other forms of filter. The drum is pre-coated with a filter aid, typically of diatomaceous earth (DE) or Perlite. After pre-coat has been applied, the liquid to be filtered is sent to the tub below the drum. The drum rotates through the liquid and the vacuum sucks liquid and solids onto the drum pre-coat surface, the liquid portion is "sucked" by the vacuum through the filter media to the internal portion of the drum, and the filtrate pumped away. The solids adhere to the outside of the drum, which then passes a knife, cutting off the solids and a small portion of the filter media to reveal a fresh media surface that will enter the liquid as the drum rotates. In vacuum filters, the pressure drop is limited to less than 100 kPa.

Centrifugal filter

Centrifugal filter is basically a basket with perforated wall rotated by a shaft connected centrally. The inner wall is wrapped with filtering medium. When basket is rotated, slurry is forced to move towards the wall. The filtrate thus comes out from the perforated wall and collected in an outer basket. The rate of filtration depends on the centrifugal force applied to slurry and the suspended solids. In food processing centrifugal separation is mostly adopted for separation of sugar crystals from the mother liquor. Since, no pump is required here, the operation cost is less compared to plate and frame filter press. The knife advances automatically as the surface is removed.

Pretreatment of milk before filtration

The milk is pre-heated to about 35-40°C for efficient filtration. As the temperature of the milk increases, the viscosity of milk decreases resulting in more efficient filtration.

The practice of straining milk was introduced to remove some of the large particles of foreign material such as straw, hair, insects, grass, dirt, flies, etc., so that the visible sediment in milk might be reduced. The straining in the ordinary sense is accomplished on the dairy farm by means of pieces of cloth, cotton, wire gauge or specially prepared strainers/strainer pads.

Important features of a filter

A filter cloth or pad of the desired pore size is used that can retain the smallest particle. Frame to compress and hold the margins of pad, so that milk can pass through pores. Perforated metal support for the pad which will not tear under the pressure of milk. An enclosure to confine both the filtered and unfiltered milk in closed system fitted suitably with inlet and outlet connections for sanitary piping.

Raw milk filtration

Raw milk is filtered using a pump that forces it across the porous surface of a filter. The pressure on either side of the filter is different, which forces any particles that are smaller than the pore size of the filter to pass through. These particles might include water, fat, protein, minerals, bacteria, somatic cells, and other tiny elements. Larger particles, like flakes, straw, hair, insects, or clots, are not able to pass through, so they are prevented from passing into the bulk tank. The filters that are used in milk filtration are most commonly in-line filters that may be made of different types of fiber, paper, or cloth that are fitted over a perforated metal support inside a cylindrical tube. When in-line filters are used, the milk should be filtered before it’s cooled. This allows more sediment to be removed and protects the cooling plates from becoming damaged later.

Filter used in RMRD and Processing Section

For cold filtration, an in-line filter may be installed in the milk receiving line between the raw milk dump tank, unloading pump and chiller or raw milk storage tank. Warm milk filters may be installed in the pasteurization circuit. In order to achieve the desired filtration effect, the filter material must have pores of 25 - 100 µ. The smaller the pores, the greater are the separation effect and filtration time. For a filtration installation with a flow of 10,000 L/h, we can assume 1 - 2 h time with pores size of 45 µ and pores size of 100 µ up to 10 h. changing of filter after every 6 h of operation is recommended.

The filter consists of stainless steel body wherein a filter with a small pore nylon cloth is placed and closed with a tight fitting lid. Milk passes from the top to bottom. After 3 - 4 h of operation, the filter bag must be cleaned. For a continuous process, a double filter must be installed. This would enable cleaning of one filter while the other is being used. The flow of milk when using such type of filter can be up to 15000 L/h.

Benefits of Filtration in the Dairy Industry

Proper filtration is essential in the dairy industry to ensure the highest quality milk makes. It not only ensures a superior product, but milk filtration can also help identify health concerns in cattle, which can greatly help dairy farms act promptly for the benefit of their animals and their bottom line. Effective filtration is also beneficial because it will help save money on milking equipment by protecting it from harmful particulates.

Application of filtration is dairy industry

- ✓ Filtration of raw milk at dump tank, either at milk collection centre or at chilling centres.
- ✓ During processing, while passing through pasteurizer.
- ✓ Reconstitution of milk powder.
- ✓ Removal of ghee residues from ghee.
- ✓ Separation of whey during cheese manufacture.
- ✓ Separation of whey during preparation of Channa.

Conclusion

Filters play an important role in dairy industry. Filtration of milk is carried out to remove foreign matter from the milk to improve the aesthetic quality of milk. Common disposable milk filters include sock and sleeve filters and filter disks. Permanent filters with stainless steel mesh be used. Milk filter may be classify based on applied pressure are pressure filtration, vacuum filtration and centrifugal filtration. Effective filtration is also beneficial because it will help save money on milking equipment by protecting it from harmful particulates.

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INSECT PESTS OF SESAME AND IT'S MANAGEMENT PRACTICES

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Abstract

Sesame (*Sesamum indicum* L.) is an annual plant that belongs to the *Pedaliaceae* family. It is one of the world's oldest oil seed crop grown mainly for its oil-rich seeds. Although the order of leading sesame producing countries is changing from time to time, The top producers of sesame seeds are mainly Tanzania, Myanmar, India, China and Japan. Of the total world production of sesame, the top 5 countries account over 64.3%, while its production is challenged by insect infestations and inappropriate agronomic practices. Among them, the most important aspect insect pest management is discussed below.

Leaf roller/ capsule borer (*Antigastra catalaunalis* Duponchel):

High relative and minimum temperature influences the pest attack to the crop. Sesame leaf webber and capsule borer is a regular pest of sesame and feed all parts of sesame, except the roots. The larva starts attacking sesame plants from seedling stage when the crop is 10 to 15 days old. In early stage of plant growth the caterpillar roll together a few top leaves and feed inside. In very early stages of plant growth, the infested plant die without producing any branch and the infested plants fail to grow further. In the flowering stage of the crop the larvae bore in to the flower bud and flowers are also often webbed. The infested buds and flowers fail to produce capsule and drop off. The caterpillars also bore in to the capsules and feed on developing seeds.

Damaged Plants Due to Leaf Webber and Capsule Borer

Management practices

- Collect and destroy the larvae from the leaf webs during the initial stages of plant growth.
- Erect bird perches @ 40-50/ha to facilitate predation of larvae.
- Spray neem seed kernels extract (NSKE) 5% or neem oil @ 5 ml/l or Chlorpyriphos 2.5 ml/l or chlorantraniliprole 18.5SC @ 0.4 ml/l

1. Gall Fly (*Asphondylia sesami*)

The incidence of this insect pest is noticed from September to November and coincides with flowering to capsule formation stage of the crop. The female fly lays their eggs in the ovaries of the flowers and the gall begins to develop before the petals wither or become twisted and stunted and do not develop into flowers or capsules. The irritation caused by the feeding of the larvae resulting in the flower abortion or developing abnormal/malformed gall. The infested buds wither and fall on the ground.

Adult of Gall Fly **Affected Capsule** **Pupa of Gall Fly**

Management practices

- The infested buds should be removed and destroyed to reduce further incidence of the pest
- Spraying of Acephate 1.5 gr/li of water

2. Hairy caterpillar

Two hairy caterpillars *viz*., *Spilosoma obliqua* walk and *Amsacta moorei* Butt. have been reported to damage the sesame crop. The incidence of these hairy caterpillars takes place at the onset of monsoon and they are active from July to October. The newly hatched larvae remain in congregation for few days, mostly on leaves and defoliate the plants leaving the papery white skeletonised leaf. Mature caterpillars migrate to other plants and feed voraciously leaving only the stem. The attacked plants become weak and consequently less number of capsules are formed.

Larvae of Bihar Hairy Caterpillar **Damaged Leaves**

Management practices

- Collect and destroy infested plant parts, egg masses and young larvae during gregarious phase.
- Erect bird perches @ 40-50/ha to facilitate predation of larvae.
- Install one light trap per hectare to catch the adults.
- Neem seed kernels extract (NSKE) 5% or Chlorpyriphos 2.5 ml/l or Acephate 75SP @ 1.5 g/l

3. Leaf Hoppers (*Orosius albicinctus* Dist.)

Leaf hopper is a serious pest of sesame and is known to transmit phyllody disease.

Infestation of the pest lead to curling of leaf edges, leaves turn red or brown and then dries up and drop. The jassid or leafhopper is a serious pest of sesame and is known to transmit phyllody disease. The pest remains active from vegetative to capsule stage.


Leaf Hopper **Phyllody Affected Plant**

Management practices

- Seed treatment with Imidacloprid 70WS @ 5 g/kg or thiamethoxam 25WG @ 5 g/kg seed.
- Spray neem seed kernels extract (NSKE) 5% or oxydemeton methyl 25EC @ 1.5ml/li.

4. Aphids

The infestation starts from 25 days after sowing. Nymphs and adults suck the sap from under surface of leaves which results in Crinkling and curling of leaves. Leaves appear shiny and sticky due to honeydew excreted by the insects. Later sooty mold grows on honey dew and leaves have a black coating.


Management practices

- Seed treatment with Imidacloprid 70WS @ 5 g/kg or thiamethoxam 25WG @ 5 g/kg seed.
- Spray Acephate 1.5 gr/l or Imidacloprid 0.3 ml/l

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SIGNIFICANCE OF SEASONAL ANNUALS IN ORNAMENTAL GARDENING

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Abstract

Annuals provide a beautiful display of colours in the garden. They enhance the decorative value of a garden within a short span of time and bring a change in the look of the garden with change in the season and keep gardeners busy in raising them throughout the year. Annuals are grown for various purposes and situations in ornamental gardening like; for cut flowers, as dried flowers, in containers, hanging baskets, window boxes, bedding plants, ground covers and as screen. They are classified into different categories based on their season of planting, hardiness, size, colour, utility and day length etc.

Keywords: annuals, season, bedding plants, utility, daylength

Introduction

Annuals also known as seasonal flowers are the group of herbaceous plants which grow from seeds, produce flowers, set seeds and complete their life cycle within one year or one season. They provide a beautiful display of colours in the garden. Whether it is a small home garden or a big public garden, it is incomplete without beds of annual flowers. They enhance the decorative value of a garden within a short span of time and bring a change in the look of the garden with change in the season and keep gardeners busy in raising them throughout the year.

Advantages

- They are versatile and easy to grow
- They exhibit a good show of blooms and provide variety of colour to the garden/
- Annuals are suitable for many purposes like bedding plants, pots, edges, cut flowers, hanging basket, etc.
- These are profuse flowering plants suitable for different climatic conditions and for different seasons.
- Cover a place within a short span of time and provides continuous blooms
- Production of large number of seeds
- Fill voids in permanent plantings while young woody plants grow
- They provide inexpensive colour and cut flowers in almost any soil
- Varied growth habit, form, flower-colour, size, shape and season of flowering
- Bring change in the outlook of the garden with the changing season

Annuals are generally classified into three broad groups according to their growing season or climatic requirements

Summer Season Annuals

These annuals grow at higher temperatures. Sowing of seeds should be done from the last week of March and at the end of the March or in the beginning of April, the seedlings are transplanted in beds or pots. The common summer annuals are: Coreopsis, Portulaca, Gaillardia, Zinnia, Kochia, Tithonia, Sunflower, Gazania etc.



Coreopsis *Gaillardia* *Portulaca*



Tithonia *Zinnia* *Kochia*

Rainy Season Annuals

These annuals grow at high humidity and rainfall. The seeds of rainy season annuals are sown during May- June and transplanted during June-July. The common rainy season annuals are: Amaranthus, Celosia, Gomphrena, Balsam, Torenia etc.



Amaranthus *Balsam* *Gomphrena*


Torenia *Celosa*

Winter season Annuals

Majority of the annuals are cultivated in winter months in plains. These are able to tolerate relatively low temperature and provide beautiful display of colours in the garden. Most of these annuals have been introduced by the British in India. These annuals should be sown during September and transplanted during October. The important winter annuals are Petunia, Pansy, Phlox, Annual Chrysanthemum, Sweet Sultan, Sweet Pea, Stock, Hollyhock, Salvia, Calendula, Dahlia, Marigold etc.

Petunia

Pansy

Phlox

Annuals can also be classified into other categories based on their colour, day length, hardiness etc.

Based on Day Length: the annuals can be classified based on the requirement of sunlight for the flowering as short day, long day, day neutral and intermediate annuals.

Salvia

1. Short day annuals: Cosmos, Salvia, Amaranthus
2. Long day annuals: Antirrhinum, Petunia, Carnation
3. Day Neutral annuals: Balsam, Gomphrena
4. Intermediate annuals: Ornamental Coleus

Based on colour: these can be classified as white, yellow, red, pink, blue, orange etc.

1. White coloured annuals: Allysum, China Aster, Phlox, Stock
2. Yellow coloured annuals: Marigold, Zinnia, Coreopsis
3. Pink coloured annuals: Sweet Allysum, Acroclinium, Candytuft
4. Orange coloured annuals: Pot Marigold, Zinnia, Helichrysum

5. Blue coloured annuals: Corn Flower, Larkspur, Ageratum, Linaria

Based on Hardiness: these can be classified as hardy, half -hardy and tender annuals

1. Hardy annuals: Hardy annuals are the most tolerant of all the types of annuals. The term hardy, as it applies to plants, refers strictly to the ability to withstand cold. Hardy annuals might be planted in early spring or in the fall allowing them to bloom again the following spring. Examples: Pansy and *Viola tricolor*
2. Half- hardy annuals: half- hardy annuals will tolerate periods of damp or cold weather but may be damaged or killed by frost. Along with the hardy annuals, these are the plants that we typically think of as spring annuals. Examples: Calendula and Nasturtiums
3. Tender annuals: tender annuals need warm soil temperatures and should only be planted after all danger of frost has passed. Examples: Celosia, Zinnia and Petunia

Viola tricolor

Nasturtium

Zinnia

Utilities of Annuals

Annuals are a versatile group that can cater to diverse requirements and situation in landscape gardening such as growing in beds, pots, hanging baskets and for cut flowers or loose flowers. Annuals suitable for specific use are:

1. For Bedding: Pansy, Phlox, Candytuft, Balsam, Zinnia, Gomphrena, Sweet William, Carnation, Sweet Sultan, Gaillardia, Marigold, Dahlia, Portulaca, Stock, Cosmos, Salvia, Petunia, Calendula and Antirrhinum
2. For Hanging Basket: Nasturtium, Portulaca, Verbena, Phlox, Petunia Etc.
3. For Pots: Annual Carnation, Balsam, Marigold, Stock, Salvia, Calendula Etc
4. For Climbers: Sweet Pea, Nasturtium and Morning Glory
5. For Rock Garden: Nasturtium, Verbena, Phlox
6. For Decorative Screening: Sweet Pea, Holly Hock, And Helichrysum
7. For Shady Situations: Salvia, Cineraria
8. For Loose Flower: Seasonal Chrysanthemum, Marigold, Aster, Gaillardia, Zinnia, Gomphrena
9. For Cut Flower: Sweet William, Sweet Sultan, Carnation, Antirrhinum, Larkspur and Lupin
10. As Green Filler: Bells of Ireland, Gypsophilla, Celosia, Amaranthus and Kochia
11. For Garlands: Marigold, Gaillardia, Chrysanthemum and Gomphrena
12. For Fragrance: Carnation, Alyssum, Phlox, Stock, Sweet William, Sweet Sultan



  

  

Conclusion

Annuals are very easy to grow, flower profusely in a short time in numerous shades of colour in different seasons. They have large number of species and many varieties which not only show variations in height and growth habit but also in the shape, size and colour of flowers. Seasonal annuals as an important group of flowering plants play a wide role in ornamental gardening *viz*., garden decoration, cut flowers and potted plants etc.

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HYDROPONICS: AN OVERVIEW

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Abstract

A soilless technique for growing plants, hydroponics uses nutrient-rich water solutions to supply vital minerals straight to the roots of the plants. Compared to conventional soil-based techniques, this novel approach to agriculture has a number of benefits, such as exact control over pH, water content, and nutrient levels, which promotes ideal plant growth. Plants grown in hydroponic systems are usually grown on inert media such as perlite, coconut coir, or rock wool, which offer them effortless access to nutrient solutions and physical support. This method enhances resource efficiency by minimizing water usage and eliminating soil-related issues such as pests and diseases. Hydroponics enables year-round cultivation, making it particularly suitable for urban farming and regions with challenging climates. The technology has gained popularity for its potential to increase crop yields, reduce environmental impact, and contribute to sustainable food production practices.

Introduction:

Photosynthesis is the important process needed for the plant growth and development. It is the process by which green plants and some other organisms use sunlight to synthesize nutrients from carbon dioxide (CO_2) and water. Photosynthesis in plants generally involves the green pigment, chlorophyll generates oxygen as a by-product.

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Thus, it shows that, plant is getting sunlight and CO_2 from atmosphere. Soil is providing minerals and water to the plant. Thus, it is possible to replace soil media by other alternative to provide mineral and nutrient which further lead to the development of soilless culture.

Hydroponics is the art of growing plants without soil, but in water enriched with nutrients and oxygen with or without the use of artificial media. It has been recognized as a viable method of producing vegetables, herbs, flowers, foliage plants.

History of hydroponic cultivation:

The word hydroponics comes from two Greek words 'hydro' meaning water and 'ponos' meaning labor- water working. This word was first used in 1929 by Dr. Gericke, a California professor who began to develop what previously had been a laboratory technique into a commercial means of growing plants. Hydroponics has a long history from ancient civilzation to present greenhouse cultivation. The U.S. Army used hydroponic culture to grow fresh food for troops stationed on infertile Pacific islands during World War II. By the 1950s, there were viable commercial farms in America, Europe, Africa and Asia. Ancient city of Babylon- hanging gardens (7 wonders of ancient world) and Gardens of the Aztecs of central America were the examples for the usage of hydroponic technique in ancient times.

Status of hydroponic cultivation:

Commercial hydroponics is a successful and rapidly expanding industry. In the early 1990s there were around 5000 hectares of commercial hydroponic production worldwide. now it is estimated to be more than 50-60,000 hectares are producing hydroponic crops. This strong growth in global commercial production is expected to continue over the next few years. Majority of hydroponic crops are grown in greenhouses. The major producer of commercial hydroponic crops in the 21st century is the Netherlands. Production is focused in affluent countries such as the Netherlands, Spain, Canada, Japan, UK, US, New Zealand and Australia, and also to countries that have access to these markets such as Mexico and China. Other major producers are Spain, Canada and France. Indian hydroponic market is growing at a rate of 13.53 % whereas north America which is being the largest market growing at a rate of 35.78 %.

Hydroponic Growing Systems:

<u>Liquid system</u>- No supporting medium for the plant roots

<u>Aggregate system</u>- Have a solid medium of support.

<u>Open</u> - Once the nutrient solution is delivered to the plant roots, it is not reused

Closed - surplus solution is recovered, replenished, and recycled

Hydroponic techniques:

1. Wick system:

The simplest type of hydroponic system. It is passive, with no moving parts. The nutrient solution is drawn into the growing medium from the reservoir with a wick. The grower using this system can use a variety of growing media: perlite, vermiculite, coconut fibre. However large plants tend to draw and use the nutrient water at a faster rate than the wick can supply it.

2. Drip systems:

These are simple to operate and very widely used. A submersed pump is controlled by a timer: when the timer turns on the nutrient solution drips onto the base of each plant using a drip line. There are two types of drip systems:

a) Recovery system is where the excess (drained off) nutrient solution is recovered in a reservoir and then recycled. It has less precise timer and ccareful monitoring and adjustment of varying pH and concentration due to the recycling process is needed

b) Non-recovery system does not collect or recycle the excess nutrient solution. It needs to be more precise to ensure that the plant gets the correct level of nutrient solution and that the runoff is kept to a minimum. Nutrient solution is not recycled so pH and nutrient levels should always be correct

3. Nutrient film technique:

Here, a very shallow continuous stream of water containing all the dissolved nutrients (nutrient film) required for plant growth is re-circulated past the roots of plants in channels. Roots develop at bottom of channel allowing for an abundant supply of oxygen to the roots. As general guide the flow rate is 1 - 2 L/min with channel length of 10-15 m. The nutrient solution is pumped into the growing tray using a tube it flows over the roots of the plants, and then drains back into the reservoir. This is an inexpensive method as it does not require the expense of replacing the growing medium for each successive crop. Roots dry out rapidly however during power outages or equipment failure when the supply nutrient solution is interrupted.

4. Deep water culture (deep flow)/Bucket or tub culture:

It is suitable for big size plants**.** It is the simplest active system to use. A platform floating on the nutrient solution holds the plants. An air pump supplies air to the air stone that bubbles the nutrient solution and supplies oxygen to the roots of the plants**.** Water culture is the system most often used for leafy vegetables such as lettuce that require fast growth and ample water. It is not suitable for most other plants that require a longer growing period.

5. Ebb and flow/ Flood and drain system:

It is recirculating cultivation system where water is not supplied continuously**.** Usually 50% less fertilizer concentration is used**.** This system floods the growing tray with the nutrient solution for a short period and then drains the solution back into the reservoir using a submerged pump and timer. The timer cuts in several times a day and as it cuts in the nutrient solution washes onto the tray, then as it cuts out the solution drains back into a reservoir. The frequency is dictated by the size and type of plants, temperature, humidity and the type of growing medium used. Several types of growing media such as perlite, rockwool, gravel or grow rocks can be used in this system.

6. Aeroponics:

The aeroponic system is probably the most high-tech type of hydroponic gardening. Here, the plants are suspended in the air having good supply of oxygen for disease free systems and can conduct good research on root morphology. It requires sophisticated mist systems. The root system is periodically (every few minutes) misted with the nutrient solution using a timer and nutrient pump on a short cycle for a few seconds at a time. Due to root exposure in this system the roots can dry out rapidly during power outages or equipment failure.

7. Aquaponics:

Aquaponics is a food production system that couples aquaculture (raising aquatic animals such as fish, crayfish, snails or prawns in tanks) with hydroponics (cultivating plants in water) whereby the nutrient-rich aquaculture water is fed to hydroponically grown plants. As existing hydroponic and aquaculture farming techniques form the basis of all aquaponic systems, the size, complexity, and types of foods grown in an aquaponic system can vary as much as any system found in either distinct farming discipline.

Crops suitable for hydroponics: Vegetables like tomato, chilli, brinjal, green bean, beat, winged bean, capsicum, cabbage, cauliflower, cucumber, radish, green onion, potato, etc. leafy vegetables like lettuce, spinach, celery and condiments like Parsley, mint coriander, etc. are most suitable for hydroponics

Containers and aggregates used in hydroponics:

a) Common containers used are: Pot, Slab, Trough and Bag

b) Popular aggregates/substrates used are: natural inorganic media *viz.*, sand, gravel, rockwool, perlite, vermiculite, pumice, zeolite and expanded clay. synthetic inorganic media used are foam mats, polystyrene foam, oasis, hydrogel, biostrate felt and organic media are sawdust, bark, wood chips, peat moss, coir and rice hulls

Merits:

- ✓ It can be used in places where in-ground agriculture or gardening is not possible (for example, dry desert areas or cold climate regions).
- ✓ More complete control of nutrient content, pH and growing environment.
- ✓ Lower water and nutrient costs associated with water and nutrient recycling.
- ✓ Faster growth due to more available oxygen in root area.
- ✓ Elimination or reduction of soil related insects, fungi and bacteria.
- ✓ Much higher crop yields.
- ✓ No weeding or cultivation required.
- ✓ Largely eliminate the use of labour for traditional agricultural practices

Demerits:

- Initial and operational costs are higher than soil culture.
- Skill and knowledge are needed to operate properly.
- Introduced soil-borne diseases and nematodes may be spread quickly to all beds on the same nutrient tank of a closed system.
- The grower must observe the plants every day.

