NOVEMBER 2023 | VOLUME 03 | ISSUE 11

(ISBN : 978-81-965582-9-1)

AgriGate

GROW WITH EVERY PAGE!

An International Multidisciplinary Monthly e-Magazine

CONTENTS

CONTENTS

CONTENTS

CONTENTS


PRADHAN MANTRI KRISHI SINCHAI YOJANA
Farmers' Welfare
Rs. 50 thousand crore to be spent in five years to bring 140 lakh hectares additional area under irrigation
Har Khet ko Pani
To bring 28.5 Lakh hectare area under irrigation during the year 2016-2017
Rs. 12,517 crore to be incurred on 23 irrigation schemes in 2016-17
#TransformingIndia

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS


CONTENTS

CONTENTS

From the Desk of Editor-in-chief

November 2023| Vol. 3 |Issue No.11

I would like to introduce the launch of **"AgriGate - An International Multidisciplinary Monthly e-Magazine Volume 03 Issue No. 11 – November 2023"** with immense pleasure. Our team is privileged to dedicate this issue to **National Education Day (November,11)** is an annual observance in India to commemorate the birth anniversary of **Maulana Abul Kalam Azad**, the first education minister of independent India. The day is also seen as an occasion to the foundations of the education system in an independent India, and evaluating and improving the country's current performance in the field of Agriculture.

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

- AgriGate shall not take any responsibility for the contents of articles published in the magazine and all such responsibility shall lie with the author/s.
- The opinions expressed in the articles are solely of the author/s.
- Authors should also confirm that submitted manuscript is not under consideration for publication elsewhere (Simultaneous submissions).
- Once a manuscript is submitted for publication, it is considered that no part of the manuscript is copyrighted by any other nor is under review by any other publication.
- It is the sole responsibility of the author to obtain proper permission for the use of any copyrighted materials in the manuscript, prior to the submission of the manuscript.
- All the articles submitted for publication in AgriGate are reviewed for usefulness.
- Decision of the reviewers shall be final.
- Authors are solely responsible for originality of the published work.
- AgriGate shall not be liable to you or anyone else for any damages (including, without limitation, consequential, special, incidental, indirect, or similar damages)


NamFarmers.com™
a Tara Blooms Initiative
Open gate for
AGRO PRODUCTS
Let's market globally
NamFarmers.com™
a Tara Blooms Initiative
English
Welcome Back, Kanakasabapathi
Good Afternoon!
Search Agri Jobs
Add Job Vacancy
Magazines
Rs. 160 / Kg(s)
Rs. 1800 / Litre(s)
Value Added Products
Moringa Leaf Powder
Tuticorin
Organic: Yes
Purpose: Selling
Quantity: 1 Kg(s)
Available Date: May, 26 2023
Value Added Products
Moringa Oil
Tuticorin
Organic: No
Purpose: Selling
Quantity: 1 Litre(s)
Available Date: May, 26 2023
GET IT ON
Google Play
Available on the
App Store
T&Cs Apply

Volume: 03 Issue No: 11

A TENSIOMETER - A TOOL FOR MONITORING SOIL MOISTURE AND SCHEDULING IRRIGATION

Article ID: AG-VO3-I11-01

***Sravanthi, D, Laxman, P, Neelima, P, Ramesh, R, Reddy Priya, P, Pavani, T, Shivakumar, R, Ramprasad, M and Naganjali, K**

Agricultural College, Aswaraopet

Professor Jayashankar Telangana State Agricultural University (PJTSAU), Telangana, India

*Corresponding Author Email ID: danamsravanthi@gmail.com

Introduction

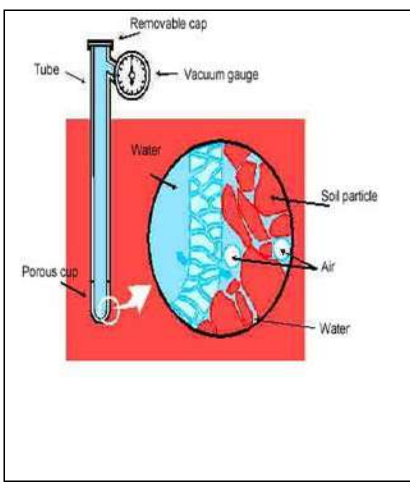
Tensiometer is an instrument designed to provide a continuous indication of the soil moisture tension and helpful for scheduling irrigation because they are sensitive to changes in soil water. The practice of deciding when and how much water to apply for irrigation is known as irrigation scheduling. Reduced yields might occur from applying too little or too much water at the wrong time. Over irrigation wastes water, costs money to pump, and may leach nutrients beyond the root zone. Tensiometers can be used to monitor the soil water condition, which is crucial for scheduling irrigation. Tension is experienced by plant roots when they extract water from a soil matrix. Tensiometers are instruments that simulate mechanical roots in order to measure the water tension in the soil. This mechanical root has a gauge that measures the force continuously.

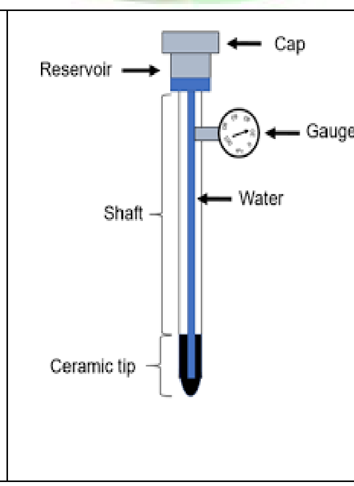
Reservoir and cap: The body tube gets its water supply from the reservoir. The tensiometer needs an airtight seal provided by the reservoir cap in order to function. In certain types, the system is sealed immediately by the cap, and the body tube serves as a reservoir instead of a larger one.

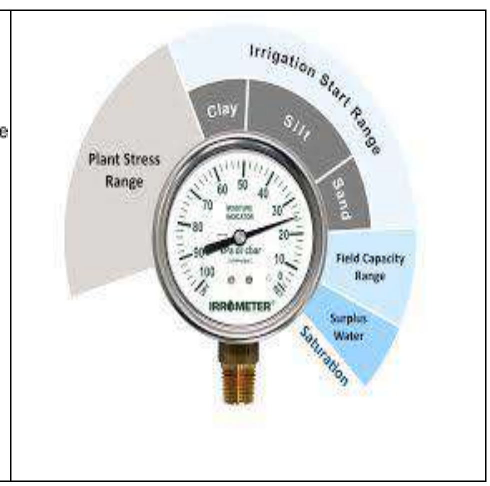
Body tube: The body tube provides support and a liquid connection between the porous tip and the vacuum gauge. Tensiometers come in various lengths, standard lengths are 6, 12, 18, 24, 36, 48, and 60 inches.

Ceramic tips: The ceramic tip is porous, but the openings are so small that when saturated with water, air cannot pass through within the range of soil water tensions to be measured. The vacuum dial gauge reading changes as water exits the porous tip, indicating the suction, or tension, at which the surrounding soil is drawing the water.

Vacuum gauges: The vacuum gauge is calibrated in centibar or hundredths of one “bar.” A bar is the unit of pressure, either positive or negative, that has been adopted for the expression of soil suction. The bar is an international unit of pressure in the metric system and is equivalent to 14.5 psi (pounds per square inch) or 0.987 atmospheres. One centibar is also equal to 1 kPa (kilopascal). A reading of zero corresponds to a completely saturated condition, regardless of the type soil. A reading of 80 indicates a very dry condition for sandy soils or sensitive crops. This also is the functional upper limit for tensiometer readings. A tension higher than 80 will cause the water column inside the tube to break rendering it nonfunctional. A depth label is usually placed on the vacuum gauge or on the side of the tube to indicate the depth at which the ceramic tip will be set when installed. This is important for identification purposes. The soil suction reading on the vacuum gauge dial is an indication of soil water availability for plant use and does not require calibration for salinity or temperature. The readings have different meaning in terms of use for irrigation scheduling depending on soil type. Each situation is different, so irrigators should monitor crop conditions, such as wheel track compaction or plow pans, that can affect root development and water movement in the soil.







	
Tensiometer installed in field	**Vacuum guage**

Procedure:

1. Select a representative spot in the cropped field. Usually between plants with in a row for convenience during the intercultural operations

2. Make a vertical hole equal to the cup diameter to the desired depth using a screw agar or a coring tool

3. Carefully remove the agar, make sure no rocks fall back into the hole. Sometimes pouring water along the driving short in easy coring of hole.

4. Collect the soil in an aluminium box. Prepare thick slurry of the collected soil and pour it in the hole.

5. Prepare the tensiometer for installation. Fill the tensiometer with distill water. Observe for any air gaps or a Bubbles in the tube

6. Hitting the top of the tensiometer with an open palm will also dislodge any air bubbles from the sides of the tensiometers.

7. Replace the cap, twisting until the stopper reaches the bottom of the reservoir, you do not need to turn too hard

8. Place the cup of the tensiometer in the mouth of the cored hole. Force the cup into the holes by pushing directly down on the cap. Do not wobble or rotate the tensiometer shaft do not push on the gauge. After properly positioning the cup of tensiometer maintain at least 3 cm distance between the bottom of the gauge and the soil surface.

9. After positioning the cup properly place small amounts of water into the bottom of the hole and allow it to soak in. This ensures proper contact of ceramic up with soil

10. Build a mount around the tensiometer to prevent the water from the running directly down the sides of the tensiometer

11. Allow the tensiometer to attend equilibrium and start monitoring the soil water tension readings in the vacuum gauge

12. Record the soil water tension reading in the vacuum gauge at the same time each day, in early morning

13. From the soil moist characteristics curve estimate the soil water content with respect to the soil moisture tension measured by tensiometer

Working Principle

Soil water exists primarily as thin films around and between soil particles and is bound to soil particles by strong molecular forces. As the soil dries, the water films become thinner and more tightly bound to soil matrixes. Water is pulled from the ceramic tip as a result of the films' increased tension when they come into contact with the tensiometer. A partial vacuum is created in the tensiometer by the removal of water from the ceramic tip. Water is sucked in until the tension of the external water films is equivalent to the vacuum generated inside the tensiometer. Water stops flowing at this point because equilibrium has been established. The amount of suction or tension is indicated by the reading on the vacuum gauge.

The soil suction decreases as more water is added to the soil through irrigation or rainfall. Soil water is sucked into the tensiometer due to the higher vacuum within, and the vacuum will be lowered until the tension is balanced. The tensile device

TABLE: 1 INTERPRETATION OF TENSIOMETER READINGS

Reading	Status	Auction
0	Saturated	Soil is saturated regardless of soil type. If readings persist, there is possible danger of waterlogged soils, a high water table, poor drainage and soil aeration; or the continuity of the water column in the tube may have broken.
5-10	Surplus water	Indicates a surplus of water for plant growth. Drainage

		continues and persistent reading indicates poor drainage
10-20	Field Capacity	Field capacity for all types of soils. Additional water will drain as deep percolation carrying nutrients without opportunity for plant use. Sandy soils, however, have very little storage capacity, and suction values increase rapidly as water is removed by plants past 15 to 20. For sensitive crops, like potato, rapid irrigation may be required before damaging stress can develop.
20-40	Irrigation range	Available water and aeration good for plant growth in fine- and medium-textured soils. Irrigation is not required for these soils at this range. Coarse-textured soils may require irrigation in the 20 to 30 range and finer sandy soils at 30 to 40 centibar ranges.
40-60		Usual range for starting irrigation. At 40 to 50 centibar, irrigation may need to be started for loamy soils. On clay soils (silty clay loams, silty clays, etc.) irrigation usually starts from 50 to 60. Heavy clay soils still have some available water. Irrigation, however, ensures maintaining readily available soil water. The stage of growth and type of crop will influence the decision
70	Dry	Stress range. However, crop is not necessarily damaged. Some soil water is available in clay soils but may be low for maximum production.
80		Top range of tensiometer accuracy; higher readings are possible, but tension within the water column inside tensiometers will break between 80 to 85 centibar. This has relationship to elevation of the area compared to mean sea level. At higher elevation, the water inside the tube may break at a lower reading according to atmospheric pressure.

Merits:

- Repeated measurements at the same location
- Nondestructive method
- Suitable for scheduling irrigation to crops raised in coarse textured soil where majority of ASM is between 0-0.85 bars or 0 to 85 kPa or centibars and requiring frequent irrigations

Demerits:

- Measurements limited to 0.85 bars suction only
- Maximum depth of insertion is about 5 m only
- Water in the tension must be maintained always at a constant height
- Requires few hours for equilibration after initial installation

Volume: 03 Issue No: 11

EMPOWERING COASTAL FARMERS THROUGH SCALING UP SEAWEED FARMING

Article ID: AG-VO3-I11-02

***Dr. Smriti Singh**

Assistant Professor

School of Agriculture, Sanjeev Agrawal Global Educational University, Bhopal

*Corresponding Author Email ID: smriti.s@sageuniversity.edu.in

Introduction

When the world is looking for sustainable alternatives in agriculture and allied sector, India seems highly ambitious to utilize the untapped seaweeds of marine ecosystem. Seaweeds are primitive, marine non-flowering marine algae without root, stem and leaves, play a crucial role in marine ecosystems. It adapts well to all environments and in all geographical conditions. One of the significant reason to ramp up its farming is it needs no freshwater, no fertilizers and no clearer land to grow. Researchers are looking forward for seaweed farming at large scale as it has potential to improvise ocean health, helps in climate mitigation and provide food security to the exploding population.

Seaweed as savior of marine ecosystem

It provides habitats for marine life forms and protect them from threats. On their part, the seaweeds derive nutrition through photosynthesis of sunlight and nutrients present in seawater. They release oxygen through every part of their bodies.

Some nutrients found in large water bodies are toxic to the marine life and can even kill them. Seaweeds, found mostly in the intertidal region, in shallow and deep waters of the sea and also in estuaries and backwaters, absorb the excess nutrients and balance out the ecosystem.

Seaweed as a super food

Researchers indicate Seaweed as ‘nutrition bomb’ as Seaweed consists of fibers, antioxidants, minerals, amino acids, Iodine. But excessive consumption of seaweed can lead to Iodine toxicity. Due to its nutritive value, it can be utilized in both human and animal feed. So stakeholders are promoting its farming for growing ecosystem.

Seaweed as revenue generating tool

Seaweeds have multifarious uses in industries. Decent Revenue can be generated by incorporating seaweeds in medicines, beauty products, biofuels, and packaging material. It is used as an ingredient in preparing toothpaste, cosmetics and paints.

Seaweeds as a bio-indicator

When waste from agriculture, industries, aquaculture and households are dumped into the ocean, it causes nutrients imbalance which leads to algal blooming. Aquatic organisms rely on iron for photosynthesis. When quantity of Iron exceeds healthy levels and becomes dangerous to marine life, seaweeds trap it and prevent damage. Similarly, most heavy metals found in marine ecosystems are trapped and removed by seaweeds.

Seaweed as frugal option for carbon sequestration

Seaweed has a significant role in mitigating climate change. By afforesting 9 per cent of the ocean with seaweed, it is possible to sequester 53 billion tons of carbon dioxide annually. Hence, it has also been proposed to term it as ‘ocean afforestation’ for farming seaweed to remove carbon.

Seaweed as feed

The importance of seaweed in agriculture and animal husbandry as feed is noteworthy. Due to its high nutritive value it can be used as a substitute of protein in human diets too. They can be used as fertilizers and to increase fish production. Also, the use of seaweed as fodder has bestowed it with names such as ‘cow’ seaweed, ‘horse’ seaweed and ‘pig’ seaweed.