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ASSESSING THE GROUND: A COMPREHENSIVE EXAMINATION OF AGRICULTURAL POLICY

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Abstract

Evaluating the impact and effectiveness of agricultural policies is essential for understanding and managing the intricacies of contemporary agricultural systems. This study provides a comprehensive examination of several monitoring and evaluation methodologies used to examine agricultural policies on a global scale. This text explores the approaches, problems, and changing paradigms that are crucial for conducting a thorough evaluation of policy initiatives. The review covers a wide range of evaluation frameworks, including quantitative and qualitative methodologies, impact assessments, and performance indicators. This text explores the incorporation of socio-economic, environmental, and technological aspects, acknowledging the need for a comprehensive approach to assessing policies in agriculture. The importance of stakeholder interaction is emphasised, promoting participatory methods to improve inclusiveness and openness in evaluation procedures. The study emphasises the importance of including several stakeholders in order to provide thorough assessments that align policies with the requirements of society. The text discusses the difficulties that arise when evaluating policies, such as a lack of data and biases in measurement. This highlights the importance of using adaptable assessment frameworks. Furthermore, the research highlights the significance of making decisions based on solid facts and employing flexible management practices to effectively address ever-changing global issues like climate change and limited resources. This review examines innovative tools and approaches that are now influencing agricultural policy assessments, drawing on worldwide case studies and best practices. The statement highlights the ongoing improvement of assessment methods, involvement of stakeholders, and incorporation of

various viewpoints as crucial in guaranteeing that policies are in line with sustainable development objectives. This study proposes an approach to evaluating agricultural policy that is flexible and sensitive to different circumstances. It emphasises the need for ongoing development of methods and strategies to effectively tackle the complex difficulties encountered by agricultural systems worldwide.

Keywords: Evaluation frameworks, Impact assessments, Performance indicator, Stakeholders, Sustainable development

Introduction

Agriculture has a fundamental role in human civilization, by supplying food, ensuring economic stability, and generating employment opportunities for billions of people worldwide. Agricultural policies have a crucial impact on the sector, influencing various aspects such as food security, rural development, and environmental sustainability. In order to ensure that these policies effectively achieve their intended objectives, it is essential to implement strong monitoring and evaluation (M&E) techniques. This article thoroughly examines agricultural policy monitoring and evaluation (M&E) strategies, including their importance, main elements, difficulties, and creative methods to enhance their effectiveness.

Importance of Agricultural Policy Monitoring and Evaluation

Agricultural policies are developed to tackle complex concerns, such as guaranteeing food security, encouraging sustainable practices, bolstering rural livelihoods, and boosting economic growth. M&E strategies serve as essential instruments for evaluating the effectiveness and influence of these initiatives. Through the systematic collection of data and analysis of results, policymakers may assess the effectiveness, pinpoint deficiencies, and make well-informed modifications, ultimately guiding agricultural sectors towards improved production and resilience.

Essential Elements of Monitoring and Evaluation Strategies in Agriculture

Clear Objectives and Indicators:

Establishing unambiguous objectives and indicators that are quantifiable and in line with policy aims is essential. By establishing pertinent indicators, it becomes possible to measure progress and assess the effects, so facilitating decision-making based on evidence.

Data Collection and Analysis:

The foundation of monitoring and evaluation (M&E) is in the use of reliable data collection methods such as surveys, remote sensing, and participatory approaches. Advanced analytics and modelling approaches facilitate the processing of this data to extract meaningful insights.

Stakeholder Engagement:

Engaging stakeholders at different phases promotes inclusiveness and guarantees the inclusion of multiple viewpoints. Farmer groups, non-governmental organisations (NGOs), governments, and commercial sector entities provide extremely useful information during the review process.

Impact Assessment:

Conducting an impact assessment is essential for evaluating the real effects of policies on various aspects of agriculture, including productivity, income distribution, environmental sustainability, and social equality. This entails conducting both quantitative and qualitative assessments.

Adaptive management:

It is crucial, since it allows for the necessary flexibility in policy modification based on monitoring and evaluation findings. Continuous monitoring facilitates prompt revisions, ensuring that policies stay adaptable to emerging challenges.

Challenges in Agricultural Policy Monitoring & Evaluation

Implementing effective monitoring and evaluation (M&E) strategies in agriculture is fraught with several problems, despite its considerable importance.

Data quality and availability:

In numerous regions, there is a scarcity or obsolescence of dependable agricultural data, impeding precise evaluations. Enhancing data collection systems and capabilities is crucial.

Complexity of Impact Measurement:

The assessment of the multiple implications of agricultural policy, particularly their long-term and indirect effects, presents challenges in measuring complexity. It is imperative to develop thorough frameworks for assessing impact.

Resource Constraints:

Insufficient financial resources and limited technical competence hinder the development of comprehensive monitoring and evaluation systems, especially in economically disadvantaged locations.

Temporal and Spatial Variability:

Agriculture's susceptibility to climatic, geographic, and seasonal fluctuations creates difficulties in obtaining consistent data across many contexts, due to temporal and spatial variability.

Policy Implementation Gaps:

Policy implementation gaps arise when there are discrepancies between the intended policies and their actual implementation on the ground. These gaps make it difficult to accurately evaluate the effectiveness of the policies. Enhancing the procedures for implementing policies is crucial.

Innovative Approaches to Enhance Monitoring & Evaluation Strategies

Addressing these challenges requires innovative approaches:

Technology Integration:

The utilisation of advanced technology, including as satellite images, IoT devices, and blockchain, improves the process of gathering data, monitoring, and ensuring transparency in agricultural systems.

Big Data and Analytics:

The utilisation of big data analytics allows for the analysis of immense quantities of data, extracting significant insights, and anticipating trends, hence revolutionising approaches in the field of media and entertainment.

Participatory M&E:

Engaging local communities and farmers in data collecting and evaluation procedures through participatory monitoring and evaluation (M&E) promotes ownership, improves data accuracy, and guarantees alignment with on-the-ground circumstances.

Policy coherence and integration:

It involve aligning agricultural policies with broader developmental targets, such as environmental sustainability and poverty alleviation. This ensures comprehensive evaluations and consistent actions.

Conclusion

A policy that is effective in agriculture the implementation of M&E methods is absolutely necessary in order to guarantee the effectiveness, longevity, and inclusiveness of agricultural systems all over the world. The ability of policymakers to make educated decisions and develop policies that encourage resilient, equitable, and successful agricultural sectors can be strengthened by overcoming problems and embracing creative ways. Additionally, these tactics can be strengthened by overcoming challenges. It is impossible to overestimate the significance of comprehensive monitoring and evaluation procedures in determining the future of agriculture as we navigate a world that is undergoing fast change.

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EXPLORING COST-EFFECTIVE TUNNELS: FIELD PREPARATION, TYPES, AND ECONOMIC ASSESSMENT

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Introduction:

The emergence of low-cost greenhouse tunnels signifies a transformative trend in modern agriculture, offering an economical solution for controlled crop cultivation. These structures, often fashioned from cost-efficient materials like PVC pipes and transparent plastic sheets, present a viable alternative to conventional greenhouses. Research by Smith et al. (2018) and Johnson and Brown (2020) emphasizes the diverse materials and structural designs utilized in these tunnels, showcasing their adaptability and affordability. Primarily designed to regulate environmental conditions, these tunnels provide a protective environment for crops, fostering growth and shielding plants from harsh weather elements. Studies by Garcia et al. (2019) and Patel (2021) delve into the economic viability of such tunnels, highlighting their potential to enhance yields while maintaining cost efficiency, particularly benefiting small-scale farmers.

Describing plastic tunnels as greenhouse-like structures covering rows of plants, these tunnels stand at approximately 1.0 meter in height and 1.5 meters in width at the base. Erected using bamboo sticks or wooden poles of about 1-inch diameter, a transparent plastic sheet is carefully positioned atop the bamboo framework. This strategic placement allows sunlight to penetrate the sheet during the day, facilitating soil absorption and elevating temperatures to optimal levels. The plastic sheet serves a dual purpose: trapping heat to minimize water loss and safeguarding plants from adverse climatic conditions.

Field preparation:

Field preparation is an essential step in ensuring successful vegetable farming. To achieve this, the land should be carefully prepared to a fine tilth. Additionally, it is recommended to apply well-rotten FYM at a rate of 1.5-2.0 kg/m2 or vermicompost at a rate of 0.5-1.0 kg/m2. Neem cake should also be applied at a rate of 200 g/m² during the final land preparation. In case the soil is acidic, it is advisable to apply dolomite/lime at a rate of 200 g/m2. Lime should be applied at least 7-10 days before planting. It is important to mix the soil well with manures and bring it to a fine tilth before transplanting. Additionally, a raised bed of about 4-5 inches should be prepared. By following these guidelines, farmers can ensure optimal conditions for their crops and increase their chances of earning high profits by using recommended seeds and staying updated with market information.

Intercultural and Irrigation:

To maintain a weed-free crop, it is typically necessary to perform two to three hoeing and weeding sessions. In order to ensure uniform and continuous growth, vegetables require an adequate amount of moisture in the soil. Therefore, irrigation is carried out at regular intervals of 10-15 days, taking into consideration the prevailing weather conditions. Dry conditions can have a negative impact on the quality and yield of vegetables.

Types of Tunnels:

Based on height:

1. High tunnel - ranging from 9 to 12 feet
2. Walk-in tunnel - 6 feet in height
3. Low tunnel - 3 feet in height

Based on structure:

1. Tunnels made of plastic pipes
2. Bamboo tunnels

High tunnel:

High tunnels, which are more affordable compared to traditional greenhouses, provide simplified yet efficient structures for cultivating crops. These tunnels have a width of 20-30 ft and a length of 100-200 ft, with a height ranging from 9-12 ft at the center. They create ideal conditions for commercially growing horticultural crops such as cucumber, tomatoes, grapes, and bottle gourd. High tunnels greatly improve crop growth, yield, and quality, while also offering protection against environmental factors and pests. The larger high tunnels have the added advantage of retaining heat for a longer period during the night, ensuring a more consistent growing environment.

Walk in tunnel:

Walk-in tunnels, designed to create controlled environments, present ease of assembly and disassembly without the need for welding. These structures, assembled entirely using nut-bolts, offer labor-saving benefits and reduce disease control costs. They facilitate favorable conditions for growing crops like cucumber, tomatoes, broccoli, and lettuce, all while requiring less fertilizer and decreasing the chances of disease attacks.

Low Tunnel:

Low tunnels, crafted from flexible materials, serve as protective barriers for plants against cold winds, frosts, insects, heavy rain, and physical damage.

Fig. 1. Low cost tunnel

These tunnels, easily installed and ideal for early vegetable crop production, create a greenhouse effect on a smaller scale. They excel in retaining daytime solar heat and are particularly useful for seedling preparation. Suited for cultivating crops such as spinach, lettuce, and coriander, low tunnels offer increased daytime solar heating, aiding in heat retention and protection for the plants.

Economic Analysis:

1. Low tunnels distinguish themselves from high tunnels by being easily removable when not in use, exhibiting lower durability, and offering heightened portability. They present a significantly reduced investment compared to high tunnels.
2. Low tunnels efficiently conserve warmth, fostering a conducive climate for germination and early growth while providing protective measures against plant injury, ultimately enhancing crop quality.
3. The benefit-cost ratio was notably higher in low tunnels compared to greenhouses, emphasizing their cost-effectiveness and advantageous returns.

Table: 1 Economic Analysis of Low Cost Tunnel

Cost of construction (per 100 m^2)

Sl.No	Particulars	Quantity	Rate	Amount
1.	20 feet Bamboo poles	28 Nos	Rs. 240/Bamboo poles	Rs. 6720
2.	Plastic 120 (GSM)	9 kg	Rs. 120/Kg	Rs. 1080
3.	Binding wire	2.5 Kg	Rs. 100/Kg	Rs. 165
4.	Miscellaneous			Rs. 3000
Grand Total				**Rs. 10,965**

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APPLICATION OF NATURAL BIOENHANCERS IN THERAPEUTICS: A REVIEW

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Introduction

Bioenhancers, also known as bioavailability enhancers, are substances that improve the absorption and utilization of various compounds, particularly pharmaceutical drugs, and nutrients, in the human body (Singh *et.al*, 2021). These substances play a crucial role in enhancing the bioavailability of drugs or nutrients, which refers to the extent and rate at which a substance enters the bloodstream and becomes available for its intended action. The primary goal of bioenhancers is to overcome challenges related to poor solubility, low permeability, and rapid metabolism that can limit the effectiveness of certain drugs and nutrients (Ara *et.al*, 2021). By enhancing bioavailability, bioenhancers can increase the therapeutic or nutritional efficacy of a substance, allowing for lower doses, reduced side effects, and overall improved effectiveness.

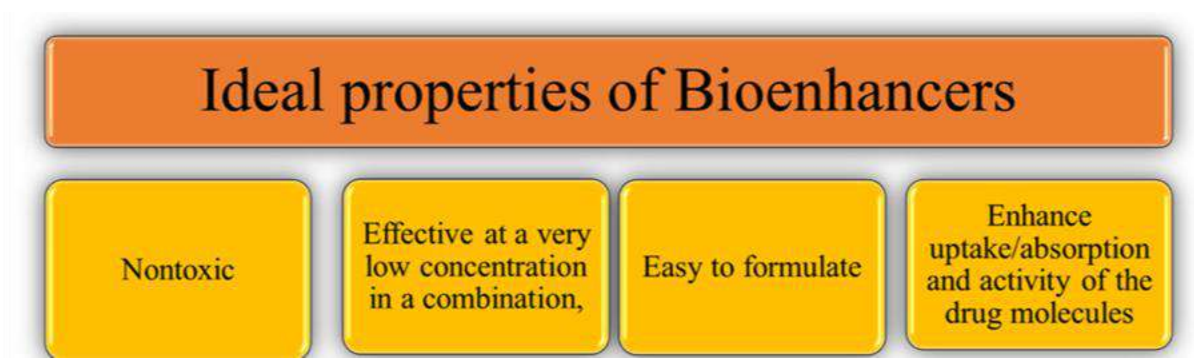


Fig 1: Ideal properties of bioenhancers

Bioenhancers can be natural or synthetic compounds and may act through various mechanisms, such as inhibiting metabolic enzymes, promoting better absorption in the gastrointestinal tract, or enhancing cellular uptake. They are employed in the production of pharmaceuticals, nutraceuticals, and functional foods to optimize the performance of active ingredients and ensure better outcomes for patients and consumers.

MECHANISM OF ACTION OF BIOENHANCERS

(Tatiraju 2013 & Yurdakok-Dikmen-2018)

- By enhancing the absorption of orally administered drugs from gastrointestinal tract by increase in blood supply.
- By modulating the active transporters located in various locations eg. P-glycoprotein (P-gp) is an efflux pump which pumps out drugs and prevent it from reaching the target site. Bioenhancers in such case act by inhibiting the P-gp.
- Cholagogues effect (promotion of bile into intestine) such as liquorice
- Decreasing the elimination process thereby extending the duration of action of drug.
- Decreasing the biotransformation of drugs by inhibiting the drug metabolizing enzymes especially microsomal enzymes like CYP 3A4, CYP1A1 and CYP1B2, CYP2E1 in the liver.
- Change in physicochemical properties of drugs (hydrophobicity, Pak, solubility).
- Modulating the drug target receptors.

CLASSIFICATION

Bioenhancers can be classified based on origin into two types i.e. plant based and animal based bioenhancers.

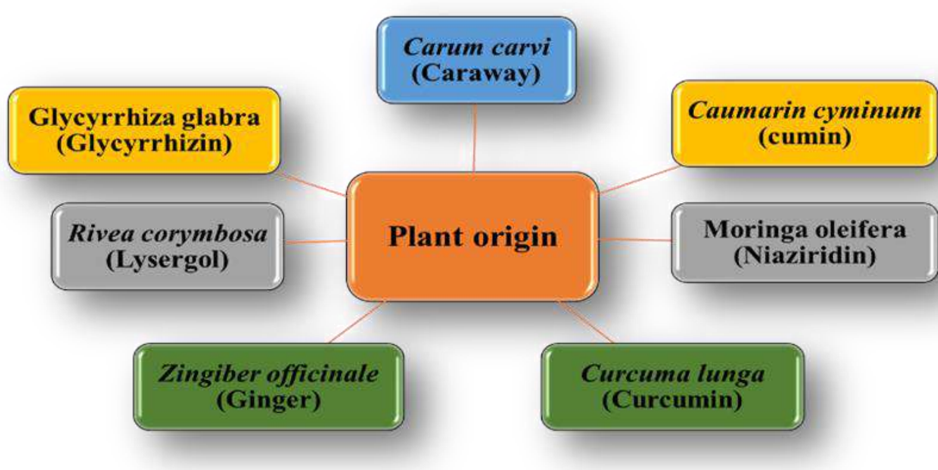


Fig 2: natural plant based bioenhancers

Plant based bioenhancers were described in the figure 2. Indigenous Cow urine distillate (Kamdhenu ark) is the only animal based bioenhancer. Bioenhancers can classify based on mechanism of action also (Singh A *et.al,* 2021)

Role of Bioenhancers in Reducing Antimicrobial Resistance (AMR)

Improved Drug Delivery:

Bioenhancers can enhance the bioavailability of antimicrobial drugs, ensuring that a higher proportion of the drug reaches its target site within the body. This optimization of drug delivery may allow for lower doses of antimicrobials to be effective, potentially reducing the selective pressure that drives the development of resistance (Dudhatra *et.al,* 2012).

Synergistic Effects:

Bioenhancers may exhibit synergistic effects when combined with antimicrobial agents. This means that their combined action may be more potent than the sum of their individual effects. Utilizing bioenhancers in conjunction with antimicrobial drugs could enhance the overall efficacy of the treatment, potentially reducing the likelihood of resistance emergence (Dudhatra *et.al,* 2012).

Combination Therapies:

Bioenhancers may enable the development of combination therapies where multiple agents work together to combat infections. Combining bioenhancers with existing antimicrobial drugs or developing novel combinations may offer new strategies to overcome resistance mechanisms.

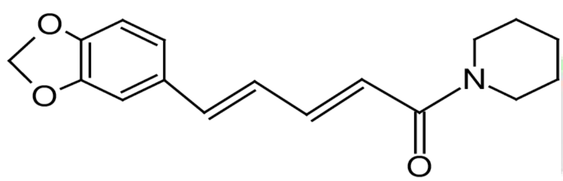
Alternative Approaches:

Bioenhancers derived from natural sources, such as certain plant compounds, might offer alternative or complementary approaches to traditional antimicrobial agents. This diversity in treatment options could help in managing resistance by providing different mechanisms of action.

Various Natural Bioenhancers

1. Piperine

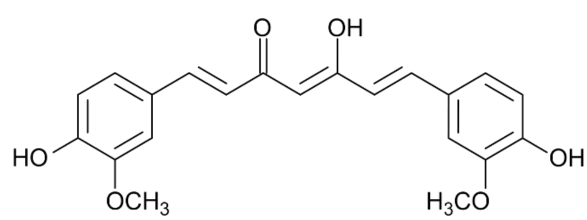
Piperine, an amide alkaloid presents in plants in the Piperaceae family such as *Piper longum* (long pepper) and *Piper nigrum* (black pepper), initially found application in human tuberculosis treatment. Piperine demonstrated its bioenhancing capability by significantly augmenting the bioavailability of rifampicin, showcasing an increase of approximately 60%. [Atal-2010]. In human medicine, it is permitted to use piperine with antitubercular drugs. Nevirapine's enhanced bioavailability was established when piperine was combined with it. Nevirapine is a strong non-nucleoside inhibitor of HIV-1 reverse transcriptase that is used along with other antiretroviral medicines to treat HIV-1 infection. Additionally, curcumin, the active ingredient in Curcuma longa, has a higher bioavailability thanks to piperine (turmeric). In humans, a 20 mg dose of piperine can boost curcumin's bioavailability by a factor of 20 (Tatiraju 2013 & Pebam *et.al*, 2022).



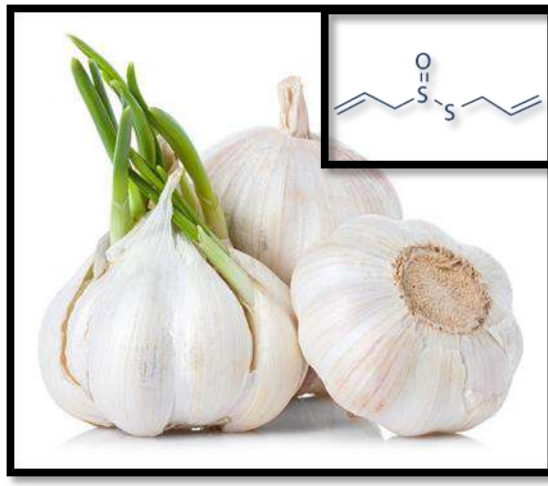
Piperine

2. Turmeric

Turmeric, scientifically known as Curcuma longa, is a widely used household remedy for diverse health issues. Within turmeric, the flavonoid curcumin plays a significant role by inhibiting drug-metabolizing enzymes such as CYP3A4 in the liver. Furthermore, curcumin has the ability to induce modifications in the P-glycoprotein drug transporter (P-gp). This dual action results in an enhanced bioavailability of drugs like celiprolol and midazolam in rats (Bahramsoltani *et.al*, 2017).



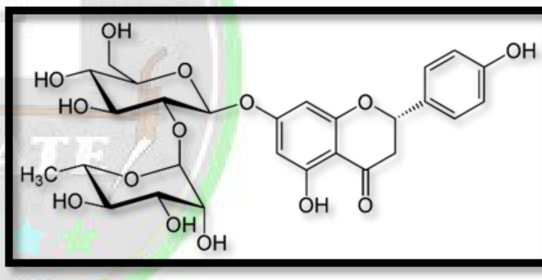
3. Allicin



Allicin is an allyl sulphur chemical that is derived from garlic (Allium sativum). Interestingly, allicin increases the fungicidal activity of Amphotericin B against pathogenic fungi, such as Aspergillus fumigatus, Candida albicans, and Saccharomyces cerevisiae yeast. Amphotericin B and allicin co-administration showed increased antifungal activity that was targeted particularly against S. cerevisiae (Dudhatra *et.al,* 2012).

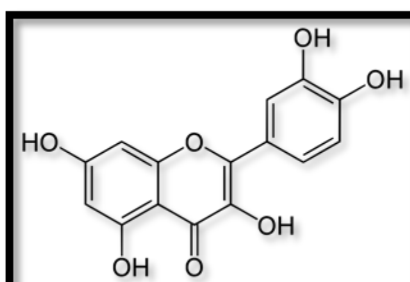
4. Naringin

Naringin is the main flavonoid glycoside present in different plants like, grapefruit, apples, onions, and tea. Pharmacological effects include blood cholesterol reduction, anti-ulcer, antioxidant, and anti-allergic properties. Naringin functions as a bioenhancer by inhibiting intestinal CYP3A4, CYP3A1, CYP3A2, and P-gp. In a dose-dependent manner, pretreatment with oral naringin intake increases the area under the curve for intravenous paclitaxel (Kheoane 2020).



5. Quercetin

Quercetin is a flavonoid that is present in citrus fruits and many plants as an aglycone form of several other flavonoid glycosides. It demonstrates antioxidant, anti-inflammatory, anti-atherosclerotic, and radical scavenging properties. It functions by CYP3A4 and P-gp efflux pump inhibition. Numerous medications, including paclitaxel, diltiazem, digoxin, verapamil, and etoposide, have been demonstrated to have increased blood levels, bioavailability, and efficacy when quercetin was present (Kheoane 2020).



Conclusion

To sum up, natural bioenhancers are a promising new development in nutrition and healthcare. Nonetheless, further investigation is necessary to determine their effectiveness, safety, and ideal application. When thinking about using natural bioenhancers, people should speak with medical professionals to make sure these supplements are appropriate for their particular needs and situations.

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NUTROGENOMICS AND ITS APPLICATION

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Introduction

Nutrigenomics, a relatively new scientific field, Nutrigenomics is the study of the effects of foods and food constituents on gene expression. It is about how our DNA is transcribed into mRNA and then to proteins and provides a basis for understanding the biological activity of food components.

Nutrigenomics has also been described by the influence of genetic variation on nutrition by correlating gene expression or single-nucleotide polymorphisms with a

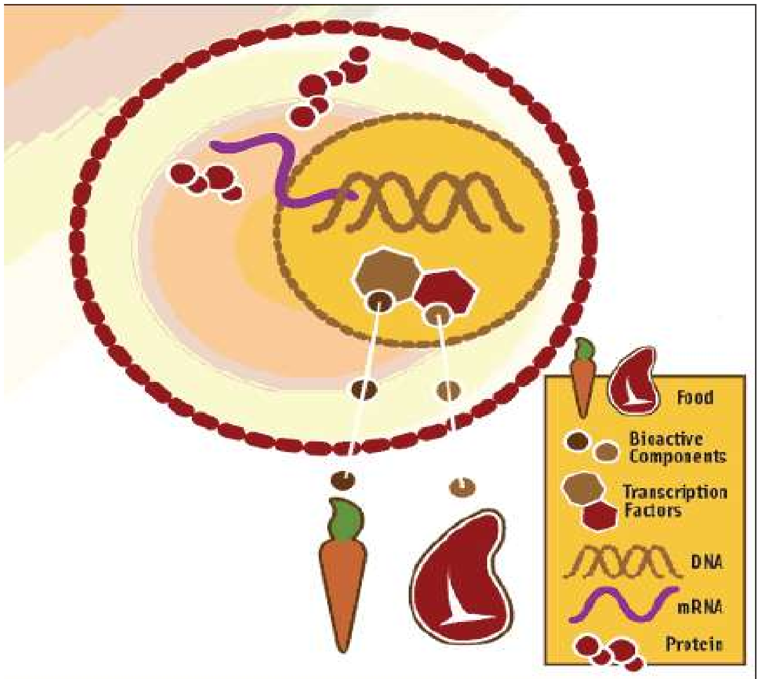
- ✓ nutrient's absorption,
- ✓ metabolism,
- ✓ elimination or biological effects.
- ✓ Nutrigenomics aims to develop rational means to optimise nutrition, with respect to the subject's genotype.

History

- ✓ Nutrient research shifted from epidemiology
- ✓ to genetics in past decade
- ✓ predispositions to diseases linked to diet
- ✓ Cardiovascular disease
- ✓ Cancers
- ✓ Diabetes Type II

How Do Nutrients Affect Genes?

Nutrients act as ligands and bind to transcription factors, resulting in the repression or activation of various genes



The working definition of nutrigenomics is that it seeks to provide a genetic and molecular understanding for how common dietary chemicals (i.e., nutrients) affect the balance between health and disease by altering the expression and/or structure of an individual's genetic makeup. Dietary chemicals include nutrients and bioactive chemicals that do not directly produce energy but exclude man-made chemicals such as pesticides.

Nutrient Gene Interaction

The importance of individual tissues in determining wholebody insulin resistance has not yet been fully resolved. Impaired responses to insulin in muscle, fat, and liver can be demonstrated in association with whole-body insulin resistance , and insulin resistance in these tissues has classically been considered to contribute to whole-body insulin resistance. On the other hand, recent studies suggested that insulin resistance in muscle and fat may not play a major role in causing whole-body insulin resistance. Furthermore, because plasma insulin levels increase to compensate for insulin resistance, plasma glucose levels are often normal in the presence of whole-body insulin resistance.

Although insulin resistance may be exactly compensated by hyperinsulinemia at the whole-body level, all responses to insulin may not be equally impaired. If some biosynthetic responses continue to be sensitive to insulin, the presence of hyperinsulinemia may actually produce a state of hyperstimulation. For example, it was proposed that obesity can lead to hypertension because the vasodilatory response to insulin is impaired, but the sodiumretaining effect of insulin is not impaired, thus leading to sodium retention due to hyperinsulinemia. Similarly, the maintenance of leptin sensitivity to insulin despite wholebody insulin resistance could explain the elevated expression of leptin (normalized to wet weight or per microgram RNA) observed in obesity because insulin stimulates leptin and insulin is elevated in insulin resistance .

However, it is unclear whether leptin sensitivity to insulin is normal in the presence of insulin resistance because insulin-induced phosphorylation of signaling proteins is impaired in the fat tissue of insulin-resistant animals . On the other hand, it is not clear whether impaired phosphorylation of signaling proteins necessarily implies impaired synthetic responses to insulin. To address the hypothesis that liver and adipose tissue might exhibit differential impairments in synthetic responses to insulin in the presence of whole-body insulin resistance, it was necessary to assess a synthetic response to insulin exhibited by both tissues. The immediate-early genes c-fos and jun-B have been used as markers of insulin and glucose stimulation in a variety of cell types in vivo and in vitro .

- Diet has long been regarded as a complex mixture of natural substances that supplies

both the energy and building blocks to develop and sustain the organism.

- nutrients have a variety of biological activities.
- Some nutrients have been found to act as radical scavengers known as antioxidants and as
- such are involved in protection against diseases.
- Other nutrients have shown to be potent signalling molecules and act as nutritional

hormones (Müller and Kersten, 2003).

- Some of the plant secondary metabolites also known as phytochemicals act as a

modulator of animal health and production.

Developing nutrigenomic foods

- ❖ The importance of nutrient–gene interactions is a new concept for the food industry and requires new ways of considering development of food.

- nutrigenomics-based foods (milk-based drinks, or cereal bars) might be developed, through a combination of food fractionation, testing in tissue culture models and validation through animal models .

This new branch of genomic and nutritional research can best be summarized with the following five tenets: and disease by altering the expression and/or structure of an individual's genetic makeup.

1.Common dietary chemicals and nutrients directly or indirectly act on the human genome to alter gene expression or structure.

2. Under certain circumstances and in some individuals, diet can be a serious risk factor for a number of diseases.

3. Some diet-regulated genes (and their normal, common variants) are susceptibility genes and likely to play a role in the onset, incidence, progression, and/or severity of chronic diseases, (multifactorial disorder: polygenic).

4. The degree to which diet influences the balance between healthy and disease states may depend on an individual's genetic makeup. (e.g.: efficient genetic polymorphism and nutrient metabolism)

5. Dietary intervention based on knowledge of nutritional requirement, nutrition status, and genotype (i.e., "individualized nutrition") can be used to prevent, mitigate, or cure chronic disease.

This new area of molecular nutrition that is, nutrient–gene interaction can unfold dichotomous directions.

key concepts that have emerged from epidemiologic, nutritional, molecular, and genetic experiments examining associations between genes and disease. The results and lessons from these different fields of research will affect the design, strategies, and approaches for nutritional genomic research and specifically for identifying diet-regulated and genotype- and diet-regulated genes involved in susceptibility, onset, incidence, progression, and/or severity of chronic diseases.

Nutrigenomics: core concepts

There is a dynamic, two-way interaction between nutrition and the human genome. As illustrated in Figure 1, this interaction determines gene expression and the metabolic response, which ultimately affects an individual's health status and/or predisposition to disease. Firstly, an individual's genetic background can determine nutrient status, metabolic response and predisposition to diet-related diseases . Secondly, nutrients can have a direct effect and interact with transcription factors to regulate gene expression. A number of transcription factors that are sensitive to nutrient and non-nutrient food components have been identified, some of which are detailed in Table 1 . Furthermore, it is becoming increasingly obvious that an individual's genetic background can also determine responsiveness to nutritional therapy and/or diet-related disease progression.

Nutrients Deficiency and DNA damage

Nutrients	DNA damage	Health effects
Folic acid	Chromosome break and hampers DNA repair	Colon cancer, heart disease, brain dysfunction
Vitamin B12	unknown	Same as folic acid, memory loss
Vitamin B6		Same as folic acid
Niacin	Hampers DNA repair	Nerve problem, memory loss
Vitamin	Mimics radiation damage	Cataract, cancer
Vitamin E	Mimics radiation damage	Colon cancer, heart disease, immune dysfunction
Vitamin D	Prevent gene variation	Colon , breast, prostate cancer
Zinc	Chromosome breaks	Brain and immune dysfunction

It is important to realize that nutrients, in contrast with specific pharmacological ligands, can have a number of direct and indirect effects on gene expression, as illustrated in Figure 2. For example, dietary fatty acids can interact with a number of transcription factors and have direct effects on gene expression, whereby they interact with a number of transcription factors and up- or down-regulate the expression of particular genes . In addition, metabolic fatty acid derivatives may mediate the effect of a dietary lipid intervention to alter gene expression. For example, eicosanoids, prostaglandins and leukotrienes are fatty acid derivatives of the cyclo-oxygenase and lipoxygenase metabolic pathways, whichmediate the effect of the primary fatty acid intervention on gene expression.

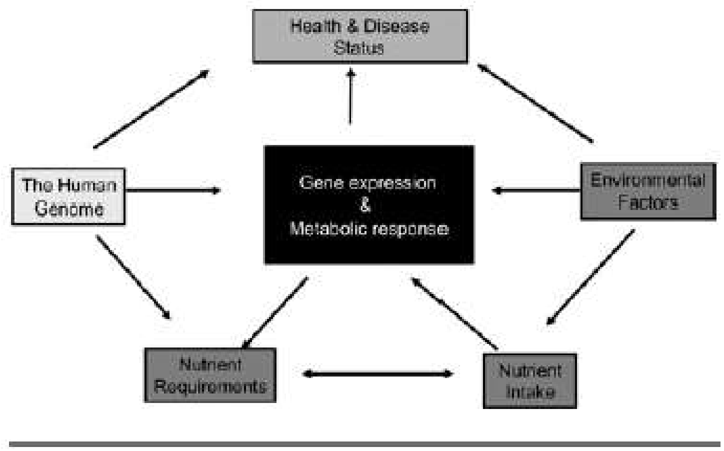


Fig. 1. Interaction between nutrition and human geneome

Furthermore, fatty acid derivatives may also alter cell signalling cascades which then alter gene transcription. For example, altering the induction of the lipid-derived second messenger diacylglycerol will affect activation of protein kinase C isoforms that mediate many cellular functions, including cell growth, activation, and differentiation . Therefore the effects of dietary lipids on gene expression that ultimately affect the cellular homoeostasis or dysregulation may represent direct and/or indirect transcriptional regulation.

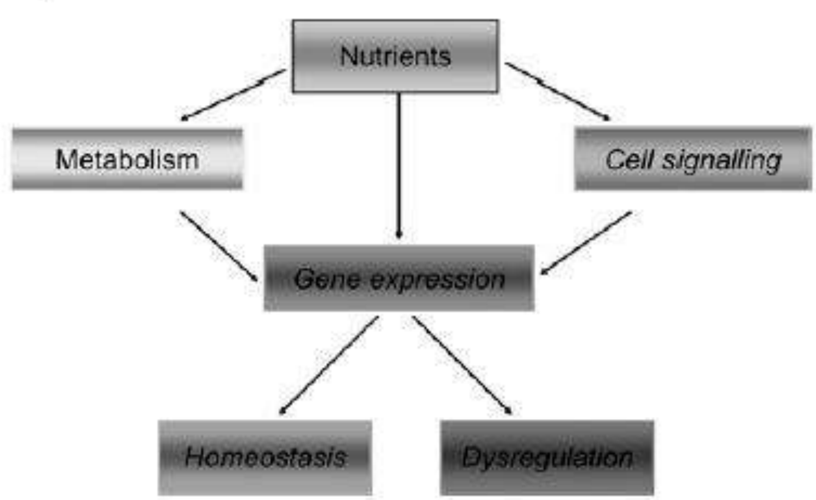


Figure 2 The direct and indirect effects of nutrients on gene expression

Application

- Its goal is to devise ‘genome-based nutritional interventions to prevent,
- delay, and treat diseases such asthma,
- obesity,
- Type 2 diabetes,
- cardiovascular disease, and
- prostate cancer.

How does Nutrigenomics manage Type-2 Diabetes?

Type-2 diabetes is a metabolic disorder associated with impaired carbohydrate, protein, and lipid metabolism. This is further linked to inactive lifestyle and consumption of 'wrong' foods.

- We know that certain foods that are high in sugar and white starches can make the symptoms of diabetes worse. However, people with diabetes will have different responses to particular foods because of their different genes.
- Nutrigenomics can come to aid through clinical diagnostics for phenotypes such as insulin level and glucose tolerance, as well as through metabolomic diagnostics in which diabetes biomarkers (biochemical substances viz.
- glucose,
- cholesterol, creatine, and fatty acids
- that indicate the susceptibility and progress of the disease) are assessed.
- Researches have shown that 'overexpression' of SREBP -1a
- SREBP -1c (t-RNAs that activate genes involved in the synthesis and uptake of cholesterol, fatty acids, and triglycerides) play an important role in the development of diabetes.
- Another research has suggested that presence of certain gut microbes increased fat reserves and insulin resistance, and thus may have an influence on the development of type-2 diabetes.
- certain fibers modulated cholesterol absorption in the gastrointestinal tract, thus playing an important role in defining nutrient bioavailability.

- This would help experts understand the complex relationship of diet-gene interaction of the diabetic person and provide more efficacious dietary recommendations.
- In the same way, nutrigenomics can also help in developing treatments for type-2 diabetes through personalized diet. And they have proven to be more effective than certain drugs.
- For example, the drug, rosiglitazone, commonly used by type-2 diabetics, is known to alter lipid metabolism in liver tissues and adipose tissues leading to liver toxicity with prolonged use.
- On the other hand, nutrients found in certain diets have the same metabolic pathway as the said drug, but without its side effects.

Developing nutrigenomic foods

- The importance of nutrient–gene interactions is a new concept for the food industry and requires new ways of considering development of food.
- nutrigenomics-based foods (milk-based drinks, or cereal bars) might be developed, through a combination of food fractionation, testing in tissue culture models and validation through animal models .

Application of dietary guidance

- Its goal is to devise 'genome-based nutritional interventions to prevent, delay, and treat diseases such asthma,
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- cardiovascular disease, and
- prostate cancer.

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GREEN HARVESTS: HOW CARBON FARMING AND CREDITS ARE DOUBLING FARMERS' INCOMES

Article ID: AG-VO4-I01-38

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Introduction

In the quest for sustainable agriculture and combating climate change, an innovative solution has emerged - carbon farming. This revolutionary approach not only nurtures the land but also offers a financial boon for farmers. By engaging in carbon farming practices and trading carbon credits, farmers around the world are witnessing a significant uptick in their incomes. In this article, we explore the symbiotic relationship between agriculture and environmental conservation, shedding light on how carbon farming and credits are reshaping the future of farming.

Carbon farming refers to a set of agricultural practices and land management techniques designed to sequester carbon dioxide from the atmosphere and mitigate climate change. The primary goal of carbon farming is to increase the capture and storage of carbon in vegetation, soils, and other agricultural ecosystems. This approach aims to enhance carbon sequestration, improve soil health, and promote sustainable agriculture while contributing to broader efforts to reduce greenhouse gas emissions.

Key components of carbon farming include:

1. **Agroforestry:** Integrating trees and shrubs into agricultural landscapes to enhance carbon sequestration and biodiversity.
2. **Cover Cropping:** Planting specific crops during non-growing seasons to protect the soil, reduce erosion, and increase organic matter, which contributes to carbon storage.
3. **Conservation Tillage:** Minimizing or eliminating traditional tillage methods to preserve

soil structure, reduce erosion, and prevent the release of carbon from the soil.

4. **Rotational Grazing:** Managing livestock in a way that mimics natural grazing patterns, promoting healthier soils and increased carbon sequestration.
5. **Improved Pasture Management:** Implementing practices such as managed rotational grazing and optimizing grazing intensity to enhance carbon storage in grasslands.
6. **Biochar Production:** Utilizing biochar, a form of charcoal produced from organic materials, as a soil amendment to enhance carbon storage and improve soil fertility.

The concept of carbon farming acknowledges the role of agriculture in both contributing to and mitigating climate change. By adopting these practices, farmers can not only reduce their carbon footprint but also potentially earn carbon credits by participating in carbon offset programs and markets. Carbon farming represents an innovative and sustainable approach to agriculture that aligns economic interests with environmental conservation.

Carbon Farming: Growing a Greener Future

1. Agroforestry - More than Just Crops:

Agroforestry, the integration of trees and crops, is a cornerstone of carbon farming. Farmers plant trees alongside traditional crops, not just for timber or fruits, but as powerful carbon sinks. These trees absorb carbon dioxide from the atmosphere, simultaneously fostering biodiversity and enhancing soil fertility.

2. Cover Cropping: A Blanket for the Earth:

Cover cropping during off-seasons provides multiple benefits. These strategically chosen crops protect the soil, reduce erosion, and promote water retention. As a bonus, cover crops sequester carbon, acting as a natural shield against climate change.

3. Conservation Tillage: Digging into Sustainable Practices:

Shifting away from traditional tillage methods, conservation tillage preserves soil structure and reduces carbon loss. This approach not only locks carbon in the ground but also minimizes the need for synthetic fertilizers, contributing to sustainable and cost-effective farming.

4. Rotational Grazing - A Win-Win for Livestock and Land:

Sustainable livestock management through rotational grazing mimics nature, benefitting both animals and the environment. By avoiding overgrazing and allowing grasslands to recover, farmers enhance soil health and increase carbon sequestration.

Carbon Credits: Turning Green Practices into Gold

1. Emission Reduction Projects: Tackling Livestock Emissions:

Farmers can earn carbon credits by implementing projects that reduce greenhouse gas emissions from livestock. Methods such as methane capture not only mitigate climate impact but also generate revenue.

2. Afforestation/Reforestation: Planting the Seeds of Change:

Transforming unused or degraded land into thriving forests isn't just an environmental win; it's a financial one too. Carbon credits from afforestation and reforestation projects reward farmers for contributing to global carbon sequestration efforts.

3. Soil Carbon Sequestration: Tilling for Tomorrow:

Practices that enhance soil health and carbon sequestration, like cover cropping and conservation tillage, can translate into carbon credits. Farmers are not just cultivating crops but actively enriching the earth, earning valuable credits in the process.

The Market Dynamics: Trading Carbon for Cash

1. Carbon Markets: A Platform for Progress:

Carbon markets provide a space for farmers to sell their carbon credits. Companies and organizations, aiming to offset their emissions, eagerly purchase these credits, creating a virtuous cycle of environmental stewardship and financial gain.

2. Government Support: Nurturing the Green Revolution:

Governments play a pivotal role in incentivizing carbon farming. Subsidies, grants, and tax credits encourage farmers to adopt sustainable practices, creating a supportive environment for the success of carbon farming initiatives.

Conclusion

As we navigate the challenges of climate change, carbon farming emerges as a beacon of hope for farmers worldwide. Beyond cultivating crops, farmers are now cultivating a sustainable future for themselves and the planet. With the right support, education, and policy frameworks, carbon farming and credits have the potential to not only double farmers' incomes but also create a legacy of environmental stewardship for generations to come. It's a win-win for farmers and the planet – a green revolution that's transforming fields into fertile grounds for prosperity.

“Growing Green, Growing Rich”

AgriGate- An International Multidisciplinary e-Magazine

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RECLAMATION OF ACID SOILS USING BY-PRODUCTS OBTAINED FROM DIFFERENT INDUSTRIES

Article ID: AG-VO4-I01-39

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Introduction

Soil is a dynamic system, in which continuous interaction between soil minerals, organic matter (OM) and microorganisms influence the physical, chemical and biological properties. Soil is a natural finite resource which sustains life on earth. India, the second most populous country in the world faces severe problems in agriculture. It is estimated that out of the 328.8 m ha of the total geographical area in India, 173.65 m ha are degraded, producing less than 20% of its potential yield (Govt. of India, 1990). The soils which possess characteristics that make them uneconomical for the cultivation of crops without adopting proper reclamation measures are known as problematic soils.

As per ICAR area under problem soils has been increased from 220 lakh hectare (2005) to 243 lakh hectares (2010), comprising of acid soils 179 lakh hectares, alkali soils-37 lakh hectares, saline soils-27 lakh hectare.

Types of problem soils

1. Physical problem soils

2. Chemical Problem soils
3. Biological Problem soils
4. Nutritional problem soils (as a result of above constraints)

1. Physical problem soils

a. Highly permeable soils:

b. Slow permeable soil:

c. Waterlogged soil:

d. Chalka soil

f. Shallow soil

2. Chemical problematic soils

A.SALT AFFECTED SOIL

1. Saline soil
2. Saline alkali soil
3. Alkali soils.
4. Degraded alkali soil

B. ACID SOIL

ACID SOIL

Soil with the dominance of free Hydrogen ions and Al ions and its various hydrated forms over OH ions ordinarily having pH below 6.5.

- Soil with the dominance of free H^+ ions and Al^{3+} ions and its various hydrated forms over OH ions.
- Having pH of <6.5
- Here precipitation exceeds the evapotranspiration and hence leaching is predominant, causing loss of bases from the soil.

Distribution of acidic soil in World and India

Acidic soils, often referred to as "acid soils" or "sour soils," are characterized by a low pH level (below 7) and high concentrations of hydrogen ions. These soils are not ideal for many crops and plants because they can affect nutrient availability and plant growth. The distribution of acidic soils varies around the world and within specific countries like India.

In India, out of 142 Mha of arable land, around 48 to 49 Mha is occupied by acid soils, of which 25 Mha show pH below 5.5 and 23 Mha have pH between 5.6 to 6.5

SOURCES OF SOIL ACIDITY:

In order to understand the soil acidification and its management , first we need to know where H^+ ion come from , how they enter the soil system and how they may be lost

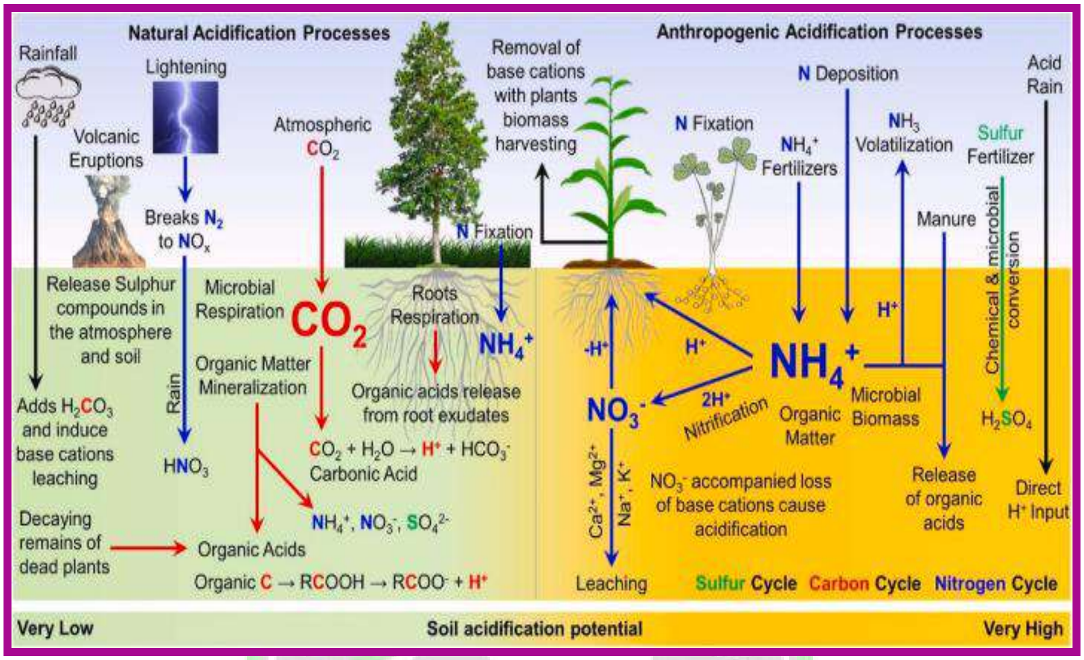


Fig 1: PROCESS OF ACIDIFICATION

1. Natural Acidification Process: Natural acidification of soils and water bodies can occur through various geological and environmental processes. Some of the key natural factors contributing to soil and water acidification include:

- **Decomposition of Organic Matter:** As organic matter (such as plant debris) decomposes, it releases organic acids that can lower the pH of soil and water.
- **Leaching:** Rainwater can wash away basic minerals and nutrients from the soil, leaving behind acidic compounds and contributing to soil and water acidification.
- **Volcanic Activity:** Volcanic emissions release sulfur dioxide (SO2) and other acidic gases into the atmosphere, which can eventually lead to the formation of acid rain when these gases react with water vapor.
- **Plant and Microbial Processes:** Some plants and microorganisms release organic acids during their metabolic processes, which can contribute to local acidification.
- **Mineral Weathering:** Certain minerals in rocks and soils can release acidic substances as they break down over time, further lowering pH levels.

2. Anthropogenic Acidification Process: Anthropogenic (human-caused) acidification primarily results from the release of pollutants into the environment. The most significant contributor to anthropogenic acidification is the emission of sulfur dioxide (SO2) and nitrogen oxides (NO_2) from human activities, such as burning fossil fuels (coal, oil, and natural gas) for energy and transportation. These pollutants can lead to several acidification-related issues:

- **Acid Rain:** Sulfur dioxide and nitrogen oxides released into the atmosphere can combine with water vapor to form sulfuric acid (H2SO4) and nitric acid (HNO3), respectively. These acids can be transported over long distances and deposited as acid rain, which can lower the pH of soils, water bodies, and aquatic ecosystems.
- **Soil Acidification:** Acid rain and other airborne pollutants can directly affect soil pH by leaching away essential nutrients like calcium, magnesium, and potassium. This can disrupt soil fertility and impact plant growth.
- **Water Body Acidification:** Acid rain can lead to the acidification of lakes, rivers, and streams, harming aquatic life such as fish, insects, and algae that are sensitive to changes in pH.
- **Building and Infrastructure Damage:** Acid rain can corrode building materials, statues, and infrastructure made of limestone, marble, and other calcium-containing materials.