Sea weed as methane reducing agent

When livestock is fed with seaweed, methane emission from cattle may be reduced substantially. The protein content of certain seaweeds is found to be higher than soybeans on DM basis and its products limit the dysfunction of the digestive system or kidney problems and improves the quality of milk and the longevity of dairy cows. A red seaweed – *Asparagopsis* – is found to reduce methane emissions in dairy animals.

Seaweed as packaging material

Plastic pollution has been a grave concern of environmentalists since long so seaweeds gelatins and other chemicals can be utilized for alternative is to plastics in packaging industries which will be eco-friendly.

Considering the ecological values of seaweeds, it is essential for the central and state governments to initiate speedy and scientific action for sustainable management of seaweeds to conserve them for posterity. India has a huge potential to utilize untapped resource of seaweeds and outcscale its production for industrial purposes.

Initiatives to be taken by Government to scale up seaweed farming:

- **Incentives to promote seaweed farming**

Incentives can be a motivating factor to ramp up seaweed farming. It will encourage farmers to adopt it on wider scale and shift from traditional farming. Seaweed farming will be promoted in a mission mode and supported under PMMSY through financial, marketing and logistical support to ensure income and welfare gains to small fisher population especially women and fisherwomen headed households. Seaweed seed banks, nurseries, tissue culture units, processing and marketing units, etc. would be supported.

- **Seaweed park**

Tamil Nadu government has passed a bill to establish Seaweed Park to scale up the cultivation for industrial uses and attract different stakeholders engaged in its commercialization and profitability.

- **Circulate Success stories of Farmers performing seaweed farming**

Uplifting and motivating farmers through success stories and giving them awards will bring sense of pride among them and encourage other fellow farmers to adopt the same.

- **Demonstration and training to fish farmers**

Awareness of profitability of the ecological and industrial values of seaweeds is need to be showcased to the farmers for their outlook change. Women and youths should be specifically encouraged for participation I the trainings for better life.

If all the stakeholders farmers, researchers, industrialists, policy makers unite and work systematically in the promotion and commercialization of seaweed farming then we would be able to utilize it fully and improve the socio-economic status of coastal farmers with the limited resources and changing climate.

Volume: 03 Issue No: 11

CLASSIFICATION OF RESINS

Article ID: AG-VO3-I11-03

M. Packialakshmi* and Rajput Nikhil Balu

[1]Assistant Professor (Forestry), Vanavarayar Institute of Agriculture, Pollachi- 642 103, Tamil Nadu, India

[2] Research scholar, Forest College and Research Institute, Mettupalayam 642 301.Tamil Nadu

*Corresponding Author Email ID: mpackialakshmi16@gmail.com

Introduction

Resin, any natural or synthetic organic compound consisting of a noncrystalline or viscous liquid substance. Natural resins are typically fusible and flammable organic substances that are transparent or translucent and are yellowish to brown in colour.

The resins are broadly classified under three major categories, namely:

a. Taxonomical Classification: The resins are grouped according to their botanical origin exclusively, such as:

i. Coniferous Resins: e.g., Colophony, Sandarac;

ii. Berderidaceae Resins: e.g., Podopyllum and

iii. Zygophyllaceae Resins: e.g., Guaiacum

In this particular instance, it has been observed that the resins that usually occur in plants of the same natural order, may exhibit more or less related characteristics features.

b. Chemical Classification: The resins may also be classified as per the presence of the predominating chemical constituents for instance:

- **Acid Resins:** e.g., Colophony (Abietic acid); Sandarac (Sandracolic acid); Shellac (Alleuritic acid); Myrrh (Commiphoric acid);
- **Ester resins:** e.g., Benzoin (Benzyl benzoate), Storax (Cinnamyl cinnamate);
- **Resin Alcohols:** e.g., Balsam of Peru (Peruresinotannol),

Guaiacum resins (Guaicresinol); Gurjun balsam (Gurjuresinol);

- **Resene Resins:** e.g., Dragon's Blood (Dracoresene); Gutta-percha (Fluavil);
- **Glycoresins:** e.g., Jalap resin from jalap i.e, Ipomea purga Haynel; (Family: Conrulvulaceae) Podophylloresin from the dried roots and rhizomesof Podophyllum hexandrum (P.emodi) Royle. (Family Berberidae)

Constituents of resin:

Invariably, to maintain the simplicity, resins may also be classified according to the major constituents present either in the resin or resin combination e.g., Resins; Oleo-resins; Oleo-gum resins; Balsams. After having been exposed to the various aspects of resins with regard to their physical and chemical properties, occurrence and distribution, preparation, chemical composition and classification, it would be worthwhile to gain some in-depth knowledge about certain typical examples belonging to resins; Oleo-resins; Oleo-gum-resins; Balsams; and Glycoresins.

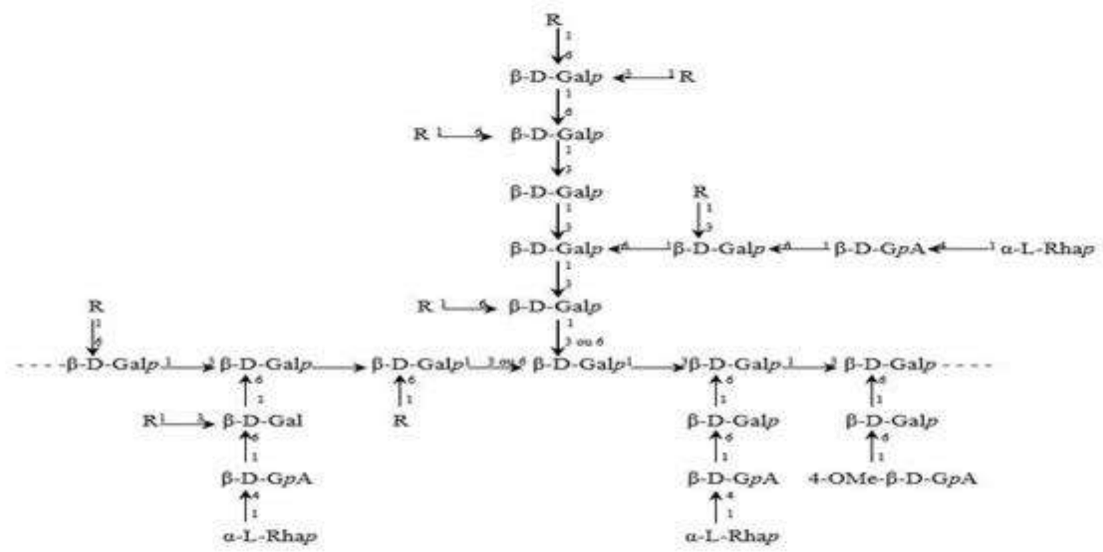
Structural aspects of gums and resin

i) Chemical properties:

a. Gums:

All the properties and applications of gums are closely linked to their chemical structures. Gums can be formed by numerous sugars, in their main chains and/or side chains, and can be more or less branched, which determines, in general, their complexity. The gum exudates are composed on dry weight basis by 2.45% of proteins, 0.85% of fats and 92.36% of carbohydrates. The latter consist of arabinose, xylitol, galactose and uronic acid (46.8: 10.9: 35.5: 6.0 mass ratio) with traces of rhamnose, mannose and glucose. Moreover, gum exudates are rich in minerals, such as sodium, potassium, magnesium, calcium and iron.

The gum arabic, produced by the *Acacia senegal* species, has a main chain made up of -D-galactopyranose joined by bonds (13) and alternated by highly branched bonds (16), as well as lateral chains made up of 4-O-methyl-glucuronic acid (1.5 percent), glucuronic acid (17.5 percent), galactose (39 percent), arabinose (28 percent), and rhamnose (1.5 percent) (14 percent). (L-Araf 13 L-Araf); (-L-Arap 13 L-Araf); (L-Araf 13 L-Araf 13 L-Araf); (-L-Arap 13 L-Araf 13 L-Araf); (-L-Arap 13 L-Araf 13 L-Araf 13 L-Araf 13 L-Araf 13 L-Araf Araf stands for arabinofuranoside, Arap for arabinopyranoside, and galp for galactopyranoside. "R" stands for radicals.



b. Resin:

The resin produced by most plants is a viscous liquid, composed mainly of volatile fluid terpenes, with lesser components of dissolved non-volatile solids which make resin thick and sticky. The most common terpenes in resin are the bicyclic terpenes alpha-pinene, beta-pinene, delta-3 carene and sabinene, the monocyclic terpenes limonene and terpinolene, and smaller amounts of the tricyclic sesquiterpenes, longifolene, caryophyllene and delta-cadinene. Some resins also contain a high proportion of resin acids. The individual components of resin can be separated by fractional distillation.

A few plants produce resins with different compositions, most notably Jeffrey Pine and Gray Pine, the volatile components of which are largely pure n-heptane with little or no terpenes. The exceptional purity of the n-heptane distilled from Jeffrey Pine resin, unmixed with other isomers of heptane, led to its being used as the defining zero point on the octane rating scale of petrol quality. Because heptane is highly flammable, distillation of resins containing it is very dangerous. Some resins when soft are known as 'oleo-resins', and when containing benzoic acid or cinnamic acid they are called balsams. Other resinous products in their natural condition are a mix with gum or mucilaginous substances and known as gum resins.

Many compound resins have distinct and characteristic odors, from their admixture with essential oils. Certain resins are obtained in a fossilized condition, amber being the most notable instance of this class; African copal and the kauri gum of New Zealand are also procured in a semi-fossil condition.

- Resins, in general, are enriched with carbon, deprived of nitrogen and contain little oxygen in their respective molecules.
- Majority of them undergo slow atmospheric oxidation whereby their color gets darkened with impaired solubility.
- Resins are found to be a mixture of numerous compounds rather than a single pure chemical entity.
- Their chemical properties are exclusively based upon the functional groups present in these substances.
- Consequently, the resins are broadly divided into resin alcohols, resin acids, resin esters, glycosidal resins and resene (i.e., inert neutral compounds).
- Resins are regarded as complex mixtures of a variety of substances, such as: resinotannols, resin acids, resin esters, resin alcohols and resene.
- Resins are nothing but oxidative products of terpenes.
- They may also be regarded as the end products of destructive metabolism.
- The acidic resins when treated with alkaline solutions they yield soaps (or resin-soaps).

ii) Physical properties

- Resins are hard, transparent or translucent brittle materials.
- They are invariably heavier than water having the specific gravity ranging from 0.9-1.25.
- Resins are more or less amorphous materials but rarely crystallizable in nature.
- On being heated at a relatively low temperature resins first get softened and ultimately melt down thereby forming either an adhesive or a sticky massive fluid, without undergoing any sort of decomposition or volatilization.
- On being heated in the air i.e., in the presence of oxygen, resins usually burn readily with a smoky flame by virtue of the presence of a large number of C-atoms in their structure.
- On being heated in a closed container i.e., in the absence of oxygen, they undergo decomposition and very often give rise to empyreumatic products i.e., products chiefly comprising of hydrocarbons.
- Resins are bad conductors of electricity, but when rubbed usually become negatively charged.

- They are practically insoluble in water, but frequently soluble in ethanol, volatile oils, fixed oils, chloral hydrate and non- polar organic solvents e.g., benzene, n-hexane and petroleum ether.

Solubility

- Majority of resins are water- insoluble and hence they have practically little taste.
- They are usually insoluble in petroleum ether (a non-polar solvent) but with a few exceptions. Such as: Colophony (freshly powdered) and mastic.
- Resins mostly got completely dissolved in a number of polar organic solvents, for instance: ethanol, ether and chloroform, there by forming their respective solutions which on evaporation, leaves behind a thin-varnish-like film deposit.
- They are also freely soluble in many other organic solvents, namely: acetone, carbon disulphide, as well as in fixed oils and volatile oils.
- Resins dissolve in chloral hydrate solution, normally employed for clarification of certain sections of plant organs.

Isolation of Resins: Pharmaceutical resins are obtained from the plants and animals by one of the following methods.

a) By extraction with alcohol and precipitation with water, e.g. Jalap, Podophyllum, Ipomoea, etc.
b) By distillation for separation of oil, e.g. Copaiba, Colophony, etc.
c) By heating the plant part, e.g. Guaiacum.
d) As plant exudates by incisions, e.g. Myrrh, Asafoetida, Balsams, etc.
e) By collecting fossil resins, e.g. copal, kauri, etc.
f) By processing the encrustations i.e. shellac.

Derivatives

- Solidified resin from which the volatile terpene components have been removed by distillation is known as rosin. Typical resin is a transparent or translucent mass, with a vitreous fracture and a faintly yellow or brown color, non-odorous or having only a slight turpentine odor and taste. It is insoluble in water, mostly soluble in alcohol, essential oils, ether and hot fatty oils, and softens and melts under the influence of heat, is not capable of sublimation, and burns with a bright but smoky flame.

- This comprises a complex mixture of different substances including organic acids named the resin acids. These are closely related to the terpenes, and derive from them through partial oxidation. Resin acids can be dissolved in alkalis to form resin soaps, from which the purified resin acids are regenerated by treatment with acids. Examples of resin acids are abietic acid (sylvic acid), $C_20H_{30}O_2$, plicatic acid contained in cedar, and pimaric acid, C20H35O2, a constituent of galipot resin. Abietic acid can also be extracted from rosin by means of hot alcohol; it crystallizes in leaflets, and on oxidation yields trimellitic acid, isophthalic acid and terebic acid. Pimaric acid closely resembles abietic acid into which it passes when distilled in a vacuum; it has been supposed to consist of three isomers.

Conclusion

The hard transparent resins, such as the copals, dammars, mastic and sandarac, are principally used for varnishes and cement, while the softer odoriferous oleo-resins (frankincense, elemi, turpentine, copaiba) and gum resins containing essential oils (ammoniacum, asafoetida, gamboge, myrrh, and scammony) are more largely used for therapeutic purposes and incense.

Volume: 03 Issue No: 11

PRECISION FARMING: THE FUTURE OF INDIAN AGRICULTURE

Article ID: AG-V03-I11-04

***Gatkal N. R[1]., Nalawade S. M[2]., Shelke, M. S.**

[1,3,4,5]Ph.D. Scholar, Department of Farm Machinery and Power Engineering, Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, MPKV, Rahuri. District-Ahmednagar, State- Maharashtra Pin-413722, India.

[2]Professor and Head, Department of Farm Machinery and Power Engineering, Dr. Annasaheb Shinde College of Agricultural Engineering and Technology, MPKV, Rahuri. District-Ahmednagar State- Maharashtra Pin-413722, India.

[3]Assistant Professor, Bordikar college of agriculture, Sailu-431503, Parbhani., Maharashtra.

*Corresponding Author Email ID: narayan96378@gmail.com

Introduction

With precision farming, inputs are used in precise amounts to provide higher average yields than with conventional cultivation methods. In order to maximize production efficiency, improve product quality, raise the effectiveness of crop chemical use, save energy, and protect the environment, it is therefore a holistic system designed to achieve these goals. It accomplishes this by utilizing essential elements of information, technology, and management (Shibusawa, 2002). Therefore, precision farming is a compelling idea, and it follows naturally from its principles that more efficient use of farming inputs will increase revenues and result in production that is less harmful to the environment. The technology for tomorrow's environmentally friendly agriculture may be provided by the precision agricultural advancements of today. Precision farming aims to significantly increase yields with the use of minimum inputs, especially for small farmers in developing countries (Fountas et al., 2004).