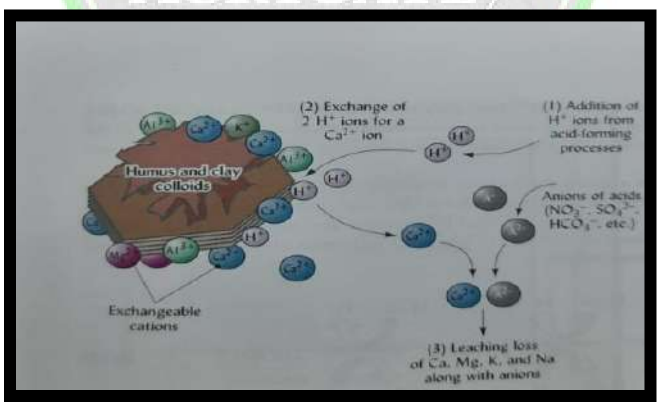
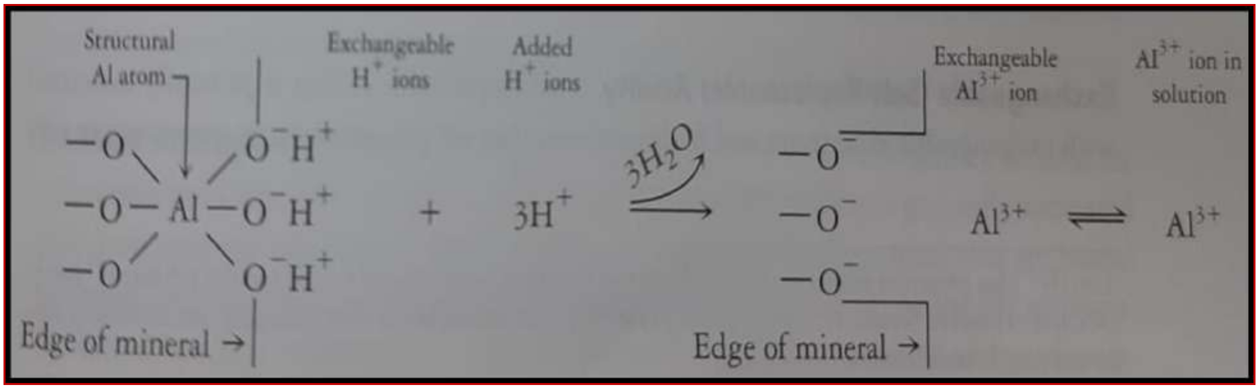


Fig 2: Soil become acid when H^+ added to soil solution exchange with nonacid Ca^{2+} ,Mg^{2+}, K^+ and Na^+ hold on humus and clay colloids

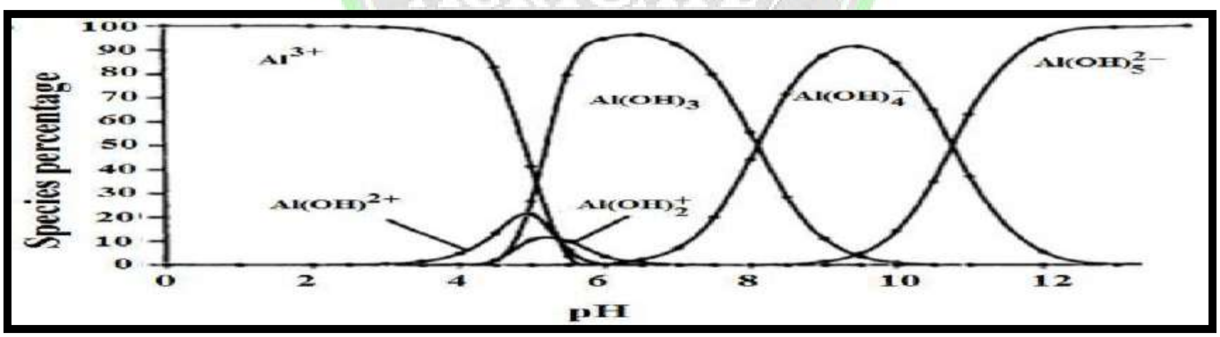
When H^+ ions adsorbed on a clay surface, they usually do not remain as exchangeable cation for long, instead they attach the structure of the minerals, releasing Al^{3+} ions in this process. The Al^{3+} ion then become adsorbed on the colloids cation exchange sites. These exchangeable Al^{3+} ions, in turn, are in equilibrium with dissolved Al^{3+} in the soil solution.



Role of Aluminium in Soil Acidity

Although pH is defined as a high concentration of hydrogen ions, aluminum also plays a central role in soil acidity.Al^{3+} ion have strong tendency to hydrolyze, splitting water molecules into H^+ and OH^- ions . The aluminum combine with OH^- ions, leaving H^+ ion to lower the pH of the solution .For this reason Al^{3+} and H^+ together are considered acid cations. **I**t is evident that hydrogen and aluminum both contribute to soil acidity. Hydrogen ions contribute acidity directly but aluminum ion contributes the acidity indirectly.

Relationship Between pH and Al Species



Stepwise hydrolysis		*Dominant aluminium*	*pH levels*
		$Al(H_2O)_6^{3+}$	< 4.7
$Al(H_2O)_6^{3+} + H_2O$	$\rightleftharpoons$	$Al(H_2O)_5(OH)^2 + H_3O^+$	
$Al(H_2O)_5(OH)^{2+} + H_2O$	$\rightleftharpoons$	$Al(H_2O)_4(OH)_2^+ + H_3O^+$	4.7 to 6.5
$Al(H_2O)_4(OH)_2^+ + H_2O$	$\rightleftharpoons$	$Al(H_2O)_3(OH)_3^0 + H_3O^+$	6.5 to 8.0
$Al(H_2O)_3(OH)_3^0 + H_2O$	$\rightleftharpoons$	$Al(H_2O)_2(OH)_4^- + H_3O^+$	8.0 to 11.0

Pools of Soil Acidity

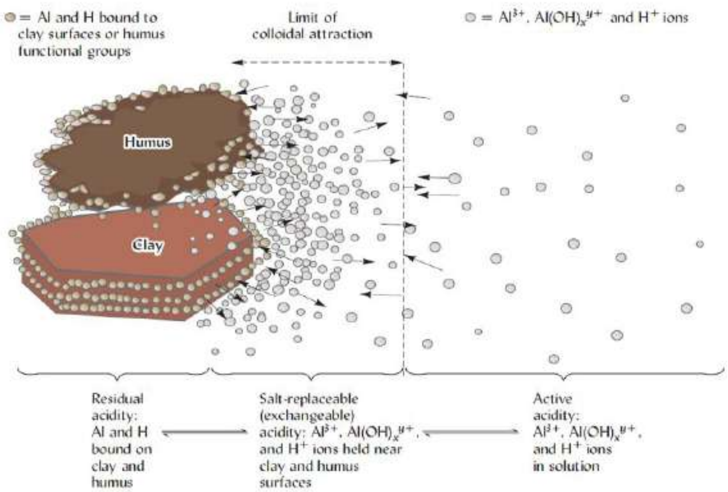


Fig: 3 Pools of Acidity

Active Acidity

The active acidity pool is defined by the H^+ ion activity on the soil solution. This pool is very negligible compared to the acidity in the exchangeable and residual pools. Such as for neutralizing the active acidity in the upper 0.15 m of a hectare of an average mineral soil at pH 4 and 20% moisture only about 2kg of $CaCO_3$ are required. Even so, the active acidity is extremely important, since it determines the solubility of many substances and provides the soil solution environment to which plant roots and microbes are exposed.

Exchangeable (Salt-Replaceable) Acidity

Exchangeable acidity is primarily associated with exchangeable aluminium and hydrogen ions. These ions are present in large quantities in very acid soils. Cation exchange with an unbuffered salt, such as KCI can release these ions into the soil. Once released to the soil solution, the aluminum hydrolyzes to form additional H^+.

Residual Acidity

Together, exchangeable (salt-replaceable) and active acidity account for only a little portion of the total soil acidity. The remaining residual acidity is generally accompanied by hydrogen and aluminium ions (including the aluminium hydroxyl ions). Those ions are attached in non-exchangeable forms by organic matter and clays. As the pH increases, the attached hydrogen dissociates and the attached aluminium ions are released and precipitate as amorphous $Al(OH)_3^0$.

Total Acidity

For most soils (not potential acid sulfate soils) the total acidity that must be suppressed to raise the soil pH to the desired value. It can be defined as: summation of active acidity , exchangeable acidity and residual acidity

IMPACT OF SOIL ACIDITY ON SOIL PROPERTIES

Soil acidity can have a significant impact on various aspects of soil properties, including physical, chemical, and biological characteristics. These impacts can affect soil health, nutrient availability, plant growth, and overall ecosystem functioning. Here's how acidity influences each of these categories:

1. Soil Physical Properties:

- **Soil Structure:** Acidic soils can have a detrimental effect on soil structure, causing particles to bind together and form hard clumps, known as aggregates. This can lead to poor water infiltration, reduced root penetration, and limited air movement within the soil.
- **Soil Erosion:** Reduced soil structure and increased compaction in acidic soils can contribute to greater susceptibility to erosion by wind and water.
- **Water Holding Capacity:** Acidic soils may have reduced water holding capacity due to poor aggregation, which can lead to water runoff and reduced water availability for plants.

2. Soil Chemical Properties:

- **Nutrient Availability:** Soil acidity can affect the availability of essential nutrients to plants. Some nutrients like phosphorus, calcium, and magnesium become less available in strongly acidic soils. Aluminum toxicity can also hinder root uptake of nutrients.
- **Cation Exchange Capacity (CEC):** Acidic soils often have a lower CEC, which affects the soil's ability to retain and exchange cations (positively charged ions) such as calcium, magnesium, and potassium.
- **pH Buffering Capacity:** Acidic soils can have a reduced capacity to resist changes in pH, making them more susceptible to rapid pH fluctuations when acidic or alkaline substances are added

3. Soil Biological Properties:

- **Microbial Activity:** Soil pH influences microbial communities and their activity. Acidic conditions can alter the composition of soil microorganisms, potentially reducing their beneficial roles in nutrient cycling and organic matter decomposition.
- **Earthworms and Soil Fauna:** Soil organisms like earthworms and certain soil fauna are sensitive to pH changes. Acidic soils can limit their abundance and diversity, affecting soil structure and nutrient cycling.
- **Root Growth and Mycorrhizal Associations:** Excess aluminum and low pH can hinder root growth and mycorrhizal fungal associations, which are important for nutrient uptake and overall plant health.

Addressing the Impact of Acidity: To mitigate the negative impacts of soil acidity, several management practices can be employed

- **Liming:** Adding agricultural lime (calcium carbonate) to acidic soils can raise pH levels, neutralize acidity, and reduce aluminum toxicity.
- **Organic Matter Addition:** Incorporating organic materials into the soil can improve soil structure, enhance nutrient availability, and encourage microbial activity.
- **Balanced Fertilization:** Applying appropriate fertilizers based on soil testing can help address nutrient deficiencies exacerbated by soil acidity.
- **Crop and Plant Selection:** Choosing plant species and varieties adapted to acidic conditions can help optimize growth and reduce the impact of aluminum toxicity.

ADVANTAGES OF USING CALCIUM CARBONATE AS A LIMING MATERIAL:

- **pH Adjustment:** Calcium carbonate effectively raises soil pH in acidic soils, reducing soil acidity and creating more favorable conditions for plant growth.
- **Nutrient Availability:**Liming with calcium carbonate improves the availability of essential nutrients such as phosphorus, calcium, and magnesium by reducing the negative effects of aluminum and promoting cation exchange.
- **Enhanced Soil Structure:**The addition of calcium carbonate can improve soil aggregation and structure, leading to better water infiltration, drainage, and root penetration.

- **Microbial Activity:** Proper liming can encourage beneficial microbial activity and nutrient cycling in the soil, contributing to improved soil health.
- **Crop Productivity:** Adequate liming can increase crop yields by optimizing nutrient availability and creating a more suitable environment for root growth.

Disadvantages and Considerations of Using Calcium Carbonate:

1. **Over liming:**Excessive application of calcium carbonate can lead to overliming, resulting in overly alkaline soils. This can negatively affect nutrient availability and disrupt soil biological activity.
2. **Calcium Imbalance:** While calcium is essential for plant growth, excessive calcium levels due to overliming can interfere with the uptake of other nutrients like potassium and magnesium.
3. **Slow Reaction:**Calcium carbonate reacts relatively slowly with soil, so its effects on pH adjustment may take time to become fully evident.
4. **Transport and Cost:** Calcium carbonate may need to be transported over long distances, which can contribute to carbon emissions and increased costs. Using locally available liming materials can be more environmentally friendly.
5. **Environmental Impact**:

- **Carbon Footprint**: Mining, processing, and transporting calcium carbonate can have a carbon footprint, contributing to greenhouse gas emissions.
- **Mining Concerns:** The extraction of calcium carbonate from quarries can impact local ecosystems and water bodies.
- **Algae Blooms:** Calcium runoff from overlimed fields can lead to nutrient enrichment in water bodies, potentially contributing to harmful algae blooms.

INDUSTRIAL BY-PRODUCTS /WASTE:

These are the wastes produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, mills, industries and mining operations. Eg. Press mud, red mud, alkaline slag, coal fly ash, Fly ash, paper mill sludge, phosphogypsum, and bone meal etc.

INDUSTRIAL WASTE	SOURCE	NUETRALIZING VALUE
Alkaline/Basic slag	Byproduct of steel industry	86
Paper mill sludge	Byproduct of paper mill industry	92
Press mud	The residue of the filtration of cane juice	91
Red mud	Produced during the Bayer process for alumina production from bauxite ore.	87
Bone meal	Byproduct of the manufacture of bone glue protein.	84
Phosphogypsum	Generated in the wet-acid production of phosphoric acid from rock phosphate.	72

The industrial by-products are often added to soil for enhancing the physicochemical properties that potentially can improve the crop yield and plant growth. The by-products may contain carbonaceous materials that can enhance the water retention of soils and provide a congenial environment which supports the microbial activity.

They can be supplied to the soil by either by surface application or homogenous mixing with the top soil. In numerous instances the by-products were reported to support an enhanced crop growth and yield through providing a soil medium with balanced nutrition and congenial condition. Some of the important industrial by-products used as soil amendments are, The industrial by-products are often added to soil for enhancing the physicochemical properties that potentially can improve the crop yield and plant growth. The by-products may contain carbonaceous materials that can enhance the water retention of soils and provide a congenial environment which supports the microbial activity.

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1.Basic slag:

Basic slag is a by-product of steel industry and is typically produced either through the blast furnace-oxy converter or electric arc furnace. The slag material is often alkaline in nature with a pH value 8-10, which makes this material a good amendment for acidic soils. It can potentially increase the water movement and air porosity of soils which provide a better plant growth condition. It contains Ca (33%), Mg (3.2%), P2O5 (2%), Si (2.3%) and some micronutrients. Its neutralizing value is 86.

2.Fly ash:

Fly ash (pH 4.5-12) is a waste of the coal industry can be used as an ameliorant for improving the physical, chemical and biological properties of problem soils. It also provides additional macro and micronutrient for plant growth. Depending upon the source of coal. Being acidic, fly ash directly brings down the pH by neutralizing carbonates, bicarbonates and hydroxyl ions. In addition to this, sulphur presents in flyash produces sulphuric acid upon microbial oxidation and this acid neutralize the alkali.

The addition of alkaline fly ash in acid soil may facilitate the release of nutrients such as S, B, K, P, Ca, Mg, and Mo by neutralizing the acidity of the soil. However, an excess increase in availability of B due to the application of fly ash may result in toxicity problem. Nevertheless, this issue can be addressed by choosing the application stage of the weathered flyash.

3.Paper mill sludge:

It is a by-product of paper mill industry. PMS is alkaline in nature with pH 7.5-12 and its CaCO3 equivalent of 30%. It contains kaolinite and high CaCO3.

4.Red mud:

Red mud is an alkaline (pH 10-13) by-product of the aluminium industry. Material rich in Fe (25-40 %) and aluminium oxide (15-20%). The predominant alkali in red mud is sodium carbonate which is more soluble in the soil solution than the conventional liming material CaCO3 . As a result, red mud can be used as a liming agent to ameliorate soil acidity. It contains Si, Al, Fe, Ca as well as array of minor constituents like Na, Cr, V, Ni, Ba, Cu, Mn, Pb, Zn etc.

ADVANTAGES OF INDUSTRIAL BY-PRODUCT OVER LIME:

- These industrial by products not only helps to increase the soil pH but also contain significant amount of nutrients like Ca ,Mg , K , P, and micronutrients so that helps in improving soil fertility and soil productivity.

- Available in low cost/ no cost.
- Easy availability.
- Most of them are biodegradable Etc…

Conclusion

Rapid industrialization and subsequent urbanization has led to excessive generation of wastes in nature. Waste is a valuable raw material located at a wrong place which can be converted into useful product by utilizing these in appropriate manner. Some industrial wastes (biodegradable) are more effective than agricultural lime for neutralizing the soil acidity when applied at equivalent rates based on their calcium carbonate content. Soil application of the industrial by-products such as red mud (RM), biomass ash (BA), bone meal (BM), basic slag/alkaline slag(AS) and coal fly ash(CFA) etc. helps in reclamation of acid soils by improving the soil condition, decreasing exchangeable Al and increasing exchangeable Ca, Mg, K and Na and effective cation exchange capacity of soil. Hence these industrial by-products not only helps to increase the soil pH but also contain significant amount of nutrients that helps in improving soil fertility and productivity.

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EFFECT OF HUMAN URINE ENRICHED BIOCHAR ON GROWTH AND YIELD OF CROPS

Article ID: AG-V04-I01-40

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Introduction

Human urine is a natural resource available in every household. Each individual produces 1 to 1.5 L of urine per day. The chemical composition of human urine depends on food habits, the amount of water consumed, physical activities, body size and environmental factors. In general, human urine contains very few microorganisms. Human urine is known to contain appreciable quantity of plant nutrient elements (especially nitrogen), which may be readily absorbed and assimilated by crops if used properly.

Biochars with large amounts of carbon in poly-condensed aromatic structures are obtained by pyrolyzing organic feed stocks at high temperatures (400 to 700ºC); also have fewer ion exchange functional groups due to dehydration and decarboxylation, potentially limiting its usefulness in retaining soil nutrients. Biochar serves as a catalyst that enhances plant uptake of nutrients and water. Compared to other soil amendments, the high surface area and porosity of biochar enable it to adsorb or retain nutrients and retain water and also provide a habitat for beneficial microorganisms to flourish. The biochar acts as an adsorbent of human urine and retains nutrients due to its large surface area and functional groups. Hua *et al*. (2009) observed an increase in nitrogen, copper and zinc retention was observed in mixed sludge biochar compost.

Characterization of Biochar

Biochar has been produced under conditions that optimize certain characteristics deemed useful in agriculture, such as high surface area per unit of volume and low amounts of residual resins. The particular heat treatment of organic biomass used to produce biochar contributes to its large surface area and its characteristic ability to persist in soils with very little biological decay (Lehmann *et al*., 2006).

Kiln-produced wheat straw biochar was represented by aromatic C (92.2%); O-alkyl C and alkyl C only explained 4.4 and 3.4%, respectively. The surface area of the biochar was 24 m2/g. Fixed C, volatile matter, and ash contents were 69, 13 and 17% respectively, and pH was 9.8. Biochar was low in mineral N but high in P-AL, K-AL, Mg-AL, and Ca-AL content. (AL = ammonium lactate extraction) compared with background soil levels. (Toole *et al*., 2012)

Characterization of Human urine

Human urine is known to contain all the nutrient elements required by the plants in varying concentrations. The nutrient concentration of the excreted urine depends on the amount of nutrients, and on the amount of liquid, which on an average for adults can be in the range of 0.8-1.5 litres per person per day and for children about half of that amount . Based upon this and other measurements, the proposed Swedish default value is 1.5 litres per person per day (550 litres per person per year) reported 1.6 litres per person per day (580 litres/person, year).

Ecosan toilet system – Collection of human urine

Characteristics of enriched biochar

The nutrient content of biochar is very low and it varies with the feed stocks used and pyrolysis temperature. Various methods can be adopted to enrich biochar. Christoph et al. (2010) suggested that variability in the adsorption dynamics of nutrient and C containing substrates by biochar, might alter the competitive interactions between microbes and change their overall community structure and dynamics.

Conclusion

Biochar application increased the P, K and Ca concentration of radish significantly at higher application rates (50 and 100 t ha). The increase in P and K contents of radish grown in biochar-amended soil was related to the high concentrations of available P and exchangeable K present in the green waste biochar Chan *et al.* (2007). Combined application of enriched biochar 1 (1:2) ratio with recommended dose of fertilizer improved nutrients status of soil and resulted in higher vegetable and dry matter yield of French bean crop reported by Gnyanaranjan Panigrahi (2019).

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CIRCULAR RNA DYNAMICS: UNRAVELING METABOLISM, FUNCTIONAL INSIGHTS AND PROTEIN INTERACTIONS

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Introduction

Circular RNAs (circRNAs) are unique non-coding RNAs characterized by closed-loop structures formed through a non-canonical "back-splicing" event. Unlike linear RNAs, circRNAs are more stable and resistant to degradation. Once considered by-products of aberrant RNA splicing, advances in sequencing technologies have led to their widespread identification in diverse species. Most circRNAs, derived from protein-coding genes, consist of single or multiple exons. Despite lacking 5′ caps and poly(A) tails, circRNAs are transported to the cytoplasm, with some exceptions localizing to the nucleus. Despite lower efficiency in back-splicing, circRNAs accumulate in specific cell types or tissues due to their high stability. Recent research reveals circRNAs play crucial roles in gene expression regulation at transcriptional and post-transcriptional levels. They act as miRNA and RNA-binding protein sponges, serving as potential biomarkers. Additionally, circRNAs may contribute to the generation of proteins and peptides through internal ribosomal entry sites (IRESs) (Zhang et al., 2020).

Biogenesis, localization and degradation of circular RNA

CircRNAs are categorized into exonic, intronic, and intergenic types based on their genomic origin, each with independent biogenesis mechanisms linked to eukaryotic splicing. In eukaryotic genes, exons and introns are spliced out by the spliceosome machinery through a conventional collinear splicing process. This process involves sequential transesterification reactions, resulting in a lariat structure with a loop and a 3′ tail. The intronic lariat without the 3′

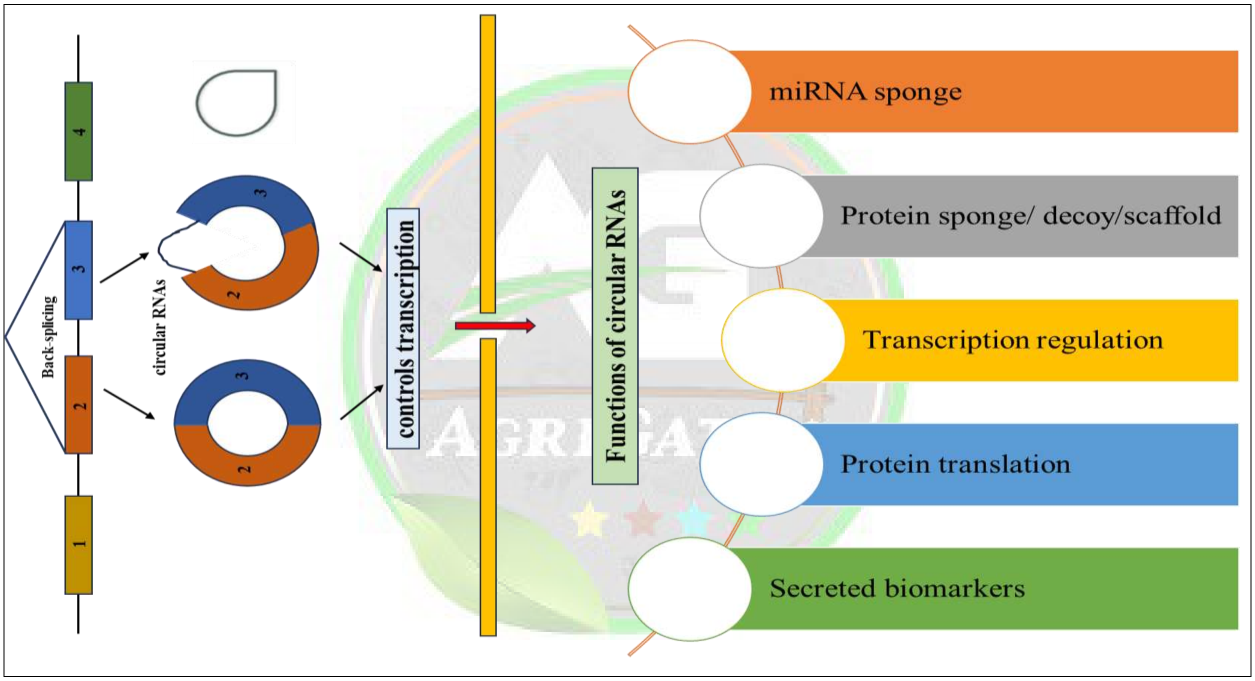
tail forms a perfect circular RNA, known as intronic circRNA. Exonic circRNAs are generated through a backsplice event, where the free 3′-hydroxyl end of an exon (tail) joins the 5′-head of an upstream exon, creating a "tail to head" RNA structure (**Fig. 1**). Single-exon circRNAs are usually produced cotranscriptionally when the 3′-tail and 5′-head are from the same exon. An intermediate lariat with exons and introns is formed when the 5′-head is from another upstream exon, and the circRNA with multiple exons is generated posttranscriptionally by removing the intron(s) through conventional linear splicing. While most backsplicing events are cis, occurring within the same or different exons of a single gene, trans-backsplicing events are also common.

The involvement of the spliceosome in circRNA generation suggests that circRNAs should contain canonical splice signals, and their production competes with linear pre-mRNA splicing. Studies have shown that exon circularization predominantly requires canonical splice signals in animals and humans. However, in rice, the majority of circRNAs are flanked by diverse non-GT/AG canonical splicing signals, suggesting alternative mechanisms for circRNA biogenesis in plants. Production of circRNAs can have both positive and negative effects on the expression of their parental genes. Recent research indicates that circRNA production is enhanced when core spliceosomal components are depleted and/or canonical linear mRNA splicing events are inhibited, adding complexity to the intricate relationship between circRNAs and their parental genes.

Exonic circRNAs are typically found in the cytoplasm, and recent studies shed light on the mechanisms governing their nuclear export. Some intron-containing circRNAs are retained in the nucleus, influencing parental gene expression. Certain exonic circRNAs are predominantly located in the nucleus, impacting the nuclear retention of proteins or recruiting proteins to chromatin. Beyond intracellular localization, circRNAs can be transported by extracellular vesicles and detected in circulation and urine. Exosomal circRNAs' sorting seems regulated by associated miRNA levels in producer cells, while their specific biological activities in recipient cells remain largely unknown. The mechanisms governing the packaging, delivery, and absorption of exosomal circRNAs are still elusive. Recent studies have identified mitochondria-located circRNAs, expanding our understanding of circRNA derivation within the mitochondrial transcriptome. However, circRNAs in other organelles or subcellular compartments warrant further investigation.

CircRNAs exhibit stability and accumulation, particularly in neural tissues, while highly proliferative tissues may experience a reduction in circRNA abundance. Recent research highlights circRNA degradation mechanisms, including global degradation by RNase L, recognition of m6A-containing circRNAs leading to cleavage, and a structure-dependent mechanism involving UPF1 and G3BP1. Additionally, miR-671, Ago2, and GW182 contribute to circRNA degradation. CircRNA excretion may play a role in their clearance. Further studies are needed to fully understand circRNA decay mechanisms and their implications for homeostasis and distribution across cell types (Zhou et al., 2020).

Fig. 1. Biogenesis and functions of circular RNAs.



Discovery of circular RNAs

rRNA-depleted total RNA-seq has been pivotal in early genome-wide circRNA profiling, often utilizing publicly available datasets for plant circRNA identification. Given the circular structures and relatively low circRNA expression levels, the preferred method involves an additional protocol using linear RNase R for library preparation. This approach has been widely applied in plant circRNA studies, proving effective in maize, soybean, bamboo, tomato, and grape. CircRNAs, formed through back-splicing, join downstream 3′ donor splice sites to upstream 5′ acceptor splice sites. Sequencing reads crossing back-splice junctions, constituted by two terminal sequences flanking the back-splice sites, are often overlooked by mapping algorithms. Recent bioinformatics tools have harnessed these features to specifically detect circRNAs, falling into two categories: the pseudo-reference-based approach (e.g., KNIFE, NCLscan) relying on accurate genome annotation and the fragment-based approach (e.g., MapSplice, find_circ, CIRI) identifying back-splice junctions from mapping information. Locus-specific circRNA profiling, utilizing genomic positions of back-splice sites, serves for validation, quantitation, and investigation of known circRNAs. Techniques such as RT-PCR are effective for circRNA validation, while ddPCR and RT-qPCR allow for circRNA quantitation. However, while genome-wide and locus-specific methods detect unique back-splice sites in circRNAs, they are unable to determine the internal splicing patterns of circRNA formation (Zhang et al., 2020).

Characteristics of plant circular RNAs

Plant circRNAs share some characteristics with their animal counterparts, such as longer flanking introns, low expression levels, and tissue-specific expression profiles. However, they also possess unique features. Cis-elements, trans-factors, and splicing factor binding sites in flanking intronic sequences play crucial roles in plant circRNA biogenesis. Unlike animals, plant exonic circRNAs are less likely to be generated from introns containing repetitive and reverse complementary sequences. While repetitive sequences may impact circRNA production in certain plants, they are less prevalent in others. Plant circRNAs exhibit evolutionary conservation across species, with some species-specific variations. In rice and Arabidopsis, the majority of exonic circRNAs contain 1-4 exons, and large parental genes with multiple shorter exons are preferentially circularized. In rice, a small percentage of circRNAs show a positive correlation between expression levels and those of their parental genes, contrasting with findings in maize and barley. Conservation of circRNAs varies across plant species. Soybean circRNAs show high conservation, especially among paralogous genes, while cotton circRNAs exhibit lower conservation between species. In polyploid soybean, a significant portion of circRNAs arises from paralogous genes with tissue-specific expression patterns. The identification and characterization of homoeologous circRNAs in other polyploid species will provide further insights into the conservation of these features (Chu et al., 2018).

Identification of plant circular RNAs

CircRNAs were initially confirmed in plants in 2014, sparking genome-wide identification efforts in Arabidopsis and rice. Subsequent studies expanded circRNA identification to various plant species, revealing numerous circRNAs in each, predominantly as nuclear circRNAs with some originating from chloroplasts and mitochondria. Identification methods often involve ribosome RNA-depleted and RNase R-treated total RNA for sequencing library creation. Although algorithms developed for animal circRNAs are commonly used, the potential for false positives in plant circRNA identification has led to the development of plant-specific algorithms like PcircRNA_finder for improved accuracy and sensitivity. The focus is primarily on exonic circRNAs, but proportions vary across plant species due to factors such as species differences, genome sequence annotation limitations, or incomplete circRNA repertoires. Assembling full-length circRNAs is crucial for understanding internal structures and alternative circularization. Innovative algorithms like circseq_cup facilitate this assembly, uncovering diverse circRNA lengths in rice. The low expression levels, tissue-specific profiles, and complex alternative splicing of circRNAs suggest that the current number of identified plant circRNAs may just scratch the surface. To enhance circRNA identification and prediction accuracy, robust algorithms tailored to plant genomes and circRNAs are essential. Additionally, adopting new sequencing technologies capable of generating long reads or full-length transcripts will contribute to a comprehensive understanding of internal structures, alternative splicing events, and trans-backsplicing in plant circRNAs (Chu et al., 2018).

Functions of plant circular RNAs

CircRNAs act as miRNA sponges

CircRNAs, known for their role as miRNA sponges, act by containing multiple miRNA-binding sites to inhibit miRNA activity, a function also referred to as competing endogenous RNAs (ceRNAs) in animals or target mimicry in plants. Due to their loop structures, circRNAs are resistant to RNA exonucleases, making them stable miRNA sponges with prolonged half-lives. For instance, circRNA CiRS-7 in humans suppresses miR-7 activity through over 70 conserved miR-7 binding sites. While some studies propose circRNAs as putative miRNA sponges in plants, experimental evidence remains limited. Plant circRNAs acting as miRNA sponges constitute a smaller proportion, with fewer miRNA-binding sites compared to animals. Experimental validation is essential to confirm their regulatory roles in processes like metabolic and developmental processes, reproductive processes, and stress responses. Crosslinking immunoprecipitation and high-throughput sequencing (CLIP-seq) can aid in validating these interactions.

CircRNAs in stress response

Plant circRNAs exhibit specific expression patterns in response to environmental stresses, including drought, chilling, heat, nutrient deficiency, and pathogen invasion. Differentially expressed circRNAs may regulate stress responses by interacting with miRNAs and influencing the expression of stress-responsive genes. Initial identification of circRNAs under biotic stress was in Arabidopsis leaves during pathogenic interaction. Similarly, in kiwifruit, circRNAs showed differential expression patterns during Pseudomonas syringae pv. actinidiae (Psa) infection. CircRNAs also function as negative regulators in the interaction with tomato yellow leaf curl virus (TYLCV) in tomato and respond to maize Iranian mosaic virus (MIMV) infection in maize. Under abiotic stresses, such as nutrient depletion, high light, heat, chilling, drought, and salt, circRNAs exhibit differential expression. For instance, in Oryza sativa roots under phosphate-starvation conditions, 27 circRNAs displayed stress-specific expression patterns. Similar stress-specific expression patterns were observed in chilled bell pepper, chilled tomato fruit, and grape leaves under cold stress. Grape Vv-circATS1, derived from glycerol-3-P acyltransferase, enhances cold tolerance in Arabidopsis by regulating the expression of stress-responsive genes. Dehydration-stressed conditions induced differentially expressed circRNAs in wheat, pear, maize, and Arabidopsis. Similar expressional changes were observed in crops under nutrient depletion, metal ion toxicity, or salt stress. Additionally, stress conditions were found to alter the lengths of circRNAs and the numbers of circularized exons in Arabidopsis (Zhang et al., 2020).

Regulation of gene expression

Exon-intron circRNAs (EIciRNAs) have been identified in plants and are implicated in gene regulation during biotic stress responses. In Arabidopsis, CircSEP3, derived from the SEPALLATA3 (SEP3) gene, regulates the transcription and splicing of its linear counterparts. CircSEP3 binds strongly to its cognate DNA locus, forming an RNA:DNA hybrid, leading to transcriptional pausing and the generation of alternatively spliced SEP3 mRNA with exon skipping. These findings suggest that circRNAs can modulate gene expression at both transcriptional and splicing levels in plants. The correlations between circRNAs and their parental genes observed in plant circRNA studies provide valuable insights, although further experimental validation is needed to understand the mechanistic basis of these correlations.

Translation of circular RNAs

Although circRNAs are generally considered untranslatable due to the absence of canonical cap-dependent translation components like 5′ caps or poly(A) tails, recent mammalian research has unveiled translation mechanisms involving internal ribosome entry sites (IRESs) and N6-Methyladenosine (m6A) RNA modification. Some circRNAs are predicted to contain open reading frames (ORFs) with IRESs, and a few have been proven to act as protein templates. Peptides derived from circRNAs, such as FBXW-185aa in circ-FBXW7, have demonstrated functions like inhibiting tumorigenesis. In addition, circRNAs with large ORFs and m6A-modified sites have been found to encode hundreds of peptides, with examples like circE7 producing the E7 oncoprotein responsible for HPV-induced carcinogenesis. However, no translated circRNAs have been reported in plants so far. As studies on m6A modification in Arabidopsis progress, the discovery of translatable circRNAs and their biological functions in plants may emerge.

Circular RNAs act as biomarkers

CircRNAs, with their universal presence across diverse cell types, conservation in different species, and specific expression patterns, have shown potential as biomarkers. They are involved in various physiological and pathophysiological processes, making them candidates for diagnosing. In plants, circRNAs have been identified as biomarkers of alternative splicing variants in Arabidopsis and play crucial roles in drought response, suggesting their potential use as effective biomarkers for genetic improvement in crop drought tolerance, as seen in maize and Arabidopsis.

Bioinformatics tools and databases for plant CircRNAs

The advent of high-throughput sequencing technologies has led to the accumulation of millions of circRNA sequencing reads in a short time. Numerous algorithms have been developed for the identification of circRNAs, including find_circ (Memczak et al., 2013), CIRCexplorer (Zhang et al., 2014), KNIFE (Szabo et al., 2015), and CIRI (Gao et al., 2015). However, their performance varies in terms of sensitivity, accuracy, and computational costs. Comparative analyses have indicated that CIRI, KNIFE, and CIRCexplorer strike a better balance between precision and sensitivity. PcircRNA_finder, designed specifically for plant circRNA detection, combines five different tools to offer a comprehensive, precise, and sensitive prediction method (Chen et al., 2016). CircPro focuses on investigating the protein-coding ability of circRNAs, employing an automated analysis pipeline that integrates five tools (Meng et al., 2017). Several databases have been established to manage the increasing number of circRNA datasets in plants, as summarized in **Table 1**. However, various databases still lack information on plant species, phylogenetic conservation, cell-type, tissue or developmental stage expression, functional annotation, and interaction with other molecules, presenting opportunities for further advancements in plant circRNA research.

Table 1. Bioinformatics resources for plant CircRNAs.

Name	**Description**	**Web links**	**Reference**
PcircRNA_finder	An integrated software for circRNA prediction in plants	http://ibi.zju.edu.cn/bioinplant/tools/manual	Chen et al., 2016
CircPro	An integrated tool for circRNA protein-coding potential	http://bis.zju.edu.cn/CircPro/	Meng et al., 2017
AtCircDB	A tissue-specific database for Arabidopsis circular RNAs	http://genome.sdau.edu.cn/circRNA	Ye et al., 2019
PlantCircNet	A database of plant circRNA-miRNA-gene regulatory networks	http://bis.zju.edu.cn/plantcircnet/	Zhang et al., 2017
ASmiR	A comprehensive database of miRNA targets in alternatively spliced linear and circRNAs	http://forestry.fafu.edu.cn/bioinfor/db/ASmiR	Wang et al., 2019a
CropCircDB	A database for crops in response to abiotic stress	http://deepbiology.cn/crop/ 2019	Wang et al., 2019b
PlantcircBase	A comprehensive database of plant circRNAs in 16 organisms	http://ibi.zju.edu.cn/plantcircbase/index.php	Chu et al., 2017, 2018
CircFunBase	A database for functional circular RNAs	http://bis.zju.edu.cn/CircFunBase/index.php	Meng et al., 2019

Conclusion

CircRNAs, present in various eukaryotes, have gained prominence with advances in sequencing technologies. While our understanding of circRNAs, primarily derived from animal studies, is applicable to plants, unique features in plant circRNAs need further exploration.

Addressing challenges like distinct backsplicing junction identification and enhancing genome sequence annotation will refine circRNA prediction accuracy. Functional investigations, particularly regarding miRNA sponge roles and diverse regulatory modes, remain limited in plants. Overcoming challenges, such as utilizing CRISPR/Cas9 for gene editing, will contribute to unraveling the molecular mechanisms and functions of plant circRNAs. Despite current limitations, the increasing focus on circRNAs in plants promises exciting discoveries in the years ahead.

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DIVERSIFICATION OF FISH TECHNIQUES AND TYPES

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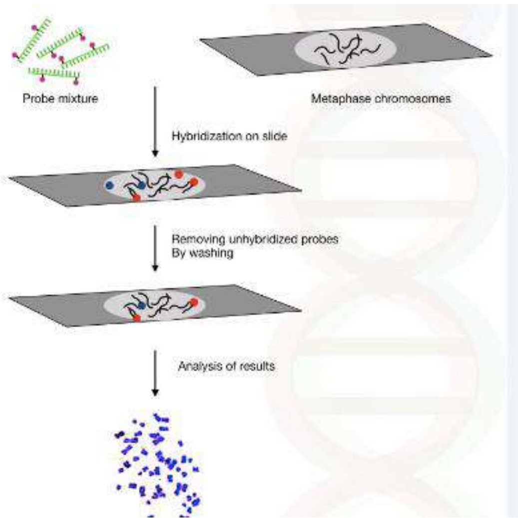
Introduction

Fluorescence in situ hybridization (FISH) is the most convincing technique for locating the specific DNA sequences, diagnosis of genetic diseases, gene mapping, and identification of novel oncogenes or genetic aberrations contributing to various types of cancers. In situ hybridization techniques initially developed by Joseph Gall and Mary Lou Pardue in 1960s (Pardue and Gall 1969) and John *et al.* (1969) have proved to be powerful tools for determining the chromosomal location of hybridized nucleic acid. Soon after that fluorescent labels quickly replaced radioactive labels in hybridization probes because of their greater safety, stability, and ease of detection.Early *in-situ* studies used radioactive RNA or DNA probes that were labeled with ^{3}H or ^{135}I, and the sites of hybridization were detected by autoradiography. These techniques have been successfully applied to both animals and plants.

Fluorescence in situ hybridization (FISH) can detect specific sites of specific DNA sequences in metaphase or interphase cells. This technique, initially developed for mammalian chromosome, was first applied to plant chromosomes by Schwarzacher *et al.* (1989) and Yamamoto and Mukai (1989). FISH has been used to detect 18S.26SrRNA and repeated DNA sequences in plant chromosomes such on *Aegilops*, *Hordeum*, *Oryza*, soybean, *Arabidopsis*, *Brassica* and barely chromosome.

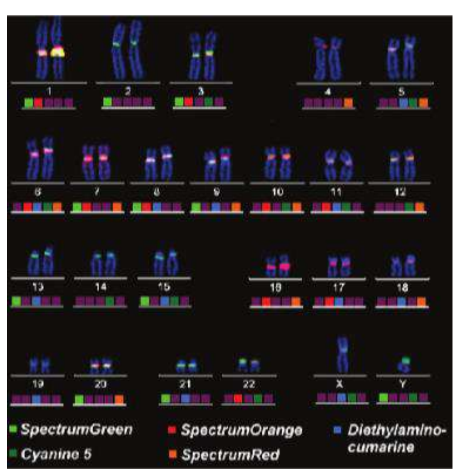


Diversification of FISH Techniques -Types

It is popular technique in other areas of biological and medical research including clinical genetics, neuroscience, reproductive medicine, cellular genomics, and chromosome biology.

(1) Centromere-FISH (ACM-FISH)

ACM-FISH is a multicolor FISH assay for detection of chromosomal abnormalities in sperm cells. The abbreviation ACM refers to the simultaneous hybridization of DNA probes for the alpha (centromere), classical (1q12) satellite and midi (1p36.3) satellite of chromosome 1 for the specific detection of duplications and deletions of 1pter and 1cen and for the identification of chromosomal breaks within the 1cen-1q12 region in human sperm. The discovery of chromosomal break/damage in the human sperm provided explanation for infertility in oligozoospermic men.



(2) armFISH

armFISH is a 42-color M-FISH variant that allows the detection of chromosomal abnormalities in the p- and q-arms of all 24 human chromosomes, except the p-arm of the Y and acrocentric chromosomes.

(3) Catalyzed Reporter Deposition-FISH (CARD-FISH)

CARD-FISH refers to the fluorescein tyramine signal amplification mediated by horseradish peroxidase (HRP)-labeled oligonucleotide probe. This technique is very useful for detection, identification, and quantification of microorganisms involved in bioleaching processes.

(4) Cellular Compartment Analysis of Temporal (Cat) Activity by Fish (cat FISH)

catFISH uses FISH to immediate early rRNA genes and confocal microscopy to identify neuronal population activated at two distinct times. This technique is used to determine the interactions of neuronal populations associated with different behaviors.

(5) hromosome Orientation (CO) -FISH

CO-FISH uses single-stranded DNA probes labeled with 5-bromodeoxyuridine during S phase to produce strand-specific hybridization. It allows to determine the relative orientation of two or more DNA sequences along a chromosome. Initially, this technique was designed to determine the orientation of tandem repeats within centromeric regions of chromosomes. This technique has also been useful in assessing chromosomal translocations and inversions.

(6) Combined Binary Ratio (COBRA) -FISH

COBRA-FISH enables recognition of all human chromosome arms on the basis of color and mapping of gene and viral integration site in the context of chromosome arm painting. COBRA-FISH protocol brings together combinatorial labeling which allows different ratios of label to distinguish between probes. This permits the use of fewer fluorochromes to produce up to 48 color combinations for differential painting of human chromosome arms within a specimen.

(7) Chromosome Orientation and Direction (COD)-FISH

This protocol is similar to CO-FISH except for the information about the directional organization of telomeric sequences. It can also stand for concomitant oncoprotein detection-FISH which allows visualization of loci signals for a particular oncogene and also the protein product derived from this gene. Another technique that has been termed COD-FISH is the combined $CaCO_3$ optical detection-FISH, in which FISH is used to detect calcifying microorganisms in open ocean.

(8) Combinatorial Oligonucleotide (COMBO)-FISH

COMBO-FISH is used for specific labeling of genomic sites. It takes advantage of homopurine/homopyrimidine oligonucleotides that form triple helices with intact duplex genomic DNA. This will not require prior denaturation of the target sequence, which is usually a prerequisite for probe binding in the standard FISH protocols. Homopurine or homopyrimidine regions of DNA are usually longer than 14 bp, representing 1–2 % of the human genome, with an average of 150–200 of such stretches in a 250-kb segment of the genome. Accordingly, specific probe sets can be constructed to target genomic regions of interest in that size range.

(9) Comet-FISH

Comet-FISH is a combination of comet assay and FISH analysis. It is used to detect genome region-specific DNA damage. It involves attachment of DNA onto agarose-coated microscope slide prior to in situ hybridization and allows specific sequences to be delineated in the comet head or tail. This will permit the assessment of sensitivity to DNA damage/breakage in the specific genomic region, which has been shown to be associated with the gene density of a chromosome rather than the chromosome size. This technique has been successfully used to determine the sensitivity of telomeres to damage.

(10) Cryo-FISH

Cryo-FISH makes use of ultrathin cryosections (150 nm thick) of sucrose-embedded cells. The spatial interrelationship of chromosome territories and the genome organization in the cell nucleus has been successfully studied with this technique.

(11) Double Fusion FISH (D-FISH)

In this FISH, a secondary color is observed since the adjacent colors overlap. The secondary color will be present or absent in the cases under study. An example is the detection of BCR/ABL translocations, where the secondary color indicates disease. The opposite situation, where the absence of secondary color is pathological, is illustrated by an assay for translocation where only one of the breakpoints is known. Locus-specific probes are made for one side of the breakpoint and the other intact chromosome. In normal cells secondary color is observed, but only the primary colors are observed when the translocation occurs. This technique is called “break-apart FISH”

(12) DNA Breakage Detection FISH (DBD-FISH)

DBD-FISH has been used to determine DNA fragmentation levels in sperms. Cells are normally stabilized in agarose beads and incubated with the unwinding buffer to form single-stranded DNA in the sample that can be hybridized with the appropriate probes.

(13) e-FISH

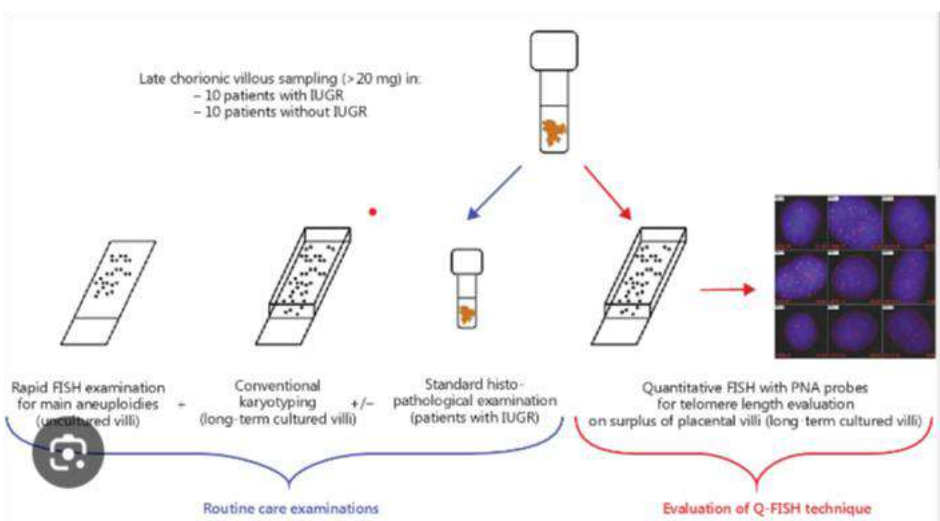
e-FISH is a BLAST-based FISH simulation program, which can predict the outcome of hybridization experiments. This program was developed as a bioinformatics tool for selecting appropriate genomic probes for hybridization experiments.