Need of precision farming:

The food system around the world is currently facing significant difficulties that will only get worse over the next 40 years. With today's knowledge and technologies, a lot can be accomplished right away with enough effort and money. The food system will need to undergo more significant changes in order to meet future challenges, and funding for research to develop fresh answers for brand-new issues will be necessary. Major issues in agricultural growth and development now include the decline in total productivity, diminishing and degrading natural resources, stagnating farm incomes, lack of an ecoregional approach, declining and fragmented land holdings, trade liberalisation on agriculture, limited employment opportunities in non-farm sectors, and global climatic variation.

Therefore, one way to boost farm productivity in the future is through the implementation of recently developed technology. A precision farming technique acknowledges site-specific variances within fields and modifies management activities accordingly, as opposed to managing an entire field based upon some hypothetical average state, which may not exist anywhere in the field. Most farmers are aware of the uneven yields that exist throughout their crops.

3.1. Global positioning system (GPS)

With an accuracy range of between 100 and 0.01 m, GPS is a satellite-based navigation system that enables users to record positional data (latitude, longitude, and elevation) (Lang, 1992). The precise location of field data, such as soil type, insect occurrence, weed invasion, water holes, boundaries, and impediments, can be found by farmers using GPS. There is an automatic controlling system with a DGPS, antenna, and receiver for light or sound. The position of GPS receivers is determined via signals emitted by GPS satellites. Inputs (seeds, fertiliser, pesticides, herbicides, and irrigation water) can be applied to a specific field based on performance criteria and past input applications thanks to the system, which enables farmers to accurately identify field locations (Batte and Buren, 1999) as shown in Figure 1.

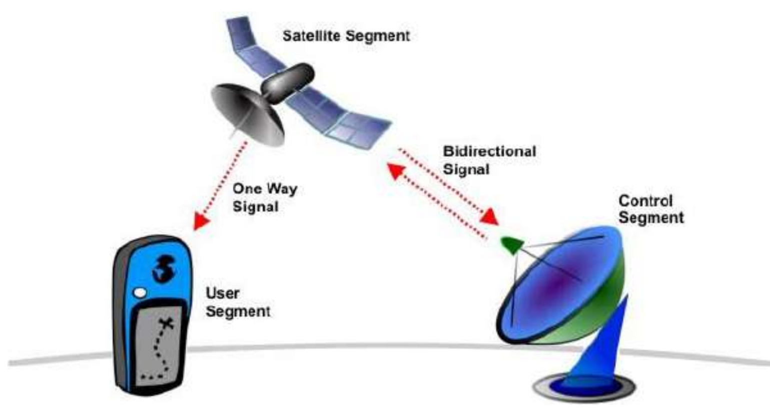


Fig. 1: Principle of Global positioning system.

3.2. Geographic information system (GIS):

System components include hardware, software, and processes for compiling, storing, and retrieving data and location data, as well as feature attribute analysis, to produce maps. GIS connects data in one location so that it can be extrapolated as necessary. Digital GIS maps are distinct. from traditional maps and have multiple informational layers (For instance, crop yield, soil survey maps, rainfall, soil nutrients, and pests). While GIS is a type of computerized map, its primary function is the use of Characters and geography are analyzed using statistical and geographical techniques. An agricultural GIS database can offer details on crop production, crop topography, soil types, surface drainage, subsurface drainage, soil testing, and irrigation (Trimble. 2005). After being analyzed, this data is used to comprehend the interactions between the numerous factors affecting a crop at a particular location. By merging and altering several data layers, management scenarios may be analyzed to compare current and alternative management as shown in Figure 2.

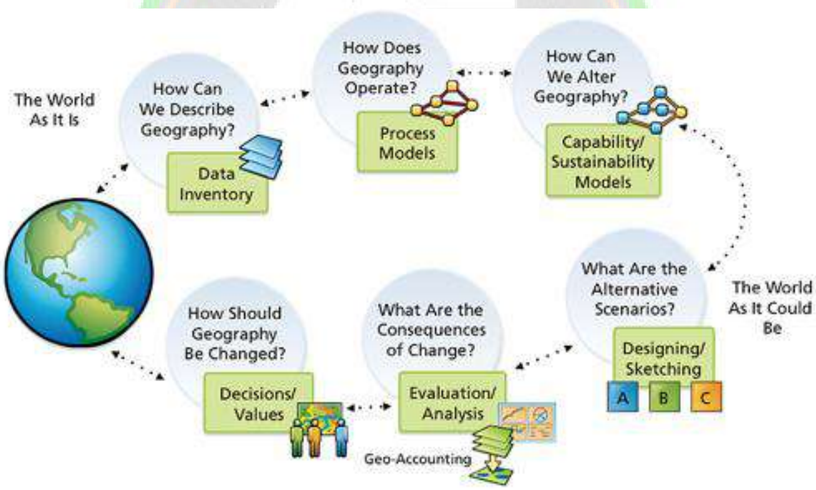


Fig. 2: Geographic information system

3.3. Variable-rate fertilizer (VRT) application and Grid soil sampling:

Automatic variable-rate technology (VRT) may be used in a variety of farming tasks as shown in Figure 3. VRT systems control rate of farm input supply based on the soil type mentioned in soil map The GIS can manage information extrapolated from it. activities include sowing, applying fertiliser and pesticides choosing the proper herbicide and applying it at a different rate the appropriate time and place. Possibly the most popular PFS is VRT (Batte et al., 1999).

The same concepts of soil sampling are used in grid soil sampling as shown in Figure 4, however sampling intensity is increased. Additionally, soil samples gathered in a methodical grid have geographic details that enable the data to be mapped. the objective grid soil sampling is a map of nutrient requirements, known as an application road map. Samples may be gathered for more than one place. of a field that lie within the same range in terms of yield, soil colour, etc. and consequently the same zone. Grid soil samples are examined in each soil sample is analyzed in the laboratory to determine the crop's nutritional requirements. The entire collection of soil samples are then used to plot the map for applying fertilizer. A computer that is mounted on a variable-rate fertilizer spreader has the application map loaded into it. The computer instructs a product-delivery controller to modify the amount and/or type of fertilizer product in accordance with the application map using the application map and a GPS receiver (Ferguson et al., 2007).

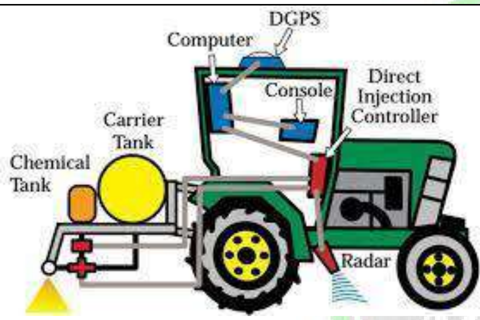


Fig. 3: Variable-rate fertilizer applicator

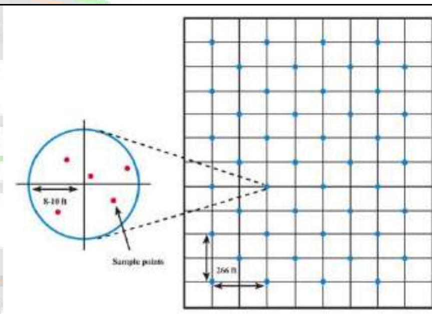


Fig. 4: Soil sampling for precision agriculture.

3.4. Remote Sensing:

Remote sensing is the method used to gather data about items without coming into contact with them directly. Emitting electromagnetic radiation, which moves in waves of varying lengths and passes through vacuum at the speed of light, serves as the information carrier in remote sensing. The visible light (VIS), near infrared (NIR), shortwave infrared (SWIR), thermal infrared (TIR), and microwave bands are the most helpful wavelengths in remote sensing as shown in Figure 5. Active sensors emit their own radiation, which interacts with the target being studied and returns to the measuring instrument. Passive remote sensing sensors record incident radiation that is reflected or released from the objects.

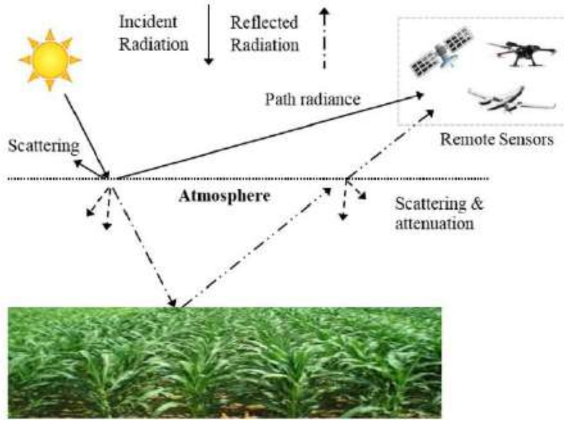


Fig. 5: Remote sensing in precision agriculture

A) Types of sensor:

1) **Active sensor:** Active sensors generate their own energy from beginning to illuminate the objects they are looking at. Radiation is emitted by an active sensor in the direction of the target under investigation as shown in Figure 6. The radiation that is reflected or backscattered from the target is then picked up and measured by the sensor. Like a satellite with a RADAR sensor, the sensor is the source of illumination inside itself. In order to scan the object, active sensors expend their own energy. Active remote sensing techniques like RADAR and LiDAR measure the lag time between emission and return.

2) **Passive sensor:** On the other hand, passive sensors pick up natural energy (radiation) that is emitted or reflected by the subject of the observation. The most frequent source of radiation detected by passive sensors is reflected sunlight. The sensors collect radiation that the object or its surroundings emit or reflect as shown in Figure 6..

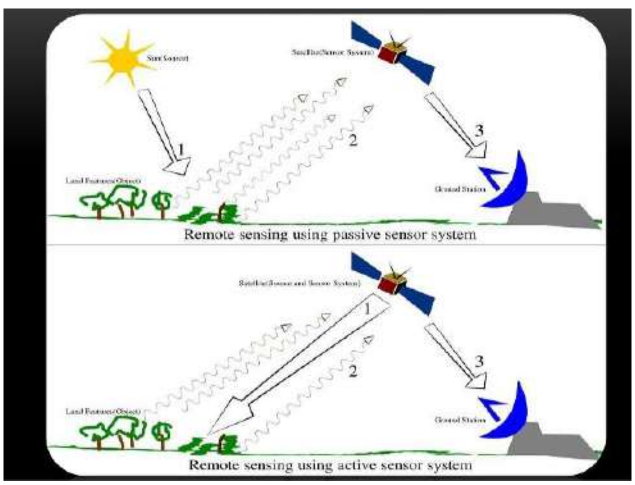


Fig. 6: Types of sensors.

The most frequent source of radiation detected by passive sensors is sunlight reflection. Radiometers, infrared cameras, and photography are a few examples of passive remote sensors. Because passive sensors produce high-quality satellite pictures, they are more often deployed. When it comes to technologically observing the earth, such as using multispectral and hyperspectral technologies, the passive sensor is superior

B) Sensor type:

The benefits and drawbacks of each type of sensor are unique. Challenges for imagery capture include the coverage, image resolution, and flight constraints.

i) **Image Resolution:** Image resolution must also be considered for earth observation. Image resolution in remote sensing is divided into three categories:

ii) **Spatial resolution:** An image's pixel detail is known as its spatial resolution. Greater detail and smaller pixel sizes result from high spatial resolution. Lower spatial resolution, on the other hand, results in greater pixel size and less detail. Typically, drones like the DJI one of the highest spatial resolution photographs. Satellites can produce images with 50 cm or larger pixels, despite being the highest in the atmosphere.

iii) **Spectral resolution:** The degree of spectral complexity within a band. Its bands are more narrow because of the high spectral resolution. Low spectral resolution features narrower bands that cover a smaller portion of the spectrum.

iv) **Temporal resolution:** The length of time needed for a satellite to complete one orbit. UAVs, aircraft, and helicopters are totally adaptable. However, satellites follow predetermined routes as they orbit the Earth. The satellites of the global positioning system are in medium Earth orbit (MEO). They follow a continuous orbital path, therefore revisit times are constant. This means that for high accuracy, our GPS receiver can usually always detect three satellites or more.

C) Application of remote sensing in agriculture:

i) **Identifying crop conditions:** Technologies like the normalized difference vegetation index (NDVI) and satellite photography are used to keep an eye on the world's food supplies. Whereas unhealthy crops reflect red or blue, healthy crops reflect green.

ii) **Determining the soil moisture content:** A satellite in space is used to measure the moisture content of the soil using both active and passive sensors. Numerous earth sciences, including the water cycle, floods, and droughts, are reliant on the amount of moisture in the soil.

iii) **Crop production forecasting:** Remote sensing is employed to forecast agricultural yield and production over a given field and to calculate how much of the crop will be harvested under the given circumstances. The number of crops that will be produced over a specific time period on a given farm can be predicted by the researcher.

iv) **Determining crop damage and crop progress:** Remote sensing technology can be utilized to penetrate farms in the event of crop damage or crop progress in order to ascertain the precise amount of a specific crop that has been damaged or under stress as well as the progress of the remaining crop in the farm.

v) **Crop condition analysis and stress detection:** The assessment of the health of the crop and the degree to which it has withstood stress relies heavily on remote sensing technology. The quality of the crop can then be determined using these data.

vi) **Drought Monitoring:** Remote sensing technology is used to track localized weather trends, especially patterns of drought. The data is used to predict local rainfall patterns and to estimate the interval between the current and the following rainfall, both of which are useful for monitoring droughts.

vii) **Water content determination of the field crop:** Remote sensing is crucial for estimating the amount of water in field crops in addition to determining the moisture content of the soil.

viii) **Crop health analysis:** It is also possible to determine a crop's health, which helps in calculating the agricultural yield.

ix) **Disaster Management and Mitigation:** A sophisticated GIS system is being employed to safeguard the environment. It has evolved into an effective, well-developed, comprehensive solution for disaster management. By showing which areas are likely to be vulnerable to natural or man-made disasters, GIS can aid in risk management and analysis.

x) **Surveying:** A land survey involves calculating the angles and distances between various points on the surface of the planet. GNSS measurements are being used by more and more national, regional, and local organisations. For topographic surveys, where centimeter-level accuracy is offered, GNSS is used. The GIS system can use these data. Both digital maps and GIS tools can be used to estimate an area.

xi) **GIS for Fisheries and Ocean Industries:** Ocean data gains value and capabilities from GIS technologies. The spatial data for a fisheries assessment and management system are determined using ArcGis. In the ocean industry, it is widely used, and we receive accurate information about a variety of commercial activities. to improve the fishing industry's ability to reduce costs. Additionally, it can locate illicit fishing operations.

xii) **Pest Control and Management:** The production of agriculture products is helped by pest management. A decline in agricultural output may result from an increase in insect and weed activity. GIS is therefore crucial in mapping out infected areas. This results in the creation of a plan for managing weeds and pests.

3.5. Crop management: Farmers can more clearly understand by using satellite data the range in topography and soil conditions that affect crop inside the industry performance. Farmers may thus accurately control the use of seeds, fertilizers, and pesticides during production using water management and herbicides to boost productivity.

3.6. Soil and plant sensors: It have been extensively reported that sensors are used to provide data on soil characteristics, plant fertility, and water status. Sensor technology is a key component of precision agriculture technology. a thorough list of available sensors as well as attributes that might make new sensors attractive in the future (Adamchuk et al., 2004).

3.7. Rate controllers: Rate controllers regulate the rate at which liquid or granular chemical inputs, like as fertilizers and insecticides, are delivered. It keeps track of the tractor/speed sprayer's as it crosses the field, as well as the material's flow rate and pressure, and it makes modifications in real time to apply the desired rate. The usage of rate controllers in standalone systems is common.

3.8. Precision livestock farming (PLF): The management of livestock production using precision agriculture is known as precision livestock farming (PLF) as shown in Figure 7.

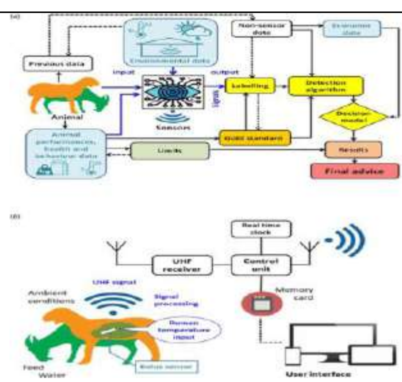


Fig. 7: Precision livestock farming

Fig. 8: Precision farming in horticultural field

The methods of precision livestock farming put an emphasis on characteristics of animal behavior, egg and milk production, disease detection, and growth of the animals. Systems include new automated feeding and weighing systems, as well as monitoring of milk to check fat and microbial levels, helping to identify potential infections. It also emphasizes automatic cleaners, feed pushers, and other tools. Pigs' increased coughing, which is an indication of a respiratory infection, is picked up by acoustic sensors. Other sensors are now used to deliver alerts and notifications related to childbirth and fertility

3.9. Precision farming in horticultural field: The recent and rapid adoption of machine vision techniques in fruit and vegetable farming enables growers to grade products and to monitor food quality and safety, with automation systems recording metrics linked to product quality. These characteristics include colour, size, form, flaws on the outside, sugar content, acidity, and other internal characteristics as shown in Figure 8. In order to provide entire fruit and vegetable processing processes, tracking of field operations, such as chemical spraying and fertilizer use, may also be possible (Njoroge et al., 2002).

3.10. Precision farming on arable land: The most popular and advanced PA approach among farmers is its application to arable land. CTF is a whole-farm strategy that tries to reduce the costs associated with traditional methods by preventing unneeded crop damage and soil compaction by heavy machinery. Controlled traffic approaches use GNSS technology and decision support systems to restrict all field vehicles to the smallest possible area of permanent traffic lanes. Optimizing the use of fertilizers, starting with the three primary nutrients nitrogen, phosphorus, and potassium, is a significant application of precision agriculture in arable land.

3.11. Yield monitor: Yield monitors are made up of several parts. They frequently contain a variety of sensors and other parts, such as a data storage device, user interface (display and keypad), and task computer, which is housed in the combine cab and manages the integration and communication of these parts. The sensors measure the speed of the separator, the ground speed, the mass or volume of the grain flow, and the grain itself. Grain yield is continuously monitored by measuring the force of the grain flow as it collides with a sensible plate in the combine's clean grain elevator.

3.12. Software: In order to perform a variety of tasks, including display-controller interface, information layer mapping, pre and post processing data analysis and interpretation, farm accounting of inputs per field, and many other duties, precision agricultural technologies are frequently applied. Software to filter acquired data, software to make variable rate applications maps (e.g. for fertilizer, lime, chemicals), software to generate maps for yield and soil, software to overlay multiple maps, and software to provide advanced geostatistical characteristics are the most prevalent.

3.13. Mobile apps: It is quite simple to share or acquire any information from anywhere due to the increasing use of electronic gadgets like smartphones, tablets, and other devices, as well as the accessibility of internet connectivity. Apps for Android offer rapid and effective functionality that can develop with technology. The apps created for agriculture monitoring and information exchange can benefit farmers in areas like PA significantly. Applications intended to monitor agriculture provide information such as meteorological data, market rates and availability, etc. Similar apps can offer forecasting of the weather, a selection of seedlings, fertilizers, insecticides, and herbicides, etc.

Conclusion

For current agricultural problems including the need to balance productivity with environmental concerns, precision farming provides a novel alternative using a systematic approach. Modern information technology is the foundation of it. In order to integrate agricultural methods to fulfil site-specific requirements, it also entails characterizing and modelling variance in soils and plant species. In addition to lowering energy use and the negative effects of agriculture on the environment, it strives to boost economic returns.

Future prospects

PA's prospects for the future include advancements in the performance and accessibility of current technologies. These encompass advancements in sensor technology, mobile applications, mechanical equipment, and internet connectivity. The use of drones for PA implementation, however, is the most exciting possibility for the future of PA. Drones do away with the requirement for GPS and a reliable internet connection. We can speed up crop scouting with drone technology, identify insect or nutritional problems in crops and fix them straight away, check for weather damage, find pivot malfunctions on irrigation systems, evaluate the functioning of drainage systems, and the list goes on.

Acknowledgement:

We would like thanks to Chhatrapati Shahu Maharaj Research, Training and Human Development Institute (SARTHI), Pune for giving financial assistance during Ph.D. research work.

Conflict of Interests: There are no conflicts of interest.

4. References:

Adamchuk, V. I., Hummel, J. W., Morgan, M. T., Upadhyaya, S. K. 2004. On-the-go soil sensors for precision agriculture. Computers and Electronics in Agriculture. 44: 71-91.

Batte, M. T. and Buren, F. N. 1999. Precision farming – Factor influencingproductivity. In Northern Ohio Crops Day meeting, Wood County, Ohio, 21 Jan. 1999.

Ferguson R., Dobermann, A. and Schepers, J. 2007. Precision agriculture: site-specific nitrogen management for irrigated corn. University of Nebraska Lincoln Extension. Bulletin.1-7.

Fountas, S., Ess, D., Sorensen, C. G., Hawkins, S., Pedersen, H. H., Blackmore, S. and Deboer, L. J. 2004. Farmer experience with Precision Agriculture in Denmark and US Eastern Corn Belt. Precision Agriculture.

Lang, L. 1992. GPS, GIS, remote sensing: An overview. Earth Observation Magazine. 23-26.

Njoroge, J. B., Ninomiya, K., Kondo, N. 2002. Automated fruit grading system using image processing, In Proceedings of the 41st SICE Annual Conference. 1346-1351.

Shibusawa S. 2002. Precision farming approaches to small farm agriculture. Agro-Chemicals Report. 2(4): 13-20.

Trimble. 2005. Precision agriculture. Available at: www.trimble.com

Volume: 03 Issue No: 11

AN INSIGHT INTO MICROBIAL BIO- TRANSFORMATIONS AND STEROID TRANSFORMATIONS

Article ID: AG-VO3-I11-05

Yamunasri. P*

Ph.D. scholar, Department of Agricultural Microbiology,

Tamil Nadu Agricultural University, Coimbatore-641 003

*Corresponding Author Email ID: yamunavisu@gmail.com

Introduction:

Transformation of the products is usually done to convert naturally occurring inactive compounds to active form. It can be done by chemical or biological means. A chemical method of transformation requires extreme conditions like high pressure and temperature, which are of higher cost and result in the accumulation of residues that could be eco-friendly. Owing to these demerits, the biological transformation of the compounds is being employed. Usually, microbial cells are preferred for biological transformation as they provide a high surface-to-volume ratio, a higher growth rate of cells, which reduces the time of conversion, and a higher metabolic rate of microbial cells, leading to efficient transformation. It is easy to maintain sterility while using microbial cells.

Microbial Biotransformation:

Microbial biotransformation is the biological process of converting organic compounds into structurally related compounds. This conversion is done to degrade or reduce the compound's toxicity or obtain the desired product. Microbial transformation is preferred over the chemical method because it is cost-efficient and easy to scale up; the number of steps involved in transformation is lesser when compared to chemical methods. Moreover, it maintains the original carbon skeleton after obtaining the products. It is of two types: enzymatic method and non-enzymatic method. Several groups of enzymes are involved in biotransformation, which are listed below.

S. No	Enzyme group	Function
1.	Oxidoreductase	Transfer of electron from one molecule to the other and it acts as a catalyst
2.	Transferase	Transfer of specific functional groups such as methyl, acyl, phosphate group, etc.
3.	Hydrolase	Cleavage of the chemical bond in the molecule by addition of water molecule.
4.	Lyase	Breaking of chemical bonds within the molecule.
5.	Isomerase	Rearranging of atoms within the molecule to form an isomer.

Applications of microbial transformation:

1. Transformation of steroids and sterols (e.g.. Conversion of progesterone to corticosteroids by *Aspergillus brasiliensis*)
2. Transformation of Pollutants(Ex. Dechlorination of Polychlorinated biphenyls and mineralization into Carbon dioxide, water and Chloride ions by *Pseudomonas* and *Burkholderia*)
3. Transformation of Non-Steroid Compound(e.g., converting toluene, a volatile organic compound, into benzyl alcohol, benzaldehyde, which is a carbon source for microbial growth).
4. Transformation of Antibiotics(Ex. Conversion of streptomycin into dihydrostreptomycin when is exposed to *streptomyces griseus*)
5. Transformation of Herbicide(Ex. Conversion of Atrazine to less toxic cyanuric acid by *Bacillus licheniformis*).
6. Petroleum Biotransformation(Ex. Hydrocarbon degradation by *Aeromicrobium*, *Brevibacterium*).

Steroid transformation:

Steroidal compounds are terpenoid lipids characterized by a carbon skeleton with four basal rings arranged in a 6-6-6-5 fashion. They have many specific physiological activities varying with the differences in functional groups attached to these rings and the oxidation state of the rings. Structure modification on steroid drugs after bioconversion may lead to profound changes in physicochemical and pharmaceutical properties such as bioactivity, solubility, absorption, and duration of action. Compared to their natural counterparts, these modified compounds are preferred due to therapeutic advantages such as high potency, longer half-lives in blood, simple delivery methods, and reduced side effects.

The process involved in the biotransformation of steroids:

Preparation of broth/medium and inoculation of microbes(Phase I)

↓

Addition of steroids for the process of transformation(Phase II)

↓

Separation of microbial cells from the medium and extraction of product from solvent (solvent extraction and precipitation method)

↓

Analysis of separated product by chromatographic techniques (Thin layer chromatography, Paper chromatography, Gas Chromatography, High Perfomance Liquid Chromatography)

References

Fermentation technology by Tanuja Singh and S.S. Purohit, 2008.

Bhatti, H. N., & Khera, R. A. (2012). Biological transformations of steroidal compounds: a review. *Steroids*, *77*(12), 1267-1290.

The Phases and Stages of Microbial Transformation of Steroids and Sterols by Shradha Kakaria, 2021. (Journal of Microbial & Biochemical Technology).

Volume: 03 Issue No: 11

SPECIALITY RICE LANDRACES CULTIVATED IN TAMIL NADU

Article ID: AG-VO3-I11-06

[1]Harivignesh, A., [2*]V. Krishnan, [3]A. Anuratha, [1]R. Dhinesh, [1]Maddu Geethanjali, [1]S. Samuel Raj, [1]B. Umasankari and [1]J. Umabalan

[1]PG Scholar, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U. T. of Puducherry 609603.
[2]Faculty, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U. T. of Puducherry 609603.
[3]Faculty, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Keezhvelur, Nagapattinam district, Tamil Nadu 611104
*Corresponding Author Email ID: anurathakrishnan66@gmail.com

Introduction

In the vibrant agricultural landscape of Tamil Nadu, a treasure trove of speciality rice landraces flourishes, each with its unique qualities and health benefits. These landraces are not only a testament to the rich agricultural heritage of the region but also a source of nourishment and wellness (Anuprialashmi *et al.*,2019). In this article, we delve into the diverse world of Tamil Nadu's special rice landraces, exploring their characteristics, nutritional benefits, and cultural significance. From ancient remedies to modern dietary trends, these rice varieties have left an indelible mark on the culinary and medicinal traditions of the region.

Rice landraces of Tamil Nadu (Balasubramanian *et al.*,2019**):**

1. Aanai Komban: It has a 140-150-day maturity duration. It helps in easy digestion, relieves constipation, helps the body get rid of excess fluid, and strengthens the nerves. The rice does not spoil for a long time, so it can be used as a snack on trips.

Figure 1: Aanai Komban

2. Adukku nel: It has 60-70 days maturity duration. High in healthy fats, high in iron, iron, magnesium, zinc, calcium, and phosphorus. This rice

Figure 2 Adukku nel

promotes blood growth and bone strength. Strengthens body muscles., Yield - 4t/ha.

Figure 3: Adukku nel

3. Arcot Kichali Samba: It has 145 days maturity duration. Its rice is rich in nutrients and has a high immune system. Cattle love to eat their hay. Excessive milk secretion. You can make food, biryani, and multi-course meals in it.

Figure 4: Arupatham Kuruvai

4. Arupatham Kuruvai: It has a 90-100 days maturity duration. It cures anaemia due to its high iron content. It is rich in fibre, which relieves constipation. It also cures nervous diseases. Yield - 4.10t/ha.

5. Arupatham Samba: It has a maturity duration of 115-120 days. It cures anaemia due to its high iron content. It is rich in fibre, which relieves constipation. It also cures nervous diseases. Yield - 4.10t/ha.

6. Balamani: It has a maturity duration of 130-140 days. It is rich in antioxidants and good for digestion.

7. Bhavani Samba: It has a maturity duration of 130-140 days. Increases digestion and rejuvenates and energizes the body, reducing sugar and bad cholesterol. Rich in iron and B vitamins.

Figure 5: Chinnar

8. Chinnar: It has a maturity duration of 145-150 days. Excretes waste. Cleanses the blood and bowels. Cures joint pain. Rice is rich in minerals including iron, zinc, and potassium. It is rich in calcium.

9. Garudan Samba: It has a maturity duration of 150-160 days. It makes the body strong. It is rich in iron and reduces anaemia. Heals kidney infections, and heals the body.

Figure6: Ilupai Poo Samba

10. Ilupai Poo Samba: It has a maturity duration of 125-135 days. Rich in iron, old rice is immune-boosting. Stabilizes bones. It has high immunity due to the high number of antioxidants. Relieves joint pain and paralysis. Since it is herbal rice, it can be cooked and eaten with other rice. Drought tolerant.

11. Kaar Arisi: It has a maturity duration of 120-130 days. It gives the body vigour and strength and is an excellent remedy for diabetes, rheumatism, and skin diseases.

12. Kaivara Samba: It has a maturity duration of 140-159=0 days. Contains many mineral salts including calcium, magnesium, zinc, potassium, and iron. Rice is rich in folic acid and antioxidants needed for fetal development. Eliminates nerve-related problems.

13. Kandasali: It has a maturity duration of 120-125 days. It is a medicinal rice. Gives blood development and hormonal balance in girls. Best medicine for thyroid problems. It removes toxic waste from the body and makes the endocrine glands work smoothly.

14. Karunguruvai: This has a maturity duration of 120-130 days. This is also called traditional Viagra. It strengthens the body. Over time, pregnant women are given proper fertility and healthy delivery. As it releases sugar slowly, it is good for diabetes. Siddha doctors use elephant feet to cure disease.

Figure 7: Karunguruvai

15. Karuppu Kavuni: This has a maturity duration of 145-150 days. It is called royal rice and was the food of Maharajas. It is also called forbidden rice, as it was not to be taken by the common people of the country. It is highly suitable for anaemic people as it is highly rich in iron. It is also used as a medicine for dog bites.

16. Karuthakaar: This has a maturity duration of 130-145 days. Suitable for Idli making. Cures leprosy, diabetes, jaundice, and haemorrhoids.