(14) Fiber-FISH

Fiber-FISH is a technique in which DNA fibers or chromatin fibers are released from cell nuclei by salt or solvent extraction and stretched on a microscope slide prior to hybridization. This technique allows high-resolution mapping of chromatin fibers or DNA such as physical ordering of DNA probes, assessment of gaps and overlaps in contigs, and copy number variants.

(15) Quantitative-FISH (Q-FISH)

This method has been used mainly for measuring the number of telomere repeats on a particular chromosome, using PNA-conjugated probes . Typically, metaphases are imaged and then analyzed using software TFL-TELO. Q-FISH has become an important tool in studying the role of telomeres in aging and cancer.



Applications of FISH

FISH has now become an essential tool for gene mapping and characterization of chromosome aberrations. Since the target DNA remains intact, unlike in molecular genetic analysis, information is obtained directly about the positions of probes in relation to chromosome bands or to other hybridized probes. Using differentially labeled probes, chromosome aberrations on particular chromosomes or chromosomal regions can be easily defined.

The diseases that have been diagnosed using FISH include Prader-Willi syndrome, Angelman syndrome, 22q13 deletion syndrome, chronic myelogenous leukemia, acute lymphoblastic leukemia, Cri-du-Chat syndrome, velocardiofacial syndrome, and Down syndrome. The analysis of chromosomes 21, X, and Y can identify oligozoospermic individuals at risk.

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REVOLUTIONIZING AGRICULTURE: THE RELIABILITY AND IMPLEMENTATION OF WIRELESS SENSORS IN

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Introduction

In the ever-evolving landscape of agriculture, technology continues to play a pivotal role in increasing efficiency and sustainability. One such technological marvel that is transforming the way we approach irrigation is the implementation of wireless sensors. These devices are not only enhancing the precision of water management but also revolutionizing the agricultural sector by providing real-time data and intelligent insights. Sensor in combination with the IOT had made a significant role in delivering the information (Harun et al. 2015). Wireless sensor-based irrigation has shown a fastening of results and made user friendly for proper water management (Hamami et al. 2020). In this article, we will delve into the reliability and implementation of wireless sensors in irrigation, exploring how they are reshaping the future of farming.

The Need for Smart Irrigation

With a rapidly growing global population and increasing pressure on water resources, there is a critical need to optimize agricultural practices. Traditional irrigation methods often lead to water wastage, overuse of fertilizers, and inefficient resource allocation. Smart irrigation, powered by wireless sensor technology, offers a solution by enabling farmers to make data-driven decisions, thereby promoting sustainable and resource-efficient farming.

Reliability of Wireless Sensors

One of the key concerns when adopting any new technology is its reliability. In the case of wireless sensors in irrigation, advancements in sensor technology have significantly improved their accuracy, durability, and overall reliability. These sensors are designed to withstand harsh environmental conditions, including water, sunlight, and soil exposure. Additionally, the use of low-power and long-range communication technologies ensures that these devices can operate for extended periods without frequent maintenance. The application of wireless sensors in irrigation is shown in Figure 01.

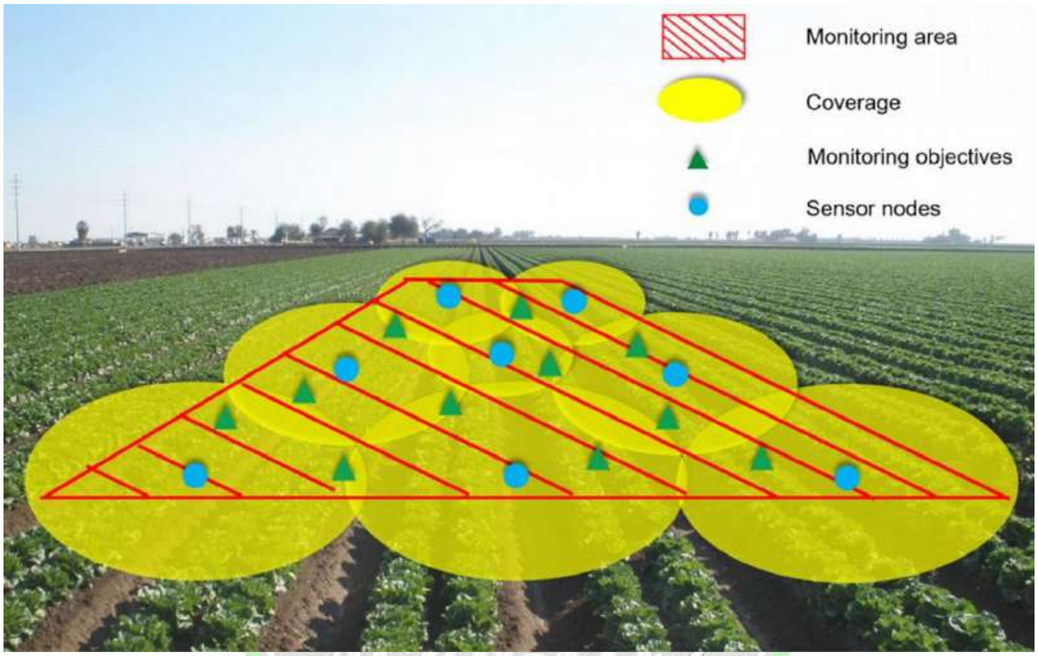

Figure 01: Application of wireless sensors in Irrigation

Real-time Monitoring and Data Collection

Wireless sensors provide real-time monitoring of soil moisture levels, weather conditions, and other crucial parameters. This real-time data empowers farmers to make informed decisions about when and how much to irrigate, optimizing water usage and minimizing waste. The ability to remotely access and analyze data through user-friendly interfaces or mobile applications further enhances the convenience and efficiency of these systems.

Precision Agriculture

The implementation of wireless sensors in irrigation aligns with the principles of precision agriculture, where inputs such as water, fertilizers, and pesticides are applied with precision based on actual crop needs. By mapping variations in soil moisture levels across the field, farmers can tailor their irrigation strategies to specific areas, optimizing crop growth and yield. This targeted approach not only conserves resources but also contributes to increased crop quality and reduced environmental impact.

Cost-effectiveness and Scalability:

Contrary to common misconceptions, implementing wireless sensor technology in irrigation can be a cost-effective solution in the long run. The initial investment in sensors and communication infrastructure is offset by the savings in water, energy, and labor costs. Furthermore, these systems are scalable, allowing farmers to start small and expand their sensor networks as needed. This scalability makes wireless sensor technology accessible to a wide range of agricultural operations, from small family farms to large commercial enterprises.

Conclusion

As the global agricultural landscape faces increasing challenges, the integration of wireless sensors in irrigation emerges as a game-changer. The reliability, real-time monitoring capabilities, and cost-effectiveness of these devices are reshaping traditional farming practices. The implementation of wireless sensors in irrigation not only enhances water use efficiency but also promotes sustainable and environmentally conscious agriculture. As technology continues to advance, the future of farming looks promising, with wireless sensors at the forefront of innovation in smart irrigation.

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RECOGNIZING EL NINO, IOD, AND HOW THEY RELATE TO INDIAN AGRICULTURE

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Introduction

The term El Niño refers to the warming of sea surface temperatures in the eastern and central equatorial Pacific Ocean, which is brought on by a weakening or reversal of the trade winds. The term "Indian Ocean Dipole," or "Ocean-atmosphere interaction" (IOD) refers to the temperature differential between the eastern and western regions of the Indian Ocean around the equator. We will examine the El Nino, IOD, and its connection to Indian agriculture in this essay (Wang et al., 2017).

The interplay between the El Nino Southern Oscillation (ENSO) and IOD

- Mechanism of Triggering: Positive IOD development in the Indian Ocean can be triggered by ENSO occurrences, particularly El Nino.
- External Drivers: Although ENSO and other external causes may occasionally trigger IOD episodes, there is evidence that subsurface processes or local circulations inside the equatorial Indian Ocean may also be responsible.
- Inside Dynamics: Even when prompted by external drivers, internal dynamics play a major role in the development and maturation of IOD events. They may demonstrate autonomous life and influence weather patterns in the Indian Ocean basin.

- Effects on IOD: When there is an El Nino, Indonesia's Pacific coast is often colder than usual, which affects the Indian Ocean coast and causes a positive IOD to form.
- Interaction Between Parties: When both events are powerful, they may have an influence on each other's circulation patterns. Each event's length and intensity may vary depending on how the two phenomena interact.
- Various Associations: While negative IOD occurrences are occasionally connected to La Nina, positive IOD events are frequently related with El Nino. This correlation is not unqualified, though; depending on the circumstances, IOD events may happen on their own or have distinct correlations.
- Collective Effects: Because of the interactions and influences between their circulation patterns, strong IOD and ENSO events can have a combined effect on weather patterns (Sang *et al.*, 2019).

Indian Ocean Dipole's effects

- Distribution of Rainfall: The Indian Ocean region's rainfall patterns are greatly influenced by IOD. More convection and rainfall occur over the Indian subcontinent and along the African coast during a positive IOD. On the other hand, in certain areas, a negative IOD results in reduced rainfall.
- Floods and Drought: When positive IOD events occur, the impacted areas may get above-average rainfall, which will help to relieve the drought and restock water supplies. But in certain places, this increased rainfall may also mean flooding and other water-related tragedies.
- Productivity in Agriculture: Because IOD modifies rainfall distribution and availability, it affects agriculture. While negative IOD events may result in lower crop yields and other agricultural difficulties, positive IOD events have the potential to increase agricultural production in the impacted regions.
- Fisheries: IOD has an effect on marine ecosystem productivity. Increased upwelling of nutrient-rich waters happens during positive IOD, which is good for fisheries and encourages larger fish stocks. On the other hand, low IOD can affect fish populations and upset the marine food chain.
- Coral Dying: Long-lasting positive IOD occurrences can raise sea surface temperatures in the impacted areas. IOD affects sea surface temperatures. Coral bleaching may result from this, which would be detrimental to marine biodiversity and coral reefs.

- Monsoon in India: The intensity and dispersion of rainfall during the Indian monsoon are influenced by IOD. Over the Indian subcontinent, positive IOD events are often linked to increased monsoon rainfall, whereas negative IOD events may result in decreased monsoon rainfall.
- Extreme Weather Conditions: In the Indian Ocean region, IOD might increase the likelihood of extreme weather phenomena including heatwaves, storms, and tropical cyclones.
- Impacts on the Economy and Society: There are direct economic and social effects of IOD on rainfall, agriculture, fisheries, and other industries. In the impacted areas, these effects may have an influence on the availability of water, food security, livelihoods, and general economic growth (Zhang *et al*., 2019).

Impacts of El Nino on the Indian monsoon

- Diminished Monsoon Winds:: The easterly trade winds that cross the Indian Ocean during an El Nino deteriorate. These winds are in charge of delivering air that is heavy with moisture to the Indian subcontinent, which makes the monsoon rains possible. Weaker winds limit the amount of moisture available, which lowers rainfall.
- Postponed Inception: An El Nino may result in the Indian monsoon starting later than usual. The monsoon season in India typically begins in June, although in El Nino years, the monsoon may arrive later and cause the rainy season to begin later than usual.
- Inadequate Rainfall: El Nino occurrences frequently cause India's monsoon season to get less rainfall than usual. Parts of the nation experience insufficient rainfall due to El Nino's changed atmospheric circulation and limited moisture transfer.
- Regional Differences: Not all parts of India experience the same effects of El Nino on the monsoon. In El Nino years, below-average rainfall is more likely to occur in some areas, especially in central and northern India. However, at certain times, rainfall in some parts of southern India may be near-normal or even above-normal.
- Conditions of Drought: El Nino-induced rainfall deficits may cause drought conditions in areas that are impacted. Crop failures, decreased agricultural production, and water shortages can result from this, which can have a negative impact on agriculture, water availability, and lives.
- Temperature Extremes: El Nino may cause some regions of India to experience higher than average monsoon season temperatures. Reduced rainfall and cloud cover can result in

heatwaves and higher temperatures, which can have an adverse effect on human health and well-being (Dandi *et al*., 2020).

Relationship between ENSO, IOD on Indian Monsoon

The IOD and the El Niño/Southern Oscillation (ENSO) have complementarily affected the ISMR during the last four decades. Whenever the ENSO-ISMR correlation is low (high), the IOD-ISMR correlation is high (low). The IOD plays an important role as a modulator of the Indian monsoon rainfall, and influences the correlation between the ISMR and ENSO. It was discovered that the ENSO-induced anomalous circulation over the Indian region is either countered or supported by the IOD-induced anomalous meridional circulation cell, depending upon the phase and amplitude of the two major tropical phenomena in the Indo-Pacific sector.

Conclusion

The Indian Ocean Dipole (IOD) event is still going strong in 2023 and is tracking at high levels right now. Around the conclusion of the southern hemisphere spring, IOD occurrences often begin to decline as the monsoon trough advances southward into the southern hemisphere. The emergence of a positive IOD this year would be appreciated as researchers continue to examine the relationship between ENSO and IOD. This would provide some relief from the expected effects of El Nino on the Indian monsoon.

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UNVEILING THE CARBON SEQUESTRATION POTENTIAL OF PERENNIAL FRUIT CROPS

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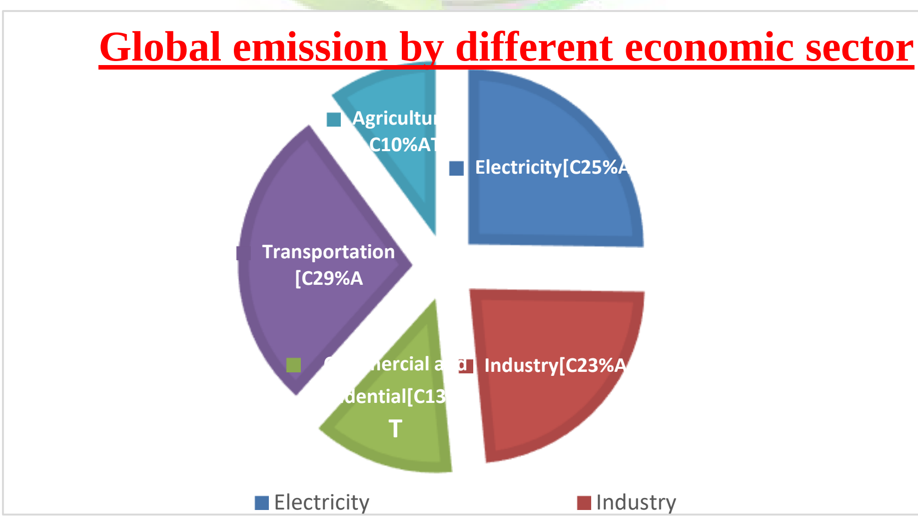
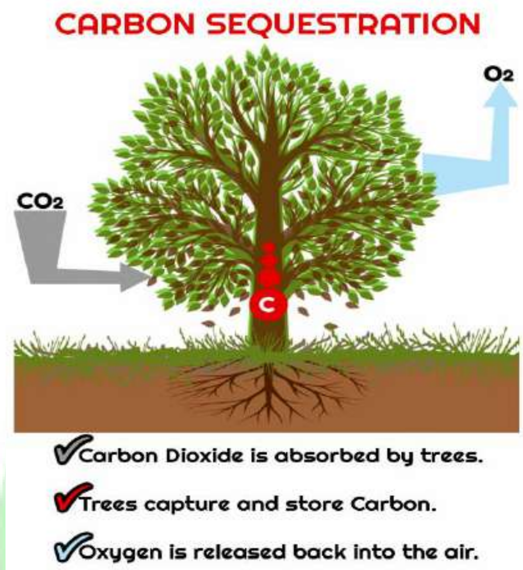
Introduction

In the face of climate change and the pressing need to mitigate carbon emissions, the agricultural sector plays a crucial role in offering sustainable solutions. One often overlooked aspect of agriculture's contribution to carbon sequestration is the cultivation of perennial fruit crops. These plants, with their long lifespan and extensive root systems, possess a remarkable capacity to sequester carbon dioxide from the atmosphere. In this article, we delve into the significant role that perennial fruit crops can play in carbon sequestration and their potential to contribute to a more sustainable and resilient agricultural future.



The Perennial Advantage

Unlike annual crops that are planted and harvested within a single growing season, perennial fruit crops such as apple orchards, citrus groves, and vineyards have a longer lifespan. This extended growth period allows these plants to capture and store carbon over several years, making them effective long-term carbon sinks.



Roots of Sequestration:

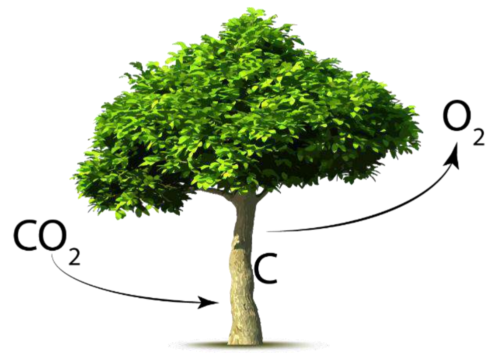
One of the key factors contributing to the carbon sequestration potential of perennial fruit crops is their extensive root systems. These root systems, which can extend deep into the soil, enhance the storage of carbon below ground. As the roots of perennial plants break down, organic matter is incorporated into the soil, contributing to soil carbon sequestration.

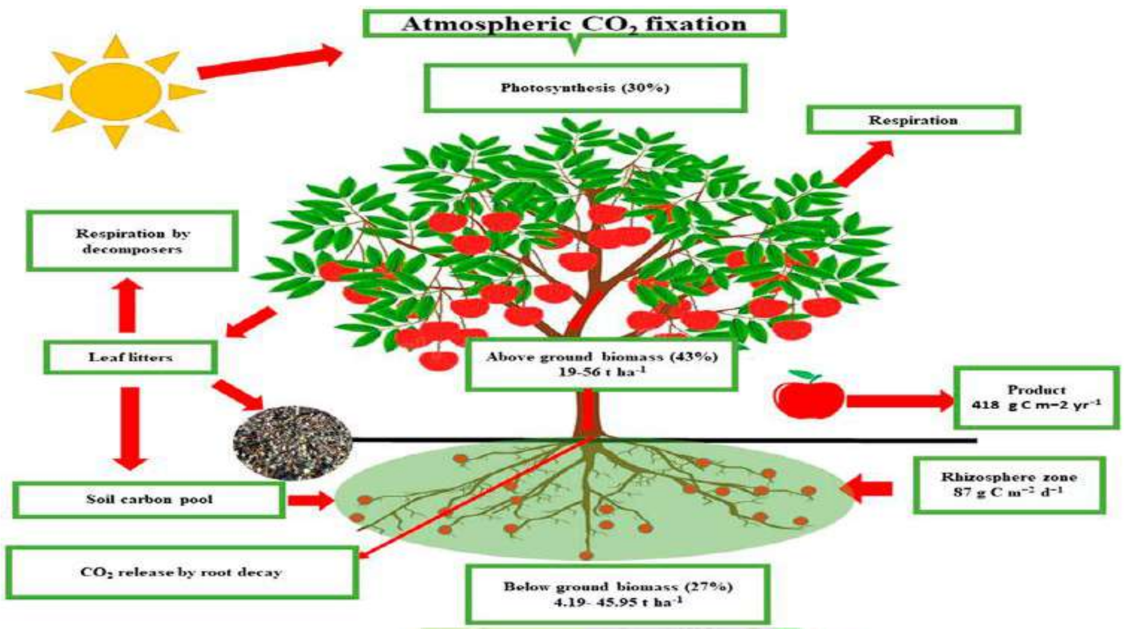
Biodiversity Benefits:

Perennial fruit crops often support greater biodiversity compared to annual monocultures. The presence of diverse plant and animal species within and around orchards fosters a more resilient ecosystem. Increased biodiversity can enhance the overall health of the soil, promoting natural nutrient cycling and further supporting carbon sequestration.

Agroforestry Practices:

Integrating perennial fruit crops into agroforestry systems amplifies their carbon sequestration potential. Agroforestry combines the cultivation of trees with crops or livestock, creating a more diverse and sustainable farming landscape. The trees in agroforestry systems contribute significantly to carbon sequestration, and when coupled with perennial fruit crops, the overall impact is substantial.



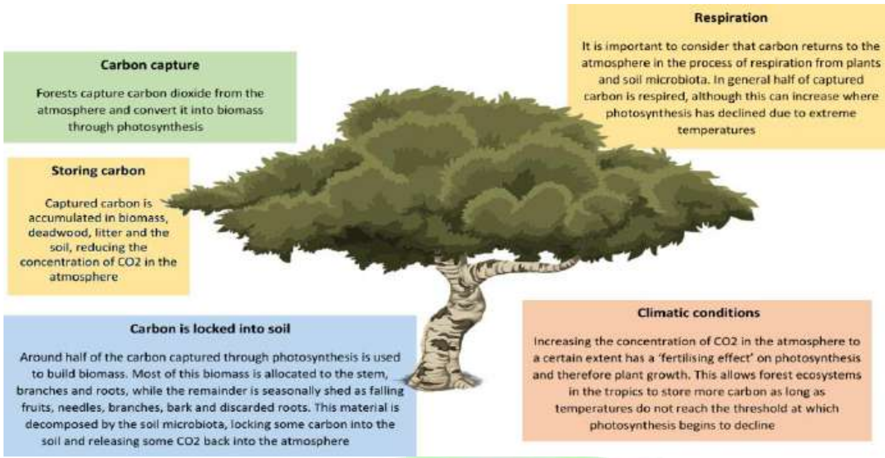


Soil Carbon and Water Retention:

The organic matter derived from perennial fruit crops enhances soil structure and water retention. Improved soil structure encourages the formation of stable aggregates, which not only sequester carbon but also contribute to better water infiltration and storage. This dual benefit of carbon sequestration and water management is crucial in the context of climate change and unpredictable weather patterns.

Challenges and Considerations

While perennial fruit crops show promise in carbon sequestration, it is essential to acknowledge potential challenges. Factors such as land-use changes, management practices, and the use of chemical inputs can influence the overall carbon balance. Sustainable and regenerative farming practices, such as minimal tillage and organic farming, are crucial to maximizing the carbon sequestration potential of perennial fruit crops.



Conclusion

Perennial fruit crops stand as unsung heroes in the fight against climate change. Their ability to sequester carbon, enhance soil health, and support biodiversity positions them as valuable assets in sustainable agriculture. As we strive to build a resilient and climate-smart food system, recognizing and promoting the carbon sequestration potential of perennial fruit crops should be at the forefront of agricultural innovation and policy. Through thoughtful cultivation practices and a commitment to sustainable agriculture, we can harness the power of perennial fruit crops to mitigate climate change and pave the way for a more sustainable future.

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NATURAL RESOURCE MANAGEMENT - AN IMPORTANT CONCERN FOR 21ST CENTUARY

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Introduction

Natural resources are those that can be used to meet human and other living creatures' requirements since they originate from the natural environment. Natural resources include things like air, water, land, wood, coal, oil, and gas.

What is Natural Resource Management?

The prudent use of resources found in the natural environment in a way that does not jeopardise future generations' ability to use those same resources to meet their requirements is known as natural resource management. Through the natural ecosystem, these resources give humanity the essentials for a good life. In order to ensure that humanity will continue to exist, there is an urgent need for natural resource management due to the needs and demands of the world's population, which is growing at an accelerated rate and depleting finite natural resources. In recent times, there have been severe concerns voiced about the abnormal usage and overexploitation of certain natural resources, which go beyond the earth's carrying capacity. Although efficient management of natural resources and their governance have always been important, the need for them to be managed well is becoming more pressing due to factors including population growth, modernization, climate change, and market demands. Effective management of these natural resources is a difficult endeavour because of the complexity involved. The quality of land, forests, and water, as well as these resources' capacity to replenish themselves at the rate at which they are being used, are all at risk due to the alarming rate of depletion and pressure on natural resources. There are major concerns to the global sustainability of natural resources, including loss and extinction. There is a contradiction between the preservation and utilisation of these natural resources, which is leading to conflicts. The political interests involved and the economic worth of these natural resources have further increased the difficulty of managing these resources in their natural habitat.