17. Kattu Ponni: It has a maturity duration of 130-140 days. Since rice is rich in fibre, it can relieve constipation. It is rich in calcium which strengthens the bones. Being easily digested, it gives strength to the elderly.

18. Kattuyanam: It has a maturity duration of 130-140 days. High in protein and good for diabetic patients.

19. Kichilli Samba: It has a maturity duration of 135-140 days. It increases immunity. You will get wealth and physical strength. It helps mothers to secrete breast milk and strengthen their bodies. The variety is suitable for daily cooking and eating by people of all ages. Controls sugar. It is root-knot nematode tolerant.

Figure 8: Kichilli Samba

20. Kothamalli Samba: It has a maturity duration of 135-140 days. The vital nutrients of this rice support blood clotting in case of injuries

Figure 9: Kothamalli Samba

in the body. Rice is ideal for diabetes control, obesity reduction and body nutrition.

21. Kottara Samba: It has a maturity duration of 145-150 days. Increases immunity. Brain development and intelligence will improve. Puberty women can increase their body strength if they eat this rice regularly. It reduces bad cholesterol.

22. Kudvaazhai: It has a maturity duration of 115-120 days. Provides excellent relief from diseases such as high blood pressure, diabetes, constipation, stomach ulcers, digestive disorders, and chronic stomach pain.

23. Kullakaar: It has a maturity duration of 105-110 days. It facilitates the secretion of breast milk, and excretion of body waste, and cures blood pressure, diabetes, constipation etc. It is a drought-tolerant variety.

24. Kuzhiadichaan: It has a maturity duration of 115-120 days. This rice is good for breastfeeding and controlling diabetes. It is a saline-tolerant rice.

25. Madumazhingi: It has a maturity duration of 135-140 days. If people who are doing a lot of physical work eat this rice they will get rid of fatigue and get the necessary nutrients for the body. It is a flood-tolerant landrace.

26. Mangal Ponni: It has a maturity duration of 135-140 days. Rice is an herbal herb with high immunity. It heals tumours and heals. It removes body waste and beautifies our mane.

27. Mappillai Samba: It has a maturity duration of 150-160 days. It increases digestive power, soothes mouth and stomach ulcers, strengthens nerves, and increases sperm production. Good for diabetes. It is a flood-tolerant landrace.

28. Muttira sannam: It has a maturity duration of 135-140 days. It is immunity-boosting herbal rice. This rice is good for lack of brain development. It increases memory power.

29. Mysore Malli: It has a maturity duration of 130-135 days. Porridge made from rice is anti-inflammatory. Its old rice is watery, flavourful and nutritious. This rice is used as an easily digestible food for children.

30. Njavara: It has a maturity duration of 150-180 days. Used in Ayurvedic medicine to treat neurological disorders called Navarakizhi treatment.

31. Perumkathai: It has a maturity duration of 140-150 days. Used in Ayurvedic medicine to treat arthritis and gout.

32. Perunachi: It has a maturity duration of 130-140 days. Rich in antioxidants and good for digestion. It is tolerant to coastal salinity.

33. Poongar: It has a maturity duration of 120-130 days. It is highly suitable for women's health against anaemia, menstrual problems and bone and muscular strength. It is rich in antioxidants and good for digestion.

34. Rakthasali: It has a maturity duration of 135-140 days. Siddha doctors use Rakthasali as a medicine to balance rheumatism, pithama and kapha doshas, this rice is used to improve blood circulation and to agitate the blood. It is drought tolerant.

Figure 10: Rakthasali

35. Rasagadam: It has a maturity duration of 135-140 days. Good for digestion and has anti-inflammatory properties.

36. Salem Sanna: It has a maturity duration of 120-130 days. Rice is the first food for infants and is highly immune and reactive. Digests quickly and strengthens the digestive system. Strengthens the nervous system and helps cure anaemia. It is a flood-tolerant landrace.

37. Samba Mashuri: It has a maturity duration of 120-130 days. It is also called Pearls of South India. It is an aromatic medium slender rice with a delicate flavour, suitable for Pongal, Coconut rice and steamed rice preparations like Idiappam. High iron content and good for diabetics, It gives a grain yield of 4-5t/ha.

38. Seeraga Samba: It has a maturity duration of 122-135 days. It has high immunity. It is highly reactive and can prevent cancer. It helps in regular heart movement, removes bad cholesterol, relieves constipation, and improves digestion. It is leaf folder resistant.

Figure 11: Seeraga samba

39. Sempalai: It has a maturity duration of 100-105 days. It is an herbal rice with high medicinal value. Rice is loved by children. It is easy to digest. This rice is ideal for body nutrition.

40. Singinni kaar: It has a maturity duration of 110-115 days. It is medicinal herbal rice, that prevents diabetes, relieves joint pain and strengthens bones. By giving this porridge to weak patients, they will get stronger and recover quicker.

41. Sivappu Kavuni: It has a maturity duration of 140-150 days. The traditional rice of royal families has been using it for medicinal reasons for a long time. It is herbal rice rich in potassium, magnesium and zinc.

42. Soorakuruvai: It has a maturity duration of 105-110 days. This speciality rice helps to strengthen the weak bones of the newborn mother. It is drought tolerant.

43. Swarna Mashuri: It has maturity duration of 135-140 days. This is an easily digestible rice. Act as nutritional food for the elderly. It is an excellent remedy food for skin diseases. This is the best rice for body strength. It is a flood tolerant landrace.

44. Thnaga Samba: It has maturity duration of 150-160 days. It is a cure for skin diseases. It increased immunity. Skin manifestations including acne will disappear. It is drought tolerant.

45. Thavalakannan: It has a maturity duration of 130-140 days. This rice is good for digestion and has anti-inflammatory properties.

46. Thengaipoo Samba: It has a maturity duration of 120-125 days. It is rich in iron, calcium, potassium, zinc, and magnesium minerals. As this rice is easily digestible, it can be used as baby food. It is saline and cyclone-tolerant.

47. Thirupathisaram: It has a maturity duration of 110-120 days. The rice cooked in this rice will not spoil for a long time. When travelling abroad, tamarind rice can be tied to a banana leaf and used for several days. The tamarind rice of this variety will last for weeks.

Figure 12: Thooyamalli

48. Thooyamalli: It has a maturity duration of 125-135 days. This rice contains a moderate amount of soluble fibre. It is rich in iron, magnesium, and zinc. Old rice is disease-resistant. Its juice tastes like fresh water.

49. Tulasi Vaasanai Samba: It has a maturity duration of 145-150 days. It strengthens the lungs. It cures colds and emaciated people should eat this rice regularly for a period.

50. Vadan Samba: It has a maturity duration of 140-150 days. As it is easily digested, children are fed with its porridge. Adolescent girls are given pudding for balanced body development. Its porridge cures jaundice and dysentery

Figure 13: Valan Samba

51. Vaikundan: It has a maturity duration of 130-140 days. Rich in antioxidants and good for digestion.

52. Valan Samba: It has a maturity duration of 140-150 days. Cleanses the bowels, beautifies the skin, relieves bile, and stomach problems, karapan and manth. Rich in iron, magnesium, and zinc. Pudding can be given to adolescent girls during menstruation to strengthen their bodies.

53. Vanapadi: It has a maturity duration of 130140 days. It is good for digestion and has anti-inflammatory properties.

54. Varappu Kudaijan: It has a maturity duration of 110-115 days. It cures anaemia due to its high iron content. It is rich in fibre, which relieves constipation. It also cures nervous diseases.

55. Vaasanai Seeraga Samba: It has a maturity duration of 110-120 days. Easily digestible, prevents gastric disturbances and stimulates appetite. Cures rheumatism. Stomach ulcers, loss of eyesight and discharge of water from the body resolve.

56. Vellai Chitrai Kaar: It has a maturity duration of 115-120 days. Packed with vitamins and minerals and rich in fibre, this rice is delicious rice that is perfect for everyone, from children to adults, to gain strength and nutrition. It is saline and drought-tolerant

57. Vellai Kuruvai: It has a maturity duration of 100-105 days. It is easily digestible, relieves constipation, strengthens the nerves, and flushes out the bad water secreted in the body.

58. Vellai Milagu Samba: It has a maturity duration of 160-165 days. It Stimulates appetite, cures headaches, strengthens the digestive system, relieves arthritis, and helps remove toxins from the body.

Conclusion:

As we conclude our exploration of Tamil Nadu's special rice landraces, we are left with a profound appreciation for the diversity and richness of this agricultural heritage. These landraces, nurtured through generations, have not only sustained communities but have also contributed to their well-being. From ancient medicinal remedies to contemporary dietary preferences, these rice varieties continue to play a vital role in the lives of the people of Tamil Nadu. In an era where the world is increasingly turning towards sustainable and locally sourced food options, these landraces stand as shining examples of biodiversity conservation and the preservation of traditional knowledge. As we celebrate these unique rice varieties, let us also recognize the importance of safeguarding and promoting such treasures for the benefit of current and future generations. Tamil Nadu's speciality rice landraces are not just grains; they are a living testament to the harmony between nature, culture, and human health.

References

Anuprialashmi KS, Malarmathy M, Priya P, Loganathan K, Mohamed Niyas M, Shivashakthivel T, Yuvaraj SC, Yenugula Pravalika, Theradimani M, Kanimoli and Mathivathana M. 2019. Studies on biochemical characterization of traditional rice varieties. The Pharma Inno. Journ., 8(5): 314-316.

Balasubramanian AV, Vijayalakshmi K, Parimala K, Subhashini S, Subramanian K Manikandan R. (2019) Traditional rice varieties of Tamil Nadu: A sourcebook, The Centre for Indian Knowledge System (CKIS).

Volume: 03 Issue No: 11

POST COCOON TECHNOLOGY OF ERI SILK

Article ID: AG-VO3-I11-07

***G. Swathiga and C.N. Hari Prasath**

Forest College and Research Institute, TNAU, Mettupalayam – 641 301, Tamil Nadu

*Corresponding Author Email ID: swati.vet@gmail.com

Introduction

The Eri silk is obtained from domesticated *samia ricini* silkworm that feeds on castor and tapioca leaves. The cocoons of eri worms are very unique in its characteristics and different from other silkworms. Eri cocoons are open mouthed with a discontinuous filament, which make them suitable only for spinning. Eri silk cocoons are made up of uneven fibres and it cannot be reeled. Approximately 90 per cent of Eri cocoons are hand spun in Assam, India. The soft cocoons are better for mechanical spinning and slightly hard and bigger cocoons for hard spinning. Eri cocoons is white or brick red in coloured and less lustrous than other silks. Eri fresh cocoon weight 3 to 5 g and shell weight 0.4 to 0.6 g, giving 11 to 14 % shell. Size of Eri cocoons is 4.8 x 2.5 cm. Denier of eri fibre is 2 to 3 with a tenacity and elongation of 3 to 3.5 g/d and 20 to 21% respectively.

I. Processing of eri cocoons

The eri cocoons are open mouthed since its silk filament is discontinuous. Hence, eri cocoon can only be used for spinning purpose. Eri silk has certain excellent textile properties such as fineness (2-2.5 denier) and thermal properties which play important role for determining the end use of a fibre. Eri silk is finer than muga and tasar silk. Major portion of eri cocoons produced in the region is locally spun through traditional devices like Takli and other spinning devices like CSTRI spinning wheels etc.

Composition of Eri silk fibre

S.NO	Content	Percentage (%)
1	Fibroin	72.2
2	Sericin	11.9
3	Fat	1.3
4	Moisture	14.6

Characteristics of Eri cocoon

S.NO	Particulars	Eri Cocoons	
		White	Brick red
1	Cocoon weight(gm)	2.40	2.46
2	Shell weight(gm)	0.35	0.36
3	Shell ratio(%)	14.87	14.20
4	Fibre length(mm)	45	48
5	Pupa weight(gm)	2.05	2.10

Cocoon Drying

Unlike in mulberry cocoon, Pupa is taken out of the eri cocoons before drying. It is the only silk where cocoons are not stifled to kill the pupa and hence qualifies as the most eco-friendly silk. The Eri silk pupa is used for human consumption and is considered a delicacy. The separated cocoon shells are dried to remove the moisture to enable storage for longer periods and to prevent fungal attack.

Sun drying is usually practised because of its simplicity. However, hot air drying is preferable where cocoons are kept in 95 to 55 0C for 3-4 hours. As eri pupa is mostly consumed by the people in this region, stifling process is not required.

However, shell drying is necessary for preservation and storage.

Cocoon selection

Clean, dry and uniform quality cocoons are to be taken for spinning.

Degumming of Eri cocoons

Silk contains two types of amino acid groups. One set of amino acid group is present in sericin or silk gum which is soft, swell and dissolve in water. The objective of degumming process is to remove sericin gum from the silk which was acting as a protective and adhesive layer for the silk filaments (brin)-Fibron. This will enable the penetration of dyes and chemicals and also gives a silky smooth feel. Sericin is a protein that coats the filaments of raw silk as it is extruded by the silkworm.

Removal of sericin from the silk is called degumming. Before hand spinning, the cocoons are to be degummed to ensure removal of the gum to facilitate easy spinning. Two methods are in use for degumming. They are traditional method and improved method.

In the **traditional method** of degumming ash obtained from the banana leaves, wheat stalk, paddy straw, moong or pieces of green papaya are commonly used. The cocoons are loosely tied in cotton cloth and boiled in 10g Soda/l of water for 45 minutes to 1 hour. After boiling, individual cocoons are stretched or opened up in plain water into thin sheets. 3-4 such sheets are joined to make a cake, which is dried and used for spinning in Takli. Locally available materials such as ash obtained from banana, wheat stalk, paddy straw and pieces of green papaya are commonly used as degumming chemical instead of soda.

In the **Improved method** of degumming, Eri cocoons are loosely tied in a porous cloth and the bundle is immersed in an alkaline solution of 10-12g soap and 2- 4g Soda per litre of water and boiled for an hour. The cocoons are then washed and reboiled in fresh water for 15-30 minutes. After proper washing the cocoon shells are dried without disturbing the fibre layer and then utilized for spinning especially in CSTRI machines.

Following equipments have been found to be generally useful in large scale degumming of eri cocoons.

1. Japanese type- vertical kier boiling chamber
2. Italian type- horizontal rotary degumming drums
3. Open bath type

II. Spinning of Eri cocoons

Spinning is an ancient textile art in which plant, animal or synthetic fibres are drawn into parallel strands and twisted together to form a yarn. For thousands of years, fibre was spun by hand using simple tools, the spindle and distaff. Only in the high middle ages did the spinning wheel increases the output of individual spinners, and mass production only arose in the 18th century with the spinning of the industrial revolutions.

Hand spinning remains a popular handicraft even today. The Eri silk yarn is produced from eri cocoons by using mainly the hand spinning device and the yarn is used for traditional products like chadder, shawl, dress materials etc. on handlooms.

As the eri cocoons are open mouthed and not composed of continuous filaments, they are not reelable. They form a good raw material for spinning. For spinning, clean and empty eri cocoons free from dry chrysalis skin and last larval skin are used. Such clean cocoon contains 100 % silk and fetch high price. Uncleaned non fibrous materials get entangled with silk fibres spun and more the movement of the machinery used for spinning. Hence, cleaning of cocoons is a prerequisite to spinning them clean. Cocoons can also be cleaned by corytor cocoon. The different machines used for spinning of eri silk in India are:

Hand spinning

Hand spinning which is very common in North Eastern states of India, is either intermittent (mule spinning principle) or continuous (ring spinning principle). The Talki is commonly used for intermittent spinning and the spinning wheel for continuous spinning. Both types of spinning involve the same basic operations: Drafting, Twisting and Winding.

Talki

It is the simplest and commonest method of spinning Eri cocoons. It has one spindle with weighted end. To this, the free end of the thread drawn out of the dry or wet Eri cocoon is attached and then spun around with a twist of the hand. In this way, the thread is drawn out evenly with the fngers until the spindle fills sufficiently. The thread formed in the spindle, is then wound off and the same spindle is put to use once again for fresh length of thread. During spinning cocoons are generally kept wet by sprinkling water. This method is very slow. Talki is made for short length fibres to be spun into fine yarns.

Charkha

The Charkha is ubiquitous wherever cotton is spun. In Charkha the twist is provided by wheel. Dry or carded cocoons can be spun well on this machine and a good thread obtained. However spinning by charkha is disadvantageous in that the process is not continues, as the wheel has to be stopped to wind the finished length of the thread on the spindle. Further it requires the constant use of both the hands of the operative one for holding and the other for turning the wheel.

CSTRI pedal cum motorized spinning

Development of a table model spinning machine for silk waste spinning by CSTRI of Central Silk Board, Bangalore during 1998-99 is a breakthrough in hand spinning technology. The spinning machine works on the principle of ring and traveller and is capable of producing up to 100gm spun yarn in the count range of 10 s to 15 s which is almost two and half times the production of talki. It can be operated by a foot pedal as well as a 1/8th HP single phase motor. The quality of the yarn produced is better compared to other hand spinning devices.

Mill spinning

Modern electricity powered spinning, originally done by water or steam power is vastly faster than hand spinning. The spinning jenny, a multi spool spinning wheel invented Circa1764 by James Hargreaves, dramatically reduced the amount of work needed to produce yarn with a single worker able to work eight or more spools at once. So far mill spinning of mulberry silk waste has been in focus, but Central Silk Technological research Institute, Bangalore has attempted to produce eri mill spun yarn of good quality of various counts. The spinning process includes degumming, cutting and dressing of eri silk material for required staple length and then spun into required counts of yarn. In the spinning process, the fibre undergoes a series of operations like opening, drafting, parallelization, twisting and winding to be converted into yarn.

III. Weaving

Weaving consists of two distinct set of yarn – warp and weft. These are interlaced to form a fabric. Weaving on traditional looms is a very lengthy process that starts with setting up of the loom-warp. Two to three days are required to weave a shawl as full process needs to be set contrary to the frame loom that allows warping for a large number of fabrics. It is recommended to use regular and strong yarn on the warp, to avoid damaging the silk threads and creating breakage. In general, best results were obtained when warp threads are finer than the weft as it gives more surfaces to it, with a softer feel and shine. Other combinations can also be used:

- Fine warp with medium weft.
- Medium warp with big weft thread, medium weft can also be used.
- Big warp thread with fine weft thread.

Generally throw shuttle looms are conveniently used for weaving eri cloth. The preliminary operation for weaving includes sizing and warping which is winding of the thread for warp. The processes are mainly manual. The warp is prepared section by section either in horizontal drum or in hand reel. The fabric can thus have the required width. The weft thread is fitted on a bobbin into a boat shaped shuttle. The finished fabric is wound on the cloth beam steadily. Now a days, fly shuttle loom is used for better equality eri fabric and also for blended fabric. The production quantum becomes 2.5 times higher than the throw shuttle loom. A throw shuttle loom can weave about half 0.5m cloth/ day working whereas the fly shuttle can weave upto 5m.

Conclusion

Ericulture, the rearing of eri silkworm is one of such socio-culturally valued practices. Unlike other silks, eri silk processing techniques are distinct. Spinning of eri silk is employed by hand and machines. Improved spinning machines helps to overcome the problems in traditional spinning devices. Furthermore, improvisation is required for spinning and weaving of eri silk. Proper training and marketing strategies are needs to tribals who involved in ericulture to exhilarating their live hoods.

Reference

Jolly, M.S., Sen,S.D.Sonwalkar, T.N., Prasand,G.K.1979. Non mulberry Silks (FAO), Agricultural services bulletin. P:178.

Package of practices of Muga, Eri and Mulberry Sericulture for North Eastern region of India, 2005, Central Muga Eri Research & Training Institute, Lahdoigarh, Jorhat, Assam.

Suryanarayana, N., Das, P.K.,Sahu, A.k.,Sarmah,M.C. And Phukan, J.D. 2005. Recent advances in Eri silkworm, *Indian silk*, P:5-6.

Volume: 03 Issue No: 11

VAPOUR HEAT TREATMENT ON FOOD PRESERVATION: A SUSTAINABLE SOLUTION FOR THE FUTURE

Article ID: AG-VO3-I11-08

***Shubham Gangwar**

Research Scholar, Deptt. of Post Harvest Technology, Banda University of Agriculture and Technology, Banda -210001

*Corresponding Author Email ID: horticultureshubham@gmail.com

Introduction

Food preservation has been a fundamental practice throughout human history, enabling us to store and consume food beyond its natural shelf life. Over the centuries, various methods of food preservation have been developed, ranging from drying and salting to canning and refrigeration. In recent years, as the world faces challenges related to food security, sustainability, and food waste, there has been a renewed interest in innovative and eco-friendly preservation methods. One such method gaining prominence is Vapour Heat Treatment (VHT).

Understanding Vapour Heat Treatment

Vapour Heat Treatment, often abbreviated as VHT, is a non-chemical preservation technique that utilizes controlled heat and moisture to extend the shelf life of food products. Unlike traditional heat treatments, VHT subjects food items to specific temperature and humidity conditions in a controlled environment. The primary objective of VHT is to inactivate or eliminate enzymes, microorganisms, and pests that contribute to food spoilage.

The VHT process can be broken down into several key stages

1. Pre-conditioning: Before the main VHT treatment, food items are typically subjected to a preconditioning phase. During this stage, the items are exposed to elevated humidity levels for a specific duration. Preconditioning helps prepare the food for the subsequent heat treatment.

2. Heating: The preconditioned food items are then transferred to a chamber where hot vapour is introduced. The temperature and humidity levels in the chamber are precisely controlled to ensure uniform heating throughout the items. This controlled heating process is one of the critical differentiators of VHT compared to traditional heat treatments.

3. Holding: Once the desired temperature is reached (in mango 47.5C^{o}), the food items are held at that temperature for a specific period. This holding phase is crucial as it ensures that enzymes, bacteria, and other spoilage agents are effectively deactivated.

4. Cooling: After the holding period, the food items are rapidly cooled down using cold air or water. This step is essential to prevent overcooking and to maintain the quality of the treated products.

5. Packaging and Storage: Following VHT, the treated food items are ready for packaging and storage. VHT not only extends the shelf life of these products but also eliminates the need for chemical preservatives, which can have adverse health and environmental effects.

Applications of Vapour Heat Treatment in Food Preservation

Vapour Heat Treatment has found applications in various aspects of food preservation, offering a sustainable and eco-friendly alternative to traditional preservation methods:

1. Fruits and Vegetables: One of the primary applications of VHT is in the preservation of fruits and vegetables. Fruits such as mangoes, citrus, and papayas are particularly susceptible to infestations by fruit flies and other pests. VHT effectively eliminates these pests without compromising the quality of the fruit. Moreover, VHT extends the shelf life of fruits and vegetables, reducing food waste and supporting food security initiatives.

2. Nuts and Dried Fruits: Nuts and dried fruits are prone to spoilage due to the presence of enzymes and microorganisms. VHT helps address this issue by inactivating enzymes and destroying spoilage microorganisms, ensuring that these products remain safe and flavorful for extended periods.

3. Spices and Herbs: Spices and herbs are essential flavouring agents in cuisines worldwide. However, they are susceptible to contamination by pests and microbes. VHT provides an effective means of decontaminating spices and herbs, ensuring that they meet safety standards while retaining their aromatic qualities.

4. Grains and Cereals: Grains and cereals form the staple diet for billions of people. Proper storage and preservation of grains are essential to prevent insect infestations and mould growth. VHT helps control these issues and extends the shelf life of grains, reducing post-harvest losses.

5. Quarantine and Export: Vapour Heat Treatment is widely used in international trade to meet quarantine and phytosanitary requirements. Many countries have strict regulations regarding the importation of agricultural products to prevent the spread of pests and diseases. VHT provides an environmentally friendly alternative to chemical fumigation, allowing exporters to meet these requirements and access global markets.

Benefits of Vapour Heat Treatment in Food Preservation

The adoption of Vapour Heat Treatment offers numerous benefits for food preservation:

1. Environmentally Friendly: One of the most significant advantages of VHT is its eco-friendliness. Unlike chemical preservatives and fumigation methods, VHT does not leave behind harmful residues that can contaminate the environment or harm non-target species. It aligns with the principles of sustainable food production and environmental conservation.

2. Preservation of Nutritional Quality: VHT preserves the nutritional quality of treated food items. Unlike traditional heat treatments that may cause nutrient degradation, VHT's controlled process ensures that vitamins, minerals, and other essential nutrients are retained, contributing to healthier and safer food products.

3. Reduced Chemical Use: By effectively controlling pests and spoilage microorganisms without the need for chemical pesticides, VHT reduces the reliance on harmful chemicals in food preservation. This not only benefits the environment but also minimizes the risk of pesticide residues in food, safeguarding consumer health.

4. Extension of Shelf Life: VHT extends the shelf life of perishable products, reducing food waste and the associated environmental impact. Longer shelf life means fewer products are discarded prematurely, which is especially important given the global challenge of food security.

5. Enhanced Food Safety: VHT effectively eliminates or deactivates pathogens and spoilage microorganisms, making food safer for consumption. This is particularly important for products that are exported or stored for an extended period.

Challenges and Considerations

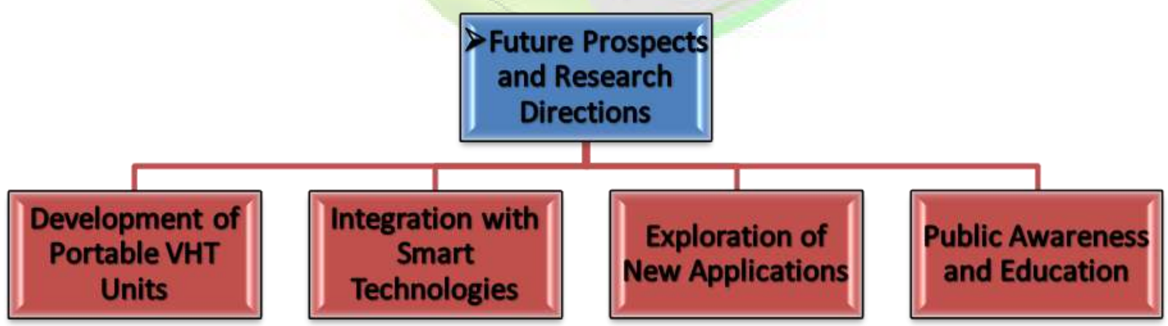
While Vapour Heat Treatment offers numerous advantages, it is essential to address some challenges and considerations:

1. Equipment and Infrastructure: Implementing VHT requires specialized equipment and infrastructure. Small-scale farmers and producers may face barriers to entry due to the initial investment required. Collaboration and support from government agencies and industry stakeholders can help overcome this challenge.

2. Treatment Protocols: The success of VHT relies on precise treatment protocols, including temperature, humidity, and duration. Deviating from these protocols can lead to inadequate pest control or product quality issues. Proper training and adherence to guidelines are crucial.

3. Consumer Perception: Consumer awareness and acceptance of VHT-treated products can vary. Some consumers may have reservations about the use of heat treatments, even when they are proven safe and effective. Educating consumers about the benefits of VHT is essential.

4. Product Variability: Different food items may require variations in VHT parameters. Tailoring treatments to specific products is essential for effective preservation and quality maintenance.



Conclusion

Vapour Heat Treatment represents a sustainable and eco-friendly solution for food preservation in an era marked by global food security challenges and environmental concerns. Its ability to extend the shelf life of food products, improve food safety, and reduce the need for chemical preservatives positions VHT as a valuable tool in the future of food preservation. By addressing challenges, promoting research, and raising public awareness, we can harness the full potential of Vapour Heat Treatment to build a more sustainable and resilient food system for generations to come. As we look to the future, VHT stands as a beacon of innovation and progress in the field of food preservation.

Volume: 03 Issue No: 11

PESTICIDE RESIDUE AND ITS IMPACT ON ONE HEALTH

Article ID: AG-VO3-I11-09

[1]Naveen, M, [2*]V. Krishnan, [2]S. Thirumeni, [1]R. Dhinesh [1]R. Anupreethi, [1]M. K. Sakthi Anand and [1]M. Narayanababu

[1]PG Scholar, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U. T. of Puducherry 609603.
[2]Faculty, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U. T. of Puducherry 609603.
*Corresponding Author Email ID: anurathakrishnan66@gmail.com

Introduction

Deenanath grass botanically called *Pennisetum pedicellatum* (2n: 72) belonging to the Poaceae family, is widespread in Sudanian and Guinean Savannahs of Africa though sparse in littoral areas, where it is a common agricultural weed, present on cultivated fields, also managed grasslands as well as extensively grazed savannahs. It is a weed in tropical uplands and croplands following disturbance or forest clearing, but is less common within forests and plantations, performing poorly under dense shade. In India, it is cultivated in Karnataka, Maharashtra, Andhra Pradesh, Bihar, Chattisgarh, Jharkhand, Odisha and West Bengal. Dinanath grass is widely used as green fodder for animal feed, as hay and silage making and also providing good quality forage for maintaining nutritional security in animals' health during lean situations. Besides, as a forage crop, it is also used as an ornamental, soil erosion control, and bio-energy crop and improves the physical and chemical properties of the soil. Apart from animal feed, it is also used to reverse land degradation, rehabilitate degraded land, and to improve the physical and chemical properties of soil. In India, it is found growing in the natural grasslands on poor and marginal soils of Bihar, Odisha, West Bengal, Madhya Pradesh, and Uttar Pradesh. *Pennisetum pedicellatum* as hay, and indicated its use as a basal diet for sheep with better performance than natural pasture hay-based diets. The grass has the potential to be used as a source of some important nutrients (47.16 % carbohydrate, 19.3 % crude fiber, 7.7 % crude protein, 22.7 % ash) in alleviating potassium, phosphorus, and calcium deficiencies in animals

Origin and Distribution

Pennisetum pedicellatum is native to tropical Africa, from Mauritania and Senegal to Ethiopia and Kenya. Nigeria grass is native to West Africa and was first introduced to India from where it has spread to South East Asia and Northern Australia. It is now widespread within 20°N and 20°S. It is mainly found on disturbed land, road edges, and recent fallows, in areas where annual rainfall ranges from 600 mm to 1500 mm with a rainy season of 4-6 months and where average day temperatures are about 30-35°C. It thrives on a wide range of soils (including degraded sandy or ferruginous soils) provided they are well drained. It is susceptible to waterlogging and frost but has some drought tolerance

BOTANICAL DESCRIPTION OF DEENANATH GRASS

It is a tall, annual, bunch of grass, up to 1.3 m high, branched from the base and often fastigiately branched above. Leaves linear, acuminate, rounded at base, sparsely hairy or glabrous; sheaths glabrous or sparsely hairy. Spikes cylindric, dense, pink or purple. Spikelets solitary and pedicelled or in groups of 2-6. lower glume is very small, and oblong. Lower lemma long, truncate, often 3-toothed, and with minute bristles or cilia at the tip. Upper floret readily disarticulating; upper lemma broadly lanceolate. Anthers not penicillate. Cross pollination due to andromonoecious conditions and wind pollination. Fibrous root system. The culm is cylindrical and glabrous. It is small to medium robust, 1 to 3 mm wide, greenish, and often tinged with purple at the base. The knots are glabrous and light in color. The leaves are hairy, 5-25 cm long and 4-15 mm wide, arranged in two rows; light to dark green in color; flat and hairless. The inflorescence is a very contracted cylindrical panicle, having the appearance of a terminal spike, 5 to 15 cm long and 1 to 2 cm wide. The rachis is angular, with prominent ribs under the involucres of bristles. Each involucre is formed of more than 10 bristles 0.5 to 10 mm long, some up to 3 cm. The terminal part of the bristles is scabrous, the middle part is feathery and the basal part is woolly with tangled hairs giving the inflorescence a pink color more or less sustained. Inside the involucres are 1 to 5 spikelets, at least one of which is carried by a pedicel 0.5 to 3 mm long. The spikelets are ellipsoid spindle-shaped, 3.5 to 6 mm long. They are composed of 2 flowers; the inferior is male or sterile, and the superior is fertile. The lower glume is lanceolate and measures half the length of the spikelet. The upper glume and the lower lemma are as long as the spikelet. They are trifid at the top. The glumes and the lower lemma are membranous, dotted with fine woolly hairs. The lemma of the upper flower is hard, smooth and shiny. It is 2 to 4 mm long and has 3 dorsal veins. Its edges are partially closed on the palea, of the same nature. At maturity, the entire involucre is detached from the rachis. The fruit is a lanceolate caryopsis 0.02-0.1 in. (0.5–2.5 mm) long. It is dorsally compressed and golden brown in color.