Natural Resource Management and Sustainable Agriculture

In addition to producing food, the agricultural industry is essential to the global economy since it also supplies raw materials, jobs, and other resources. Natural resources are used in the production of crops and animals, which is known as agriculture. Production of crops and animals depends on a number of variables, including labour, capital, and land. Land is necessary for the production of both crops and animals, much like other production variables, and how long it can best meet the needs and wants of the expanding population depends on how it is managed. Due to unsustainable practises, a significant portion of the world's arable land is either depleted or already under use and is no longer productive. The formerly fertile and productive areas have now degraded. The world's land degradation rate has accelerated due to altered global temperatures and overuse of inputs to sustain or boost production levels.

Pesticides and fertilisers, which are extensively used in commercial agriculture, return to the environment through leaching or runoff, negatively impacting the ecosystem. This excess nitrogen in the ecosystem can have a negative impact on plant diversity and cause a significant loss of biodiversity, including a reduction in the population of beneficial birds and insects. In addition to potentially upsetting the equilibrium between prey and predator, runoff has the potential to contaminate surface and groundwater. The use of chemical fertilisers on farms over time causes the soil's acidity to rise, which eventually stunts or stops plant growth.

Given the foregoing, sustainable agriculture is the answer for guaranteeing food security and protecting the environment. Commercial and industrial agriculture is now considered unsustainable since the natural resources it uses up are being degraded more quickly than the environment can replace. Promoting farming methods and systems that lessen the negative effects of unsustainable practises on the environment is one of the goals of sustainable agriculture (see below). Since sustainable agriculture acknowledges the finite nature of natural resources, it advocates for restraints on economic expansion while demanding equitable resource distribution. The goals of sustainable agriculture include social justice and fairness, general economic growth and development, and environmental conservation and preservation. The goal of the sustainability debate is to satisfy current wants without endangering the capacity of future generations to satisfy their own.

Need for Conservation of Natural Resource Management

The consumption of natural resources is rising along with the world's population, which is growing at an alarming rate. Therefore, in order to preserve ecological balance and preserve these resources for future generations, they should be maintained. Conservation is the appropriate management of a resource to avoid its exploitation or destruction.

- To sustain life by promoting ecological equilibrium
- To guarantee that the resources will be accessible to future generations
- To ensure the survival of the human race
- To protect biodiversity

Energy resources

These consist of biomass, coal, natural gas, etc. These are taken advantage of on a daily basis in one way or another. Coal is the primary energy source for electricity, and natural gas is frequently used for cooking. Cars are powered by petroleum products. They are being devoured at an incredible rate every day. Because energy supplies are finite, it is imperative that they be conserved. The actions listed below can aid in their energy-based biomass conservation.

- Reduce excessive use of these non-renewable energy sources.
- Endorsing environmentally friendly technologies such as solar panels and other renewable energy sources.
- Increasing public knowledge of the importance of conservation.

Biodiversity

In-situ

We refer to the preservation of flora and fauna in their native environments as "in-situ conservation." National parks and wildlife sanctuaries are a couple such examples.

Ex-situ

The preservation of flora and fauna away from their native environments is known as ex situ conservation. These consist of gene banks, botanical gardens, zoos, pollen banks, seed banks, and so forth.

Need for management of natural resource management

The world's resources are finite. The growing human population is driving up resource demand, which is happening on a daily basis. Effective management can ensure that natural resources are utilised sparingly, meeting the needs of the current generation while ensuring their sustainability for future generations.

- When natural resources are managed properly, short-term gains are prevented from being exploited and long-term perspectives are taken into account.
- In order for everyone to benefit from the resources, fair distribution of natural resources can be ensured through effective management.
- When natural resources are extracted or exploited, they can cause environmental damage. Appropriate management will consider this and identify ways to minimise the damage.

Sustainable Management

Prudent management of forest resources to ensure their availability for upcoming generations. In order to think about forest protection, we would like to look at the following stakeholders:

- Individuals who sleep in or near forests are dependent on forest resources for several areas of their lives.
- The government's Forest Department, which is in charge of managing the land and forest resources.
- Industrialists, ranging from those who make bidis out of 'tendu' leaves to those who run paper mills and utilise a variety of forest products.
- Those who are passionate about wildlife and the environment and wish to preserve it in its purest form through regulation.
- To refill the forests, a large-scale initiative known as silviculture has been launched, which involves planting more trees and plants.

Afforestation

It is the growth of forests on bare, unprotected terrain. Van Mahotsava is a tree-planting initiative run by nonprofit and governmental organisations twice a year in February and July.

Planting new trees

It is creating new forest cover in the areas where exploitation has caused damage or clearance. It is administered using the following techniques:

Division of the Economy Forestry

Industry-required useful plants should ideally be planted separately on waste land. Producing plants needed by industry is known as a production plantation.

Grazing Management

Grazing management should be coordinated with the availability of pasturage.

Deforestation

Deforestation is the removal, reduction, or degradation of a neighborhood's forest cover.

Effects of Deforestation

Soil Erosion

Detachment, transportation and deposition of soil particles from one place to another by the action of water or wind is described as soil erosion. During this process, fertility of the soil destroyed rapidly due to loss of upper layer of land. Water erosion like sheet erosion, rill erosion, gully erosion, stream bank erosion and another wind erosion etc. are the types of soil erosion.

Desertification

The Earth becomes dry when the plains' forest cover is removed. The dirt gets loose during the warmer season. Sand loses single soil particles to air currents.

Floods

Seasonal loss of absorption capacity by exposed soil causes the formation of numerous ephemeral rivulets. In low-lying areas, the rivulets cause floods that destroy property, destroy forests, and take lives.

Destroying Uncontrolled Life

Wild plants and animals lose their native habitats as a result of deforestation. As a result, wildlife is destroyed. Climate Changes: In areas without forest cover, summer temperatures rise and winter temperatures drop. The amount of rainfall is less frequent.

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SEED LABEL IN REGIONAL LANGUAGES- A STEP TO AVOID CROP LOSSES

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Introduction

Crop productivity ultimately depends on quality of seeds sown and agronomic practices followed. And hence, seeds are considered as essential and crucial input for any crop production. The investment on seed is less than 5% of cost of production but yet this 5% investment will decide the fate of remaining 95% investment made on other agronomic practices during production. By knowing the importance of seeds, Indian Seed Act 1966 was passed to safe guard the rights of farmers for quality seeds. As per the Indian Seed Act 1966 **"Seed certification is voluntary and labelling compulsory"**. This clearly says that any seeds sold as a seed should be label and sold in the market. This label may be azure blue for certified seed class and Opel green for truthfully labelled class.

Certified seeds:

These are seeds certified by seed certification officer of State Seed Certification Agency (SSCA) as per the Seed Act 1966. Only notified kind and varieties under Section V of seed Act are certified by the certification Officer. Any issues related to seed quality during commercial crop production will be handled by concerned Seed Certification Officer only. The risk is on the shoulder of seed certification agency and Producer. Public sectors/ organizations like National Seed Corporation (NSC), State Seed Corporation (SSC), State Agriculture and Horticulture Universities, Krishi Vijnana Kendra, State Farms and very few private companies are involved in certified seed production of varieties in cereals, pulses and oil seeds. These are considered as high volume low value crop seeds, as the seed rate per unit area is more and cost of seeds are less. Certified seeds are released to the market with tag/ label issued form seed certification officer and producer tag from seed producer.

Truthfully labelled seeds (TFL's):

These are seeds certified by the seed producer himself as self certified seeds. No involvement of seed certification agency in assuring the seed quality. To encourage the investment in seed industry from private firms, provisions were made in Seed Act 1966 for self certified seed class. With this relaxation of volunteer certification and compulsory labelling, has attracted huge investment in research and development of new promising hybrids in all kind of crops. However, these private sectors are concentrating on high value low volume crops like hybrids of cereals and vegetable crops. The complete responsibility of seed quality sold will be held by the seeds producer himself.

Note: There is no difference in seed quality of certified seed and truthfully labelled seeds. Both should meet minimum seed certifation standards as per Indian Seed Act.

Both the seed categories contains seed label on seed packets compulsorily. On the seed label information of seeds are printed in English language for the benefit of farmers. A seed label should contain following information;

General Information

Kind: crop and type
Name of the variety:
Type: OPV or Hybrid (F1/ Hy)
Date of Testing:
Date of packing:
Validity period:
Seed Lot number:
Seed quantity: in g/ number
Price (MRP): Rs.

Seed standards

Min. Genetic purity (%)
Min. Pure seeds (%)
Max. Inert Matter (%)
OCS (no./kg)
Weed seeds (no./kg)
Min. Germination (%)
Moisture content (%)

Specific Information

Recommended Region
Recommended Season
Seeds treatment status

Producer Information

Producer details
Marketing details
Customer service Toll Free number

All the above information has to be printed on seed label with specific size based on the seed packet size compulsorily. However, all these information are printed and published in English language only where it initiates problems and leading to crop loss.

Why information on seed label is important?

Seeds are tested compulsorily for seed standards in Seed Testing Laboratories notified under Seed Act of private STLs as per the protocol of seed Certification Board. Seed Analyst will conduct the test and issue seed analysis report and hence, only quality seeds are released to the market. As mentioned earlier seed standards for certified class and TFL class is same there is no difference in quality of seeds. However, in recently complaints are being filed on many TFL class for crop performance rather than seed germination. Farmers are facing problems due to poor/no flowering, poor fruit setting or no fruit setting or no yield rather than germination alone. Such performance problems are majorly reported in hybrids rather than traditional varieties or high yielding varieties. Hybrids are known for their uniform crop performance and higher yield due to higher responsive for external application of nutrition and proper disease management. However these are known for photo insensitivity and wide environmental adaptability character but recent hybrids are more responsive for temperature and day length. Any hybrid/ variety before releasing for commercial production its mandatory to give information on production season too. Lack of such information on recommended season among farmers are leading to crop loss and no economic earnings.

Vegetable seed industry is majorly dominated by private seed companies and their share is more than 85%. Public sector is involved in onion and chilli where OPV are in demand. These private companies are doing seed business majorly in TFL seeds category which does not require release and notification of kind and variety under section V of seed act 1966. Release of new varieties for commercial production from public organization should be done scientifically and follow strict protocol and procedure as per state level sub-committee. But it’s not the same for private varieties or hybrids. In Karnataka, private companies will apply for permission/ registration to release new varieties/ hybrids based on the trial data developed by company itself. In Tamil Nadu private companies will request for permission for state department based on the field trail conducted by companies but inspected by specialized scientists of state agri/ horticulture universities. Whereas, in Maharashtra and Gujarat, field testing trial of new varieties/ hybrids will be conducted by concerned scientists of state agri/ horticulture universities as and when requested by private companies. Based on the data presented on performance during testing trial variety/ hybrid will be released for commercial cultivation after registration.

On the seed label its mandatory to give information about recommended region and season for that particular hybrid/variety. The information on recommended region and season will decide the yield potentiality of particular hybrid/variety. However, farmers are under still under loss after all these strict monitoring of seed sales. Following are few illustrations;

Case study 1: Sri Kempegowda s/o Boregowda from Kebballi village, Mandya, Karnataka has grown okra by sowing the crop in March, 2023. He is unaware about the contents of seed label stating the season for that particular hybrid from private seed company. There was no problem in seed germination or vegetative growth or flowering or fruiting, but the problem was in fruit quality interms of colour. Consumer prefers dark green – medium green fruits as good quality in okra. Such fruits fetches higher price in the market. While, light green colour pods indicates poor quality and implies over maturation of the pods. Farmer has practiced all agronomic practices as per the package of practice of the crop and got good yield but unable to earn income due to poor colour of the fruits and incurred huge loss. High temperature during fruit development stage may have resulted poor colour development in okra. The problem is the ignorance about recommended season for that particular hybrid and it was *kharif* but not for summer.

Case study 2: A farmer in Piriyapatna, Mysuru, Karnataka, has grown 3 acres of pumpkin hybrid during summer, but that particular hybrid has been recommended for *khraif* and *rabi* season only. There was good vegetative growth, but no production of female flowers resulting in no fruit setting in pumpkin.

Case study 3: Paddy farmer in Mandya district of Karnataka has grown two acres of paddy variety released from a private company of Andhra Pradesh. The crop growth was good and has produced panicles profusely however, there was no grain setting and majority of panicles were chaffy without grain. When enquired, it came to know that the particular variety has not been recommended for Karnataka and that information has been given on seed label but farmer was unaware about the recommended region.

Recently such poor crop performance complaints are submitted to department of horticulture questioning supply of poor seed quality. But the basic issue is the ignorance during selection of hybrid/ variety from the farmers end. On the seed label details of kind, variety, recommended region and season to grow along with seed standards and validity period has been mentioned. But majority of the farmers are ignoring such details and facing problem in crop performance. Such issues are increasing due to change in the climate too. Any slight changes in temperature or sun shine hours during flowering or fruit setting resulting in no flowering or poor colour development affecting final quality of fruits.

Solution?

Seed sellers/ retailers/ dealers and farmers should be educated about the recommended region and season of the varieties/ hybrids in the market. Further, create awareness about reading seed label. Here farmers are facing problem as they don't know to read in English, all seed labels are printed in English language only. The solution to make farmers to read seed label is to print the label in respective regional languages so that farmers will be well aware of information about the variety/ hybrid he is interested to grow. This awareness will help farmer to grow the crop at recommended region and season.

Precautions to be taken during purchase of seeds?

1. Information about the kind and variety
2. Information of class of seeds purchased
3. Seed validity period
4. Recommended region and season
5. Seed treatment status
6. Collect valid credit/cash bill (seeds are exempted from any kind of tax/ No tax on seeds)
7. Mention kind, variety, seed lot number and producer details on bill
8. Keep the seed purchased bill and seed packet/ label safely till the produce are sold in the market.

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RECENT ADVANCES IN NEMATODE MANAGEMENT IN RICE UNDER CHANGING CLIMATE SCENARIO

Article ID: AG-VO4-I01-48

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Introduction

Climate is the primary determinant of agricultural productivity. The most important fact of global climate change is the increase in the atmospheric temperature due to increase in the greenhouse gases. Over the last 2000 years, the global temperature has risen around 4^0C. The direct impact of climate affect plant growth and yield due to change in rainfall and temperature. Increase in temperature would reduce crop duration, enhance crop respiration, change the pattern of crop pests and diseases, shift equilibrium of pest and disease attack and accelerate the nutrient mineralization thereby reduce the fertilizer use efficiency. All these could ultimately affect crop yields in the long run. The major challenges the world faces today is to ensure food security to the rising population. There has been an estimate of rise in the world population by 35% around 2050 with increase in the food demand in the order of 75% due to economic development and changes in food preference.

Rice is an important crop of the world grown in 114 countries of Asia, Africa, Central & South America and North Australia. Asia accounts 90% of rice production in the world. China, India, Indonesia, Bangladesh and Vietnam are the five highest rice producing areas of the world (FAO, 2008). There are five major rice growing environments which have great impact on pests, disease and plant parasitic nematodes and their effect on rice. Irrigated rice constitutes of 53% of world rice growing areas produces of 75% of total rice production. Rain fed lowlands constitute 31% of world rice areas and have wide range of growing conditions related to depth and duration of standing water. Deep water paddy comprises of 3% of the rice area. These areas mostly occur in the river deltas of South and South-East Asia.

Sl. No.	Nematode	Rice affected
1.	*Aphelenchoides besseyi*	Irrigated, lowland
2.	*A. nechaleos*	Irrigated, lowland
3.	*A. paranechaleos*	Irrigated, lowland
4.	*Ditylenchus angustus*	Deep water paddy
5.	*Hirschmanniella oryzae*	Irrigated, lowland and deep water
6.	*H. mucronata*	Irrigated, lowland and deep water
7.	*H. gralilis*	Irrigated, lowland and deep water
8.	*H. belli*	Upland and irrigated
9.	*H. imamuri*	Upland and irrigated
10.	*H. mexicana*	Upland and irrigated
11.	*H. spinicaudata*	Upland and irrigated
12.	*Heterodera oryzicola*	Upland and irrigated
13.	*H. elachista*	Upland and irrigated
14.	*H. sacchari*	Upland and irrigated
15.	*H. oryzae*	Upland and irrigated
16.	*M. graminicola*	Upland and irrigated
17.	*M. javanica*	Upland and irrigated
18.	*M. incognita*	Upland and irrigated
19.	*M. anenaria*	Upland and irrigated
20.	*M. oryzae*	Upland and irrigated
21.	*M. salasi*	Upland and irrigated
22.	*M. triticoryzae*	Upland and irrigated
23.	*Pratylenchus indicus*	Upland
24.	*P. brachyrus*	Upland
25.	*P. zeae*	Upland

Tidal wet lands occur near the sea coast and inland estuaries and are directly or indirectly influenced by lids. Uplands constitute 3% of world rice production. It is grown in soil without surface water accumulation. Most rice in Africa and Latin America and upland. Plant parasitic nematodes are major threat in global production and productivity of the crops. Plant parasitic nematodes contribute an average yield loss up to 14.6% in tropics and subtropics and 8.8% in developed countries.

Plant parasitic nematodes of rice

Since rice is grown under diverse agro climatic conditions of the world several plant parasitic nematodes are found associated this crop in various regions of the world under different growing conditions. A list of plant parasitic nematodes affecting rice is provided below.

Ditylenchus angustus

This nematode causes ufra (India) or Tiem dot san (Vietnam). This nematode is distributed in Bangladesh, Burma, India, Madagascar, Malaysia, Thailand and Vietnam mainly in major river deltas on both deep water and low land rice.

Symptoms and damage

- White patches, on white speckles in splash pattern develop at the base of young leaves during vegetative stage.
- Brown stains develop on leaves and sheaths.
- Leaves inside such sheaths are wrinkled.
- Young leaf bases are twisted, leaf sheath distorted and lower node swollen with irregular branching.
- After heading infected panicles are crinkled with empty shriveled glumes.
- The panicle head and flag leaf and twisted and distorted.
- Panicles often remain completely enclosed within leaf sheath (swollen ufra) on partially emerge (ripe ufra).

Management

- Destruction and removal of infected stubbles, straw and burning the stubbles gives effectives control (Butler, 1919).
- New growths in ratooning hills after harvest of rice should be destroyed to prevent further multiplication.

- Lowland transplanted rice rotated with mustard, another non-host and jute is not affected by *D. angustus* (Chakraborty, 2000).
- Removal of volunteer rice, wild rice and other weed host will prevent the carryover of nematodes from one rice crop to next.
- Nematodes easily spread in surface water. Preventing flow of river water into fields by construction of bunds on banks will be beneficial.
- *D. angustus* survives for a short periods and lengthening overwinter periods can reduce primary infection (Das and Bhagwati, 1992). This can be achieved by using short duration rice cultivars on late sowing and transplanting.
- In Vietnam four improved breeding likes, IR 9129-393-3-1-2, IR 9129-169-3-2-2, IR 9224-117-2-3-1 and IR 2307-247-2-2-3 and three cultivars BKN 6986-8, CNI 53 and Jalaj are described to be slightly infected by this nematode. Two cultivars IR 36 and IFT 4094 in West Bengal were less susceptible (Chakrabarty *et al.*, 1985). The Rayada group of deep water rice in Bangladesh are reported to exhibit promising resistance (Das and Sarmah, 1995). The cultivars Padmapani and Digha in this group are not attacked by this nematodes species.

Aphelenchoides besseyi

This is a seed borne nematode which causes white tip disease in rice.

Symptoms and damage

- Susceptible plants may be symptomless but in general yield loss occurs in plants exhibiting some symptoms.
- At early growth stage there is emergence of chloratip leaf tip upto 1/3rd new leaves from leaf sheath because nematodes feed on cells of leaf primordia resulting in misalignment of epidermal and motor cells.
- These tips later grow dry and curl while the rest of the leaves are normal.
- The young leaves are speckled with white splash pattern on distinct chlorotic pattern.
- The base of the flag leaves may be characteristically twisted.
- Viability of infected seed is lowered, germination is delayed.
- Diseased plants have reduced vigour and height.
- Infected panicles are shorter with fewer spikelets

- Infected plants mature late and have sterile panicles borne on tillers produced from high nodes.

Management

- Straw, debris and weeds should be removed and should be buried or burnt at the time of transplanting.
- Hot water treatment of paddy seeds should be done at 53-55^{0}C for 10 minutes. For this one volume of seed is soaked in two volumes of water and then two volumes of boiled water are added and stirred continuously for 10 minutes to maintain a temperature of 53-55^{0}C.
- Soak paddy seeds with 0.1% carbosulfan for 6 hours followed by foliar spraying with 0.02% carbosulfan 40 days after transplanting.
- Use of healthy certified on nematode free seeds is one of the best ways to avoid this nematode damage.
- Sowing paddy seeds under flooded condition removes the nematodes from plant surface.
- Sun drying of paddy seeds 6 hours daily for 4 days on a hot cemented floor during April and May reduces maximum number of nematodes present inside the grain.
- Varieties of rice viz., Gurmatia, CO 13, Ratna, Padma, Vijaya, Sona, IR 30, Kaveri, Annapurna and TKM 9 are resistant to white tip nematodes.

Root knot nematodes

Several species of *Meloidogyne* are associated with rice. *M. anenaria, M. incognita* and *M. javanica* are ubiquitous and of major economic significance in temperate, warm and tropical regions. *M. graminicola* has been reported from Bangladesh, India, Laos, Thailand, USA and Vietnam.

Symptoms and damage

- Above ground symptoms include chlorosis, wilting, retarded maturation and reduction in growth and tillering. It also reduces elongation activity of deep water paddy.
- All the *Meloidogyne* spp. can cause swellings and galls throughout the root system. Infected root tips become swollen and hooked.
- In upland conditions and shallow flooded land, all species can cause severe growth retardation, unfilled spikelets, reduced tillering and poor yield.

Management

- Continuous flooding is very effective for control of *Meloidogyne* spp. to minimum.
- Fallow on crop rotations with non-host plants reduces root-knot nematode populations. Rotation with groundnut, sweet potato, maize and soybean are effective in reducing *M. graminicola* populations.
- Cultivars resistant to *M. graminicola* include ARC-12620, CR-94-CCRP-51, INRC-202, Baharsia, Bonnet 73, Dumai, Garum, Hamsa, IR-2, IR-5, IR-47 and Patni 6.
- Nursery treatment with carbofuran @ 0.1 g a.i/m^2 and field application of carbofuran 1 kg a.i/ha 40 days after transplanting is very effective.
- Soaking paddy seeds in 0.1% carbosulfan for 12 hours is also equally effective for control of root-knot nematodes.
- *Pseudomonas fluorescence* @ 20 g/m^2 in nursery bed reduces seedling infection by root-knot nematodes. Substances with low carbon to nitrogen (C/N) ratio, such as leguminous green manures and oilcakes, produce a rapid increase in soil NH_3 which is toxic to nematodes and they also stimulate the growth and activity of nematode antagonistic or predatory organisms. Effect control of nematode is obtained by mustard/sorghum species green manures which produce isothiocyanate and HCN compounds effectively during decomposition.

Conclusion

Although many species of plant parasitic nematodes have been reported on rice, quite a few of them are of economic importance. However, the economic importance of the above species is often influenced by environmental conditions. The nematodes which are of economic importance today may not be that important after few years because of changing climatic scenario. Minor important nematodes may pose a greater threat in future. Control of rice nematode poses a number of problems, because measures to control one nematode species may increase the damage caused by another. Cultivars with resistance to nematodes are important component of control of nematodes in the present age of global warming.

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FOOD LOSS AND WASTE IN FISH VALUE CHAINS

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Abstract

Fishing is a significant source of animal protein in a variety of ways, but since the capture fisheries industry and the resources it depends on are frequently overfished and in danger of being overfeed, reducing losses and waste in the industry must come before looking for ways to boost production. Identifying and comprehending the primary reasons for loss is essential to providing decision-makers with the knowledge they need to minimize fish loss and waste. The exploratory fish loss assessment method (EFLAM) is based on a series of quantitative and qualitative data on fish losses, as well as their operations. The methodology is designed to facilitate the transformation of knowledge and shared experiences into actions directed toward production systems that are environmentally sound, socially acceptable, and economically justified. This paper presents a comprehensive analysis of fish loss, waste, and economics in the value chain of fish value chains. Efforts should focus on reducing post-harvest losses, improving supply chain infrastructure, enhancing consumer awareness, and promoting responsible consumption practices. By tackling these issues comprehensively, we can minimise the waste of this valuable natural resource and ensure that fish can continue to play a vital role in global nutrition and livelihoods.