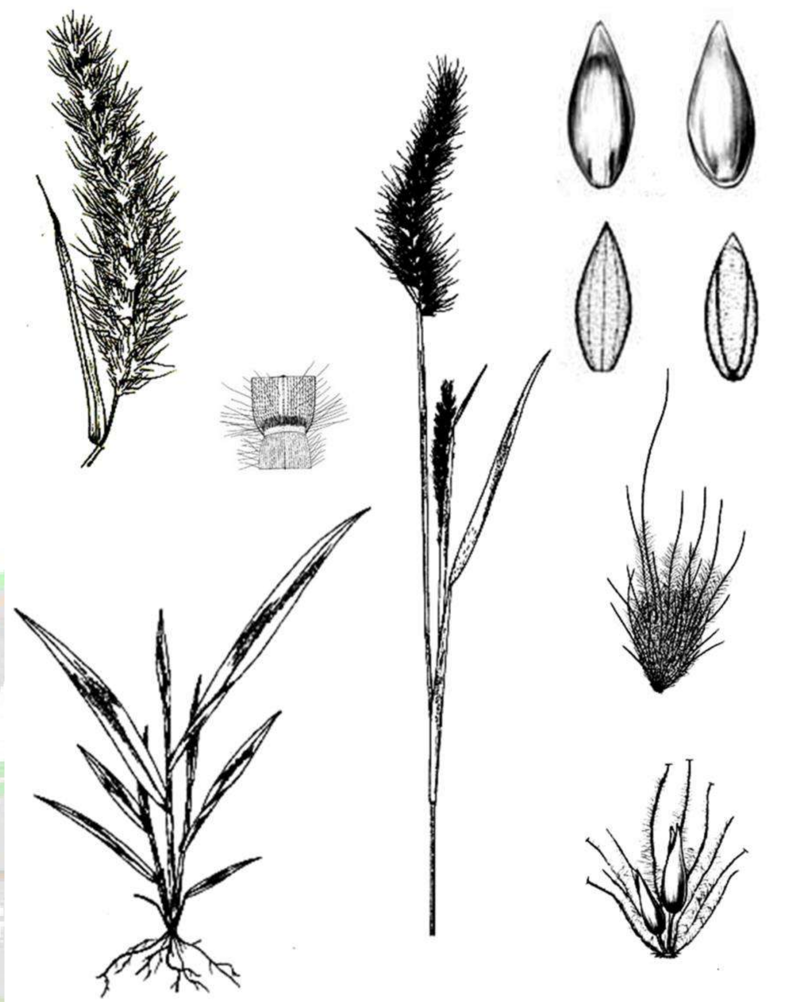


Fig. 1. Deenanath grass- ***Pennisetum pedicellatum***

Growing conditions

It is mainly found on disturbed land, road edges and recent fallows, in areas where annual rainfall ranges from 600 mm to 1500 mm with a rainy season of 4-6 months and where average day-temperatures are about 30-35°C. It thrives on a wide range of soils (including degraded sandy or ferruginous soils) provided they are well drained. It is susceptible to waterlogging and frost but has some drought tolerance.

Cultivation aspects

All types of soil with good drainage. Does not come up well on heavy clay soil or flooded or waterlogged conditions. Ploughing 2-3 times to obtain good tilth and form beds and channels. As basal fertilizer apply: FYM 25 t/ha NPK 20 : 25: 20 kg/ha. For top dressing: 20 Kg N on 30th day after sowing and 50% of this has to be applied for rainfed crop. Seed rate 2.5 kg/ha. Spacing 35 x 10 cm or solid sowing in lines 30 cm apart. After cultivation Hoeing and weeding on the 30th day after sowing. Irrigation done once in ten days or depending on the soil condition. After two months from the time of sowing, Deenanath fodder can be cut and fed to livestock after 45 days of the first harvest, another harvest can be made. It gives a yield of 60-80 quintal of fodder every hectare.

Uses of Deenanath grass

1. Deenanath grass is used as a year-round fodder.
2. Due to its rapid growth rate, it is used as a cut and carry fodder by regular harvests, even reaching monthly cuts during the rainy season.
3. Once in a year, just before the dry season, sufficient grass is harvested and stored as hay to feed the livestock until the rains return.
4. Grown as grass strips, or hedgerows, to prevent runoff and soil loss on hill slopes.
5. The culms are woven into mats and also used for thatching.
6. It is used for daubing with clay to make hut-walls
7. A decoction of the whole plant is considered diuretic.
8. It is used as a soil stabilizer.
9. Grown as a cover crop and promote soil formation on coal spoil heaps.

Forage quality of deenanath grass

Green fodder:

Deenanath grass is used as green fodder and it is considered to be a very palatable species to cattle, It provides high yields of green herbage ranging from 30 to 109 t/ha, comparing favorably with *Sorghum bicolor* or other *Pennisetum* species. It responds well to fertilizer and can be combined with fodder legumes in mixtures or rotation cropping. Deenanath grass should be cut 4 months after sowing at 8 cm from ground level to obtain the highest yield. It provides huge quantities of good quality green forage and can stand several cuts per year.

Hay and Silage:

Once a year, just before the dry season, sufficient grass is harvested and stored as hay to feed the livestock until the rains return. The nutritive value of hay is Dry matter 93%, crude protein 4%, crude fiber 44.2%, Neutral digestible fiber 78.8%, Acid digestible fiber 50.9%, lignin 7.8% and mineral ash 8.6%. The nutritive value of Deenanath grass is Dry matter 32.9%, crude protein 6.7%, crude fiber 36.5%, Neutral digestible fiber 71.6%, Acid digestible fiber 42.5%, lignin 5.9% and mineral ash 15.5%.

Nutritive value of green fodder:

Dry matter 26.8%, crude protein 6.5%, crude fiber 40.9%, Neutral digestible fiber 75.8%, Acid digestible fiber 47.4%, lignin 7%, and mineral ash 9.5%.

Protien:14.24%, calcium:1.22%, Phosphorus: 0.43%.

Palatability: Deenanath grass pasture was found to be palatable to goats, though less so than Bermuda grass, but its palatability has been reported to be average than other forage grasses.

Pasture: Deenanath grass is used in temporary pastures.

Toxicity: Contains high amounts of phytates and Saponins and low levels of Oxalates.

Advantages of Deenanath grass

1. High biomass production per year.
2. Valuable grazing grass for sheeps
3. Good green fodder for horses
4. Used to recover coal spil heaps affected soils.
5. Very good for short term ley.
6. The grass has good quantity of tannins and alkaloids.

Limitations of Deenanath grass

1. Being an aggressive weed, it invades agricultural lands to the level that its dense growth leads to the abandonment of the whole farm.
2. Nutritive value decreases with the aging of the crop.
3. They have lower vigor and germination, due to which they need specific operations such as defluffing, separation of true seeds, cleaning, and grading by specific machines. In designing a machine for a specific use, physical properties and their behavior with moisture play an important role.

Conclusion

In conclusion, Deenanath grass crop production has the potential to provide valuable resources for livestock, enhance soil quality, and contribute to environmental sustainability in arid and semi-arid regions. However, successful cultivation requires careful management, attention to seed quality, and adaptation to local conditions. To fully realize the benefits of Deenanath grass, farmers should engage in ongoing research and extension activities and consider market opportunities in their region.

References

1. Ahmed S; Sahay G; Sridhar K; Singh S; Saxena P; Roy A K. 2017. Improved forage crop varieties of IGFRI. Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh, India, Technical Bulletin, 1/2017, pp: 64.
2. TNAU crop production guide 2023
3. Hanna WW (1992) Utilization of germplasm from wild species. In: Desertified Grasslands: Their Biology and Management. Academic Press, London, UK, pp 251-257.
4. IBPGR, ICRISAT (1993) Descriptors for pearl millet[Pennisetum glaucum (L.) R.Br.]. IBPGR, Rome, Italy and ICRISAT, Patancheru, India, 43 p.

Volume: 03 Issue No: 11

SPECIES DIVERSITY AND GENETIC BLENDING POTENTIAL OF *Arachis species*

Article ID: AG-V03-I11-10

[1]S. Saravanan* and [2]J.R. Jerish

[1]Associate Professor and Head, Rice Research Station

[2] Doctoral scholar, Department of Genetics and Plant Breeding, VOC AC & RI, Killlikulam

*Corresponding Author Email ID: saravananspbg@tnau.ac.in

Introduction

Groundnut (*Arachis hypogaea* Linn) is a vital legume *cum* oilseed crop cultivated globally over 100 countries encircling regions of Asia and Africa. Groundnut considered as a native of South America brought to Asia from Brazil by Portuguese as early as 16th century when the regular trading possession had taken in the Indian region. The *Arachis* species has been grown for as long as four to five centuries in Western Africa, East Indies, India, China and Japan excluding their occurrence in wild form over south Eastern countries. Reports from Archeological department had established groundnut cultivation over Peru, South America and distributed eastward of Andes Mountain from Amazon River to La Plata, South America. The centre of origin of *Arachis* thought to lie in Southern Argentina and Southern Bolivia. Recent literatures also suggest the probability of Peru as centre of Origin.

Groundnut is considered as a ideal asset for small and marginal farmers who grow groundnut under low input conditions for food, oil, cattle feed and confectionery purposes. But, the crop suffers from many potential diseases and pests that cause serious yield reduction. However, the wild relatives of groundnut have been reported to be the probable sources for number of diseases such as rust, late leaf spot, early leaf spot, bud and stem necrosis besides their tolerance to insect pests such as thrips and aphids. Hence, utilization of wild *Arachis* for genetic improvement of Groundnut along with their tolerance to major biotic stresses forms a key factor for groundnut research considering that those are lacking in cultivated *Arachis hypogaea* Linn.

Species diversity of *Arachis*

Gene pool of *Arachis*

Arachis construed as a largest genus with more than 100 species belonging to the family Fabaceae wherein only twenty species alone have been taxonomically defined. *Arachis* is attached to tribe Aeschynomeneae and sub-tribe Stylosanthinae as per position of basal and dorsal androecium, flowers in terminal or axillary spikes or smll heads, pinnate leaves and astipulate leaflets. The genus has been further subdivided into sections by Krapovikas (1973) and by Gregory *et al.*(1973)(Table 1). With the start of *Arachis* species documentation by Linnaeus (1753) with *Arachis hypogaea* during 16th century, a year later Bentham (1841) described five more wild species namely *Arachis glabrata*, *Arachis pusilla*, *Arachis villosa*, *Arachis prostrata* and *Arachis tuberose.* Krapovickas and Gregory (1994) described 69 species under nine sections namely Trierectoides, Erectoides, Procumbentes, Rhizomatosae and Arachis (Table 2). Several monographs have since been published by Chevalier (1936), Hoehne (1940) and Hermann (1954). Around 22 species of Arachis genus have been described and documented besides eleven species names have been reported in various literature. In total, the number of species eventually to be published has been estimated to be between 40 and 70 (Gregory and Gregory, 1976). Further, *Arachis hypogaea* has been divided into two sub-species each with two botanical varieties (Krapovickas, 1973). Sub species *hypogaea* does not have flowers on the plant main stem and has alternating pairs of vegetative and reproductive axes along with lateral branches. Sub species *fastigiata* has flowers on main stem and sequential reproductive axis along with lateral branches. Krapovickas and Wynne (1974) pointed the evidence for genetic differentiation between subspecies of Arachis.

Taxonomic section of *Arachis*

Research reports augmented that the cross compatibility in the *Arachis* genus identified that species within a section will usually hybridize but hybrids under different sections of same genus are difficult to hybridize and are usually sterile. However, the cultivated groundnut usually has been divided into two classes, erect and prostrate types. The erect types are supposed to be originated from *Arachis pusilla* and are now known as *Arachis hypogaea* sub spp *fastigiata* while the trailing or running types are known as *Arachis hypogaea* sub spp procumbens which is supposed to have originated from *Arachis prostrata*. In line of these facts, the morpho-type of erect or bunch, spreading, semi-spreading and trailing types in groundnut had been made.

Progenitor of *Arachis hypogaea*

The domesticated peanut is an amphidiploid or allotetraploid meaning that it has two sets of chromosomes from two different species thought to be *Arachis duranensis* and *Arachis ipaensis*. These likely combined in the wild to form the tetraploid species, *Arachis monticola*, which gave rise to the domesticated peanut. This domestication might have taken place in Paraguay or Bolivia where the wildest strains do occur.

Cytology of *Arachis species*

Sectional analysis of genome relationship in Arachis has led to the identification of two genomes, A and B, in the diploid species. There is evidence that the cultivated tetraploid species *Arachis hypogaea* is an amphidiploid (AABB) involving these two genomes from the diploid species (Singh and Moss, 1984). Gregory (1946) reported tetraploid species of groundnut, *Arachis glabrata* 2n-4x=40 besides Mendes (1947) reported diploid species *Arachis diogoi* 2n=2x=20, *Arachis marginata* , *Arachis villosulicarpa* and *Arachis prostrata*. Smartt and Stalkar (1982) documented chromosomal reports for 26 species together with cytological analysis.

Meiotic analysis in diploid *Arachis* 2n=2x=20 revealed 10II system of chromosome pairing but however quadrivalent do occur in small level in *Arachis villosa* and *Arachis spegazzinii* (Singh and Moss, 1982). Meiosis in tetraploid groundnut (2n=4x=40) is generally normal with 20II with few occasional multivalent (Raman, 1976). Although, the *Arachis* species under section Rhizomatosae revealed irregular meiosis.