Introduction

Approximately 17% of animal protein consumed worldwide is made up of fish, with over 20 kilograms consumed annually per person. Fishing can be preserved as a significant source of animal protein in a variety of ways, but since the capture fisheries industry and the resources it depends on are frequently overfished and in danger of being overfished, reducing losses and waste in the industry must come before looking for ways to boost production.

An estimated 27% of fish that are landed worldwide are lost or wasted in between landing and consumption. Identifying and comprehending the primary reasons for loss is essential to providing decision-makers with the knowledge they need to minimize fish loss and waste. When it comes to fish, food loss refers to fisheries and aquaculture products that are meant for human consumption but are eventually not consumed by people or have degraded in quality, which typically results in a decrease in both nutritional and commercial value. Worldwide, the fishing and aquaculture industries employ 200 million people, most of whom are found in developing nations. A significant portion of these workers are women, who work mostly in processing.

Food loss

Food loss (FL) is the term used to describe the decline in food quality or quantity that occurs in the food value chain during the phases of harvesting or post-harvest processing.

Food waste

Food waste (FW) is the term for throwing away or putting food to another use when it was fit for human consumption. It results in food loss, usually at the distribution and consumer household level, either by choice or as a result of food being neglected and allowed to rot or expire.

Causes of food loss and waste

Capture fisheries: Fish capture is the act of collecting and removing fish from their natural habitat. In addition to fishing gear and techniques, it employs a wide range of technology, from artisanal to highly industrial vessels and equipment.

Loss situation in transport:

- ✓ Handling on board in both small and big scale fisheries
- ✓ Discards
- ✓ Freezers Vessels

Aquaculture: Across the whole value chain, employment in aquaculture is provided for both genders. High mechanization through the use of cutting-edge feeding harvesting and processing technologies, or low input through the use of simple feeds and basic equipment.

Loss situation in aquaculture:

- ✓ Agricultural loss scenario
- ✓ Post harvest handling

Processing and storage: The terms "processing" and "storage" describe actions used on fish to change or preserve it in various operating conditions. In small-scale fisheries, removing fish entrails, smoking, sundrying, and salting are typical examples of traditional processing methods.

Loss situation in Processing and storage:

- ✓ Fish products are stored by artisans
- ✓ Fish drying
- ✓ Salting are done by artisans
- ✓ Fish processing
- ✓ Fish canning
- ✓ Freezing
- ✓ Cold storage

Wholesale:

A range of fish products, including fresh, frozen, dried, smoked, and live ones, are sold in wholesale fish markets. Products can originate from aquaculture and small-scale fishing. They may be kept for longer lengths of time or they could go through in a couple of hours.

Loss situation in wholesale:

- ✓ Fish landing sites
- ✓ Urban wholesale marketplaces

Transport

A crucial component of most fish value chains, if not all of them, is transportation. Between the time of harvest and ultimate consumption, it might happen at a variety of points. Numerous modes of transportation are employed. Transport methods for fish and fish products include walking, bicycling, canoeing, motorcycling, rail-up trucks, boats, lorries, refrigerated trucks, shipping in reefer containers, and flying. Fish that is live, fresh, frozen, dried, smoked, and canned, as well as the majority of fish-based products, all undergo some sort of transit. Transport durations and distances might range from a few hours to several weeks.

Loss situations in transport:

- Fish landing centres

- Urban wholesale markets

Retail

Fish and fish products supplied to consumers for home preparation and consumption are referred to as retail. This also includes the final preparation of fish consumed away from home. Retailers come in many different forms: from global chains to mobile fish vendors, mini-marts, markets, and fisher shops.

Loss situations in retail:

- ✓ Restaurants
- ✓ Caterers
- ✓ Shops
- ✓ Multiple retailers
- ✓ Fresh fish

Consumption

The quantity of fish that is fit for human eating is called consumption. Depending on the amount of fish lost and wasted in the home, it can be of worse quality than the accessible fish.

Loss situations in consumptions:

- ✓ Poor planning
- ✓ Overspending
- ✓ Inadequate freezing

Solutions for reducing FLW fish value chains are:

- Provide advantages in economics
- Boost food security
- Increase the effectiveness of using natural resources
- Lessen waste and its effects on the environment
- Apply appropriate technology
- Require skills and expertise
- Be subject to regulations
- Promote social and gender justice
- Markets

Methodologies to access food loss and waste in food value chains

1. Exploratory fish loss Assessment Method (EFLAM)

2. Load tracking (LT)

3. Questionnaire loss Assessment Method (QLAM)

Exploratory fish loss Assessment Method (EFLAM)

The planned yet adaptable exploratory fish loss assessment technique (EFLAM) can be used to swiftly produce indicative quantitative and qualitative data on fish losses. This approach is predicated on the resources and ideas linked to the two research approaches listed below:

Participatory Rural Appraisal	Rapid Rural Appraisal
PRA approaches make it easier to capture the View point of the fisherman, greatly increasing the community of beneficiaries involvement in analysis and decision-making. The methodology allows for the application of tools that facilitate the transformation of knowledge and shared experiences into actions directed toward production systems that are environmentally sound, socially acceptable, and economically justified.	The Rapid Rural Appraisal (RRA) approach seeks to integrate rural communities perspectives and expertise into the development and administration of development initiatives. Its emphasis on actively interacting with locals and getting first-hand information from them is a crucial component. A interdisciplinary team is therefore required.

EFLAM data collection techniques and tools:

• Semi- structured interview with key informants (SSI)

• Group interviews with stakeholders

• Observation

• Flow diagrams

• Triangulation

• Community-level validation workshop

• Load Tracking

This is typically used to get data for the assessment of loss between two stages in a distribution chain that are statistically valid and significant. It entails the real measurement or observation of conditions related to a fish sample or fish product before and after they occur. Opportunities for loss reduction can be found and the effectiveness of interventions can be evaluated by using LT. It can be applied as a quick troubleshooting method for companies experiencing issues with low-quality external raw material supplies or as an internal analysis tool for company losses.

Purpose of load tracking

Load tracking is used to

1. Measure physical and quality losses.
2. Identify why and where losses occur.
3. Observe activities that cause or avoid losses.
4. Estimate the value of losses in monetary terms.
5. Monitor, evaluate and test the effectiveness of loss reduction interventions.

Questionnaire loss Assessment Method (QLAM)

Formal questionnaire surveys are the foundation of the Questionnaire Loss Assessment Method (QLAM). A number of inquiries concerning physical and qualitative loss, as well as their operations, are posed to fishermen, traders, and processors. The responses are noted and subjected to statistical analysis. Before making any attempts to intervene. QLAM is utilized to validate any loss cause and effect data obtained using EFLAM or load tracking approach.

Conclusion

Food loss and waste in fish value chains are significant issues with far-reaching economics, environmental, and social consequences. In conclusion, addressing these challenges is crucial for sustainable fisheries management and global food security. Efforts should focus on reducing post-harvest losses, improving supply chain infrastructure, enhancing consumer awareness, and promoting responsible consumption practices. By tackling these issues comprehensively, we can minimise the waste of this valuable natural resource and ensure that fish can continue to play a vital role in global nutrition and livelihoods.

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SUPPRESSIVE SOIL: A NATURAL WAY TO CONTROL SOIL BORNE DISEASES

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Abstract

This study explores disease suppressive soils, where pathogens fail to establish or cause minimal damage. It categorizes suppressiveness into general and specific types, driven by antagonistic microorganisms with mechanisms including direct parasitism and competition. While naturally present, human attempts to enhance these microorganisms face challenges. The advantages of disease suppressive soils include reduced pesticide use, but their integration into organic farming demands intensive management. Documented cases worldwide highlight the potential, particularly in Fusarium wilts and take-all of wheat. To manage suppressive soils effectively, practices like incorporating root-colonizing microorganisms and improved agronomy are proposed, offering a sustainable approach to disease control.

Keywords: Disease suppressive soils, Antagonistic microorganisms, Sustainable agriculture, Pathogen control, Agronomic practices

Introduction

Soil is a complex mix of organic and inorganic matter that includes thousands of different species, the vast majority of which are still undescribed. Some of the organisms are pests which cause significant crop losses while others perform 'environmental services' such as biological control of pests, aeration, drainage, nutrient and water cycling. As a dynamic living resource, soil is the basis of sustainable agriculture, as well as the physical support for most other human activities. Disease suppressive soils have been recognized for over 100 years and the mechanisms by which disease suppression is brought about has been the subject of study for nearly four decades. Disease suppressive soils are defined by Cook and Baker (1983) as soils in which the pathogen does not establish or persist, the pathogen establishes but causes no damage or the pathogen causes some disease damage, but the disease becomes progressively less severe even though the pathogen persists in soil. The degree of suppressiveness is linked to soil physical conditions, fertility level, biodiversity and populations of soil organisms and soil management.

Concept

The concept of disease suppressive soil has been described in terms of general suppression and specific suppression.

1. General suppression

General suppression of a pathogen is directly related to the total amount of microbial activity in the soil or plant at a critical time in the life cycle of the pathogen. The general suppression is non-specific, operates against most, if not all pathogens and involves the activities of many resident soil organisms.

2. Specific suppression

Specific suppression operates against only certain types of pathogens. Specific suppressiveness has been described for *Fusarium* wilts*, Gaeumannomyces graminis* var. *tritici*, *Phytophthora* spp., *Pythium* spp., *Rhizoctonia solani* and *Thielaviopsis basicola*. In all cases, a particular pathogen causes significantly less disease in suppressive soils than in other soils (Conducive soils); the effect is lost when soil is treated with biocides, indicating the involvement of microorganisms.

The phenomena of disease suppressive soils have been documented for numerous plant-pathogen systems around the world and few of them are provided in table 1. Among plant/fungal patho-systems, soils suppressive to Fusarium wilts caused by *F. oxysporum* or take-all of wheat caused by *G. graminis var. tritici* has been studied most extensively and represents a classical example of plant –fungal patho- system in suppressive soil.

Table 1: Plant pathogens concealed by disease suppressive soils

Pathogen involved	Disease	Reference
Cyst nematode *Heterodera* spp.	Molya disease	Kerry 1988; Westphal & Becker, 1999
Streptomyces scabies	Scab	Menzies, 1959
Fusarium oxysporum	Wilt	Stotzky & Martin, 1963; Scher & Baker, 1980
Phytophthora cinnamomic	Root rot	Broadbent & Baker, 1974
Plasmodiophora brassicae	Clu root rot	Murakami *et al.*, 2000
Pythium spp.	Damping off	Hancock, 1977
Rhizoctonia solani	Root rot	Henis*et al.*, 1978, 1979

Mechanisms of Action

The mechanisms by which antagonistic microorganisms affect pathogen populations are not always clear, but they are generally attributed to one of the four effects: (1) direct parasitism or lysis and death of the pathogen, (2) competition with the pathogen for food, (3) direct toxic effects on the pathogen by antibiotic substances released by the antagonist, and (4) indirect toxic effects on the pathogen by volatile substances, such as ethylene, released during the metabolic activities of the antagonists.

Many of the antagonistic microorganisms mentioned earlier are naturally present in crop soils and exert certain degree of biological control over one or many plant pathogens regardless of human activities. Humans, however, have been attempting to increase the effectiveness of antagonists either by introducing new and larger populations of antagonists, e.g., *Trichoderma harzianum* and *Pasteuria penetrans,* in fields where they are lacking and/or by adding soil amendments that serve as nutrients for, or otherwise stimulate growth of, the antagonistic microorganisms and increase their inhibitory activity against the pathogen. Unfortunately, although both approaches are effective in the laboratory and in the greenhouse, neither has been particularly successful in the field. New microorganisms added to the soil cannot compete with the existing microflora and cannot maintain themselves for very long. Also, soil amendments, so far, have not been selective enough to support and build up only the populations of the introduced or existing antagonists. Thus, eventually their potential for disease control is quite limited. There are several cases of successful biological control of plant pathogens where the antagonistic microorganism is used for direct protection of the plant from infection by the pathogen.

Advantages and disadvantages

Suppressive soil reduces the legal, environmental and public issues and by reducing the use of pesticides it indirectly reduces the residual effect of hazarduous chemicals. In addition to this, suppressive soil can easily be integrated with plant disease management under organic farming. However, development of suppressive soil takes more intensive management and planning and the disease control is not achieved immediately.

Several soilborne pathogens, such as *Fusarium oxysporum* (Vascular wilts), *Gaeumannomyces graminis* (Take-all of wheat), *Phytophthora cinnamomi* (Root rots of many fruit and forest trees), *Pythium spp.* (Damping-off), and *Heterodera avenae* (Oat cyst nematode) cause severe losses when occur in conducive soils. However, in suppressive soils, they are not able to develop profusely and cause significantly less damage. The mechanisms by which soils are suppressive to different pathogens are not always clear but may involve biotic and/or abiotic factors and may vary with the pathogen. In most cases, however, it appears that they operate primarily by the presence in such soils of one or several microorganisms, antagonistic to the pathogen. Such antagonists, through competition, or parasitizing of the pathogen, production of antibiotics and/or lytic enzymes, do not allow the pathogen to reach high enough populations to cause severe disease. Numerous kinds of antagonistic microorganisms have been found to increase in suppressive soils; most commonly, however, disease suppression has been shown to be conducted by fungi, such as *Trichoderma, Penicillium, and Sporidesmium*, or by bacteria of the genera *Pseudomonas, Bacillus, and Streptomyces*. Suppressive soil added to conducive soil can reduce the amount of disease by introducing microorganisms antagonistic to the pathogen. For example, soil amended with soil containing a strain of a *Streptomyces* species becomes antagonistic to *Streptomyces scabies* (Potato scab), and resulted potato tubers became significantly free from potato scab. Suppressive, virgin soil has been used, for example, to control Phytophthora root rot of papaya by planting papaya seedlings in suppressive soil placed in holes in the orchard soil, which was infested with the root rot causing fungus *Phytophthora palmivora*.

Suppressive Soil Management

1. **Incorporation of root colonizing rhizosphere microorganisms:**

These organisms can promote phytostimulatory and biofertilising effects which make the plant 'stronger'. Many rhizosphere microorganisms can induce a systemic response in the plant, resulting in the activation of plant defence mechanisms.

2. **Better agronomic practices:**

Adaptation of cultural practices has been proposed as a means to decrease the soil inoculum potential or increase the level of suppressiveness to diseases. Indeed, disease suppressiveness has been obtained through crop rotation, biofumigation, intercropping, residue destruction, organic amendments and tillage management practices alone or in different combinations.

The phenomenon of disease suppressive soils has been documented for numerous plant-pathogen systems around the world. Harnessing the potential of these soils as a practical means to manage diseases in agro-ecosystems has long been a goal of plant pathologists. It has been well demonstrated and documented that the manipulation of microbial communities to induce a disease suppressive soil environment does possess potential as a tool in the management of soilborne plant diseases. The initial objective of biological control is to maximize soil suppressiveness through the manipulation of resident antagonists. These microorganisms probably resided in equilibrium with pathogens and plants before the intervention of agriculture. However, the residents may not be present at sufficient levels for effective disease control at specific vulnerable sites on the plant or at specific vulnerable stages of crop growth. In these circumstances, the population has to be enhanced with inoculants formulation, knowing that the site and conditions are favourable for the control agents.

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SOILLESS CULTURE

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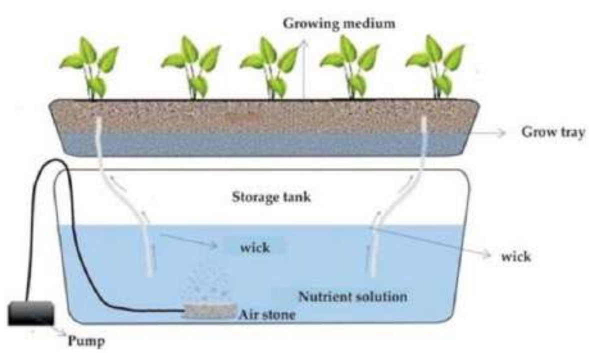
Introduction

Soil less culture is a method of growing plants without soil. It is an artificial means of providing plants with support and a reservoir for nutrients and water. The plants are grown in an inert growing medium and the nutrition is applied through nutrient solution (water and fertilizer mixed). The simplest and oldest method for soilless culture often called as solution culture or water culture but there are literally hundreds of method of soil less gardening with slight modifications. Soilless culture in modern agriculture includes technique of hydroponics and aeroponics.

Hydroponic Structures and Their Operation

Hydroponic system are customised and modified according to recycling and reuse of nutrient solution and supporting media. Commonly used systems are wick, drip, ebb-flow, deep water culture and nutrient film technique (NFT) which are described below.



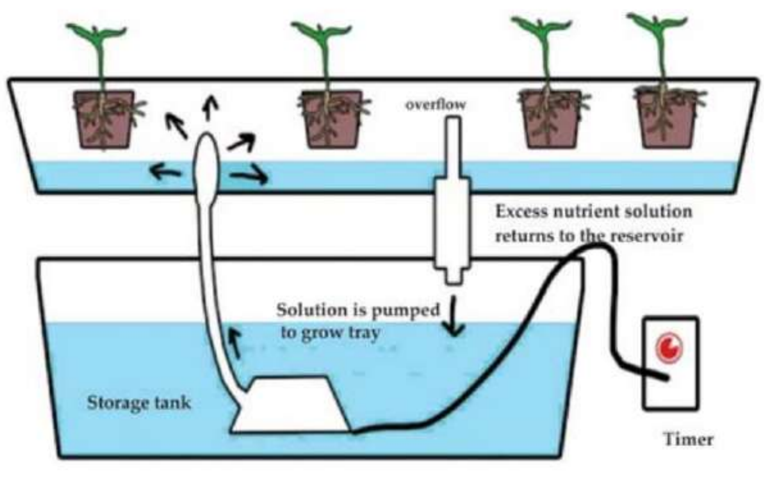
Wick System

Wick System

This is simplest hydroponic system requiring no electricity, pump and aerators (Shrestha and Dunn, 2013). Plants are placed in an absorbent medium like coco coir, vermiculite, perlite with a nylon wick running from plant roots into a reservoir of nutrient solution. Water or nutrient solution supplied to plants through capillary action. This system works well for small plants, herbs and spice and doesn't work effectively that needs lot of water.

Ebb and Flow system

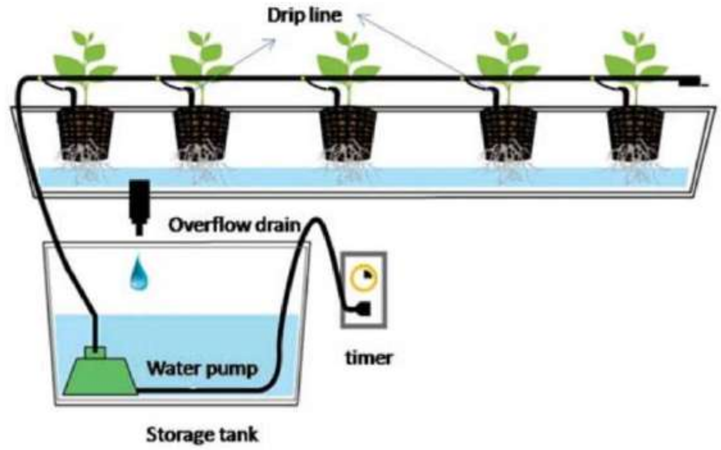
This is first commercial hydroponic system which works on the principle of flood and drain. Nutrient solution and water from reservoir flooded through a water pump to grow bed until it reaches a certain level and stay there for certain period of time so that it provide nutrients and moisture to plants. Besides, it is possible to grow different kinds of crops but the problem of root rot, algae and mould is very common (Nielsen *et al.*, 2006) therefore, some modified system with filtration unit is required.



Ebb & Flow System

Drip system

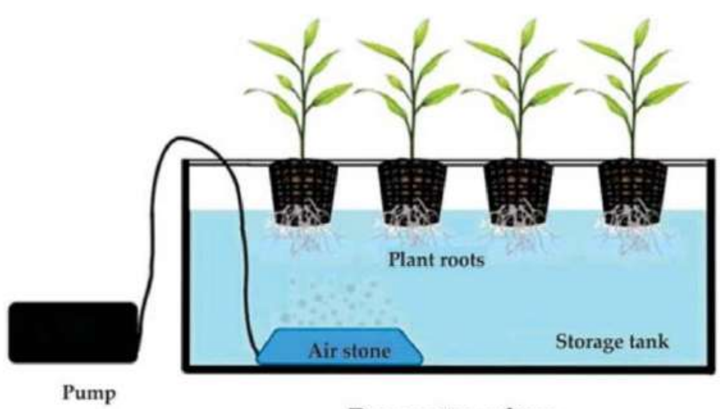
The drip hydroponic system is widely used method among both home and commercial growers. Water or nutrient solution from the reservoir is provided to individual plant roots in appropriate proportion with the help of pump (Rouphael and Colla, 2005). Plants are usually placed in moderately absorbent growing medium so that the nutrient solution drips slowly. Various crops can be grown systematically with more conservation of water.



Drip system

Deep water culture system

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. Hydroponics buckets system is classical example of this system. 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 (Domingues *et al.*, 2012) as algae and moulds can grow rapidly in the reservoir. This system work well for larger plants that produce fruits especially cucumber and tomato, grow well in this system.

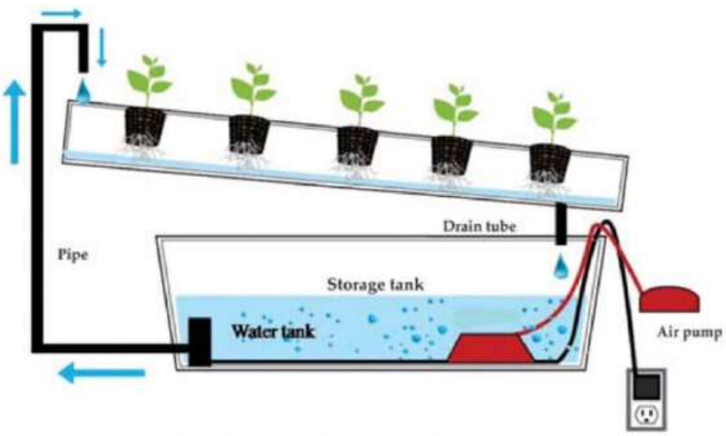


Deep water culture

Nutrient Film Technique (NFT) system

NFT was developed in the mid 1960s in England by Dr. Alen 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

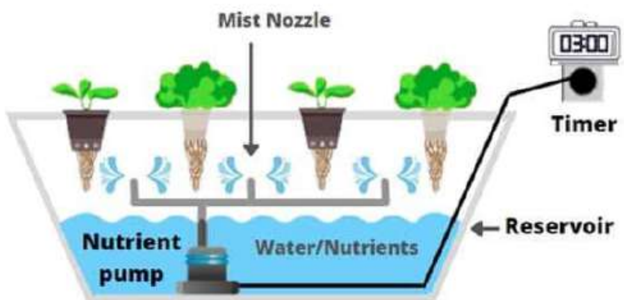
(Domingues *et al.*, 2012). The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir. Plants are placed in channel or tube with roots dangling in a hydroponic solution. Although, roots are susceptible to fungal infection because they are constantly immersed in water or nutrient. In this system, many leafy green can easily be grown and commercially most widely used for lettuce production.



NFT (Nutrient Film Technique)

Aeroponics

Aeroponics is the practice of growing plants in an air or mist environment without the use of any substrate. That is, the plant roots are suspended in the air and are misted or sprayed periodically with a nutrient solution or aerosol of nutrient solution. Water and nutrient use efficiency in an aeroponic system are higher than those in NFT or DWC systems. The biggest advantage of aeroponics is that roots are exposed to air, thus there is never an issue of insufficient oxygen. Its disadvantages are high initial construction costs, high maintenance of the system, and high level of technical knowledge required.



Advantages of Soilless Culture

- Better quality produce.
- No soil borne diseases and pests.
- No weed problem.
- No need of fumigation.
- Continuous cultivation is possible.
- Efficient use of available resources.
- More productivity per unit area and time.
- Cultivation of crops are possible in saline and desert areas.
- One can grow the crops who do not have their own field.
- Helps to face challenges of climate change.

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