These observations have led to the identification of certain routes for the introgression of desirable genes from the compatible wild diploid species of section Arachis into cultivated groundnut. Husted (1931) have confirmed the somatic chromosome complement of *Arachis hypogaea* as 2n=4x=40 as inferred from 20II chromosome pairing during metaphase I of meiosis. Hybrids among the varieties of *Arachis hypogaea* also do showed 20II chromosome pairing. Inter-subspecific hybrids among the Spanish, Valencia and Virginia varieties also had mostly bivalent chromosome pairing with limited occurrence of univalents and multivalent (Stalkar, 1980). Due to chromosome structural differences in valencia and virginia groundnut, their hybrids exhibited the most irregular meiosis (Stalkar, 1980).

The chromosome of *Arachis hypogaea* are small (less than 4µm) and hence difficult to karyotype. However, Husted (1936) distinguished a chromosome pair with a secondary constriction (B Chromosome) and one pair which were distinctively smaller than the other (A chromosome). The A chromosome can pair easily while the B chromosome do exhibit species specific chromosome pairing. Several types of secondary constrictions have been reported *Arachis hypogaea* by Babu (1955). Based on molecular and cytogenetic analysis, *Arachis hypogaea* is made up of A and B genomes and the molecular analysis confirmed that *Arachis kempffmercadoi* may not be as closely related to *Arachis hypogaea* as some of the other A genome species (Mallikarjuna *et al.*, 2003)

Table 1. Taxonomic sectional classification of *Arachis* (H. T. Stalkar, 1983)

Krapovickas (1969)	Gregory *et al.* (1973)	Krapovickas (1973)
Section Axonomorphae	Section Axonomorphae	Section Arachis
	Series Annuae	
	Series Perennes	
	Series Amphiploides	
Section Erectoides	Section Erectoides	
	Series Trifoliolalae	Section Trierectoides
	Series Tetrafoliolalae	Section Tetraerectoides
	Series Procumbensae	
Section Caulorhizae	Section Caulorhizae	Section Caulorhizae
Section Rhizomatosae	Section Rhizomatosae	Section Rhizorhatosae
	Series Prorhizomatosae	
	Series Eurhizomatosae	
Section Extranervosae	Section Extranervosae	Section Extranervasae
Section Ambinervosae	Section Pseudoaxonomorph	Section Ambinervosae
	Section Triseminalae	
Section Goniorhiza		

Genetic introgression mechanism in *Arachis*

The genus *Arachis* contains a number of wild species exhibiting tolerance reaction to major foliar diseases and pests (Table 3). Gregory *et al.*, (1973) divided the genus into seven sections based on morphological affinities and cross compatibility. The section *Arachis* Kraf *et* Greg. nom. nud. comprises the cultivated tetraploid species, *Arachis hypogaea* and a number of diploid wild species. The compatable wild diploid species are good sources of resistance to diseases such as rust (*Puccinia arachidis*) and leafspots (*Cercospora arachidicola* and *Cercosporidium personatum*) (Table 3) and to insect pests such as Thrips (*Scirotothrips dorsalis* wood) and Aphids (*Aphis cracivora* Koch.) (Amin, 1985). Many wild species from the section Arachis such as *Arachis villosa, Arachis correntina, Arachis diogoi, Arachis stenosperma, Arachis cardenasii, Arachis duranensis* and *Arachis batizocoi* have been successfully crossed with cultivated species (Stalkar *et al.,* 2002, Stalkar and Simpson 1995). Introgression studies for tomato spotted wilt virus resistance from *Arachis cardenasii* to *Arachis hypogaea* was reported by Miller (2003). Herselman *et al.,* (2004)) characterized protocols to transfer of foliar disease tolerance to cultivated *Arachis species* besides Sangam *et al.* (2002) *and Favero* et al.(2009). Hence, the section *Arachis* has immediate potential as sources for the genetic improvement of groundnut though the differences in ploidy levels seem to be the major bottleneck in gene transfer from wild diploid to cultivated tetraploid.

Table 2. Sectional designations of *Arachis* species (H. T. Stalkar, 1983)

Sl.No	Species	Section	Series
1	*Arachis batizocoi*	*Arachis*	Annuae
2	*Arachis duranensis*	*Arachis*	Annuae
3	*Arachis spegazzinii*	*Arachis*	Annuae
4	*Arachis stenosperma*	*Arachis*	Annuae
5	*Arachis ipaensis*	*Arachis*	Annuae
6	*Arachis helodes*	*Arachis*	Perennes
7	*Arachis villosa*	*Arachis*	Perennes
8	*Arachis correntina*	*Arachis*	Perennes
9	*Arachis diogoi*	*Arachis*	Perennes
10	*Arachis cardenasii*	*Arachis*	Perennes
11	*Arachis chacoense*	*Arachis*	Perennes
12	*Arachis hypogaea*	*Arachis*	Amphiploides

13	*Arachis monticola*	*Arachis*	Amphiploides
14	*Arachis guaranitica*	Erectoides	Trilfoliolatae
15	*Arachis tuberosa*	Erectoides	Trilfoliolatae
16	*Arachis benthamii*	Erectoides	Tetrafoliolaatae
17	*Arachis martii*	Erectoides	Tetrafoliolaatae
18	*Arachis paraguariensis*	Erectoides	Tetrafoliolaatae
19	*Arachis oteroi*	Erectoides	Tetrafoliolaatae
20	*Arachis rigoni*	Erectoides	Procumbensae
21	*Arachis lignosa*	Erectoides	Procumbensae
22	*Arachis repens*	Caulorhizae	
23	*Arachis pintoi*	Caulorhizae	
24	*Arachis burkartii*	Rhizomatosae	Procumbensae
25	*Arachis glabrata*	Rhizomatosae	Eurhizomatosae
26	*Arachis hagenbeckii*	Rhizomatosae	Eurhizomatosae
27	*Arachis marginata*	Extranervosae	
28	*Arachis lutescens*	Extranervosae	
29	*Arachis villosulicarpa*	Extranervosae	
30	*Arachis macedoi*	Extranervosae	
31	*Arachis prostrata*	Extranervosae	
32	*Arachis pusilla*	Triseminalae	
33	*Arachis angustifolia*		

Triploid and Hexaploid pathway

Arachis hypogaea (2n=4x=40) is hybridized with a diploid wild *Exhia apwxiwa (2n=2x=20)* to produce a sterile triploid (2n=3x=30), which is then treated with colchicines to produce hexaploid (2n=6x=60). This amphidiploids is first crossed and then selfed or backcrossed with *Arachis hypogaea* until the tetraploid hybrid is obtained after eliminating the excess chromosomes during segregation. Diploid wild Arachis species *viz., Arachis villosa, Arachis correntina, Arachis duranensis, Arachis cardenasii, Arachis chacoense, Arachis kempffmercadoi, Arachis helodes, Arachis batizocoi, Arachis stenosperma, Arachis ipaensis,* *Arachis cruziana* and *Arachis diogoi* were successfully hybridized with *Arachis hypogaea*. While *Arachis spegazzinii* and *Arachis ipaensis* succeeded as female parent, *Arachis helodes* and *Arachis diogoi* are the most successful as male parents in crossing programs. Cross involving *Arachis hypogaea* and wild diploid *Arachis* lead to production of triploids which are sterile and confirmed multivalent formation on cytological investigations. However, to restore fertility in sterile triploid hybrids, plants have been obtained at the hexaploid level (2n=6x=60) by chromosome doubling using colchicine.

Table 3 MULTIPLE DISEASE AND PEST RESISTANCE IN WILD *Arachis sp.*

(Bera, A.K., Rathnakumar, A.L and Radhakrishnan, 2004)

Species	EL	LL	RT	SP	HE	TH	JA	AP	PM	PSt	PS
Arachis stenosperma	HR	HR	HR	-	HR	HR	HR	R			
Arachis duranensis	R		I	-	HR	S	I	R			I
Arachis spegazzinii	HR		I	-	HR	R	HR	-			R
Arachis batizocoi	S		I	-	HR	I	HR	R			
Arachis khulmanii	HR	R	I	-	-	-	-	R			
Arachis correntina	HR	R	I	-	HR	HR	HR	R	R		R
Arachis chacoense	HR	HR	I	R	HR	HR	HR	R	R	R	S
Arachis cardenasii	HR	HR	I	-	HR	HR	HR	R	R	I	S
Arachis villosa	R	R	I	-	-	-	HR	-			I
Arachis paraguariensis	R	HR	I	R	S	-	-	R		R	R
Arachis appressipila	HR	R	I	R	HR	HR	-	-			R
Arachis repens	S	S	-	-	HR	I	HR	-			I
Arachis kempffmercadoi	R	-	-	R	HR	I	I	R			
Arachis villosulicarpa	HR	HR	I	-		-	-	-			
Arachis glabrata	HR	HR	I	R	HR	I	HR	-		R	R

Arachis hagenbeckii	I	HR	I	R	HR	R	I	-		R	
Arachis pusilla	HR	HR	I	R	HR	I	I	-	R	S	

EL- Early Leaf Spot; LL- Late Leaf spot; RT-Rust; AP- Aphids; JA- Jassids; TH-Thrips; PM- Peanut Mosaic

Pst- Peanut stripe virus PS - Peanut stunt virus, SP-Spodoptera

HR- Highly resistance; R-Resistance ; I- Immune, S-Susceptible

Hexaploids have been obtained for crosses of *Arachis hypogaea* besides irregular chromosome behavior with higher univalent formations upon cytological investigation. Company *et al.*, (1982), Peters *et al.*,(1982) and Spielman and Moss (1976) obtained hexaploid utilizing *Arachis hypogaea* (male parent) and diploid species (female parent) *viz., Arachis villosa, Arachis correntina, Arachis stenosperma, Arachis duranensis, Arachis chacoense, Arachis spegazzinii* and *Arachis cardenasii*. However upon meiotic analysis, though 30II chromosomes association reported, higher irregular univalent formations also documented. Upon first selfing, the hexaploid progenies showed 60 chromosome level (Company *et al*, 1982). However, in the advance generation after repeated selfing, the hexaploid hybrids reported to exhibit variable chromosome numbers (Smartt (1964) and Davis and Simpson (1976)). The chromosome loss had evidently occurred in the allohexaploid plants and many progenies at the lower chromosome number had wild species traits. Reducing the chromosome number from 2n = 60 in interspecific hybridization to 2n=40 of cultivated groundnut via backcross programs is difficult. Further, hexaploid x diploid crosses are apparently incompatible besides hexaploid x tetraploid crosses produced pentaploid progenies in certain cross combination (Peters *et al* 1982).

The pentaploids do not flower profusely accounting irregular chromosomal association right from univalent to multivalent formation. Considering the abnormal meiosis in their hexaploid parents and the nature of the genomes from different species there was greater homology and a more regular meiosis in their pentaploid plants than expected. With all the above being the facts, Simpson and Davis (1983) reported fertile triploid from *Arachis hypogaea* and wild Arachis species. When the same backcrossed to *Arachis hypogaea*, 50 chromosome progeny resulted. Krapovickas *et al.*,(1974) obtained 40 chromosome progeny from a triploid plant which was self fertilize to produce the fertile hybrid. Apart hybridizing *Arachis hypogaea* with diploid section of diploid section of Arachis, the cultivated groundnut also hybridized with *Arachis monticola* 2n-2x-40 to produce fertile hybrid highlighting their perfect homologies.

Amphiploid pathway

Maximum genetic exchange was exploited when two wild diploid species hybridized with genomic constitution AA and BB followed by chromosome doubling to produce amphiploid (AABB) which then crossed with *Arachis hypogaea* to produce AA BB to synthesize fertile progeny (Singh and Moss 1984). The hybrids so produced are fertile indicating the auto and allo syndetic pairing in crosses involving different ploid levels.

Cytological investigations showed that amphidiploids from hybrids between closely related species with a A genome behaved like autotetraploid with a higher frequency of quadrivalents and low pod fertility. The amphiploids from hybridization between distantly related species with A and B genomes showed higher associations and greater pod fertility. The amphiploid derived progeny has been effective in transferring disease resistance from wild diploid species into *Arachis hypogaea*

Diploid-tetraploid pathway using bridge species

This pathway has been considered as an effective and most successful method of gene introgession utilizing cultivated (A genome) and wild (B genome) genomic constitution using the later as bridge species. *Arachis cardenasii* was first to cross with *Arachis diogoi*, both diploid species and the resulting hybrid was crossed as male parent with *Arachis batizocoi*, the B genome diploid species. The resulting diploid is the three way cross and stained sterile and hence subsequently chromosome doubled with colchicine and then crossed with *Arachis hypogaea* to derive a synthetic fertile hybrid. *Arachis hypogaea* loss greater genomic affinity with diploid *Arachis batizocoi* (B genome) followed by annual and perennial species with the A genome. The auto-tetraploids of these species do not significantly differ each other in chromosomal associations but however annual species auto-tetraploids have higher pollen and pod fertility. Though there is no difference in crossability between *Arachis hypogaea* and wild diploid *Arachis species*, there do reported differences in the levels of fertility in the hybrids of the resultant crosses.

Diploid-tetraploid pathway

The diploid wild *Arachis* species were crossed with *Arachis hypogaea* after chromosome doubling of each of the diploid with colchicines. The resultant hybrid is amphidiploids are fertile enough to make the cross. High level of sterility is the major constraint that limits this technique.

Conclusion

The information furnished in this article establishes the complexity in the genetic improvement of the *Arachis species*. Tapping the genetic variability in any crop species will help a plant breeder his desired goal of varietal evolution. In this regard, the breeders can tap the secondary gene pool or tertiary gene pool rather tapping primary gene pool. The reports in *Arachis* evolution confirmed the fusion of A and B genome of different diploid wild species, *Arachis hypogaea* and *Arachis monticola*. Several studies in interspecific hybridization of the *Arachis* species construed that to hybridize a common *Arachis hypogaea* with all the species under section *Arachis* and then observe meiosis under uniform environments. The extent of triploid fertility will determine the closeness of the species which are employed in hybridization based on the nature of frequency of unreduced gametes in specific hybrid combination. The tetraploid amphidiploids involving *Arachis* species have been synthesized using *Arachis duranensis* and *Arachis ipaensis* which then crossed with *Arachis hypogaea* to release the genetic variation among the species. Further a strategy has to be framed to undertake a resistance breeding programme with the mandate of developing superior cultivars *via* interspecific approach.

References

Herselman, L.Thwaites, R. Kimmins, F.M., Courtois, B, Van Der Merwe, P.J.A., Seal, S.E. 2004. Identification and mapping of AFLP markers linked to peanut (Arachis hypogaea L.) resistance to the aphid vector of groundnut rosette disease. Tag Theoretical And Applied Genetics. 109(7):1426-3

Sangam Lal Dwivedi, Suresh Pande, Joginedi Narayan Rao and Shyam Narayan Nigam.2002. Components of resistance to late leaf spot and rust among interspecific derivatives and their significance in a foliar disease resistance breeding in groundnut (Arachis hypogaea L.).125(1): 81-88

Alessandra Pereira Fávero, Sérgio Almeida de Moraes, Antonio Augusto Franco Garcia, José Francisco Montenegro Valls and Natal Antonio Vello. 2009. Characterization of rust, early and late leaf spot resistance in wild and cultivated peanut germplasm. 66(1)110-117.

Chavalier, A. 1936. Monographie de I'arachide. Revue de Botanique Appliquee et d'Agriculture. Tropicale. 16:673-871.

Company, M. and Stalker, H.T. and Wynne, J.C. 1982. Cytology and leafspot resistance in Arachis hypogaea x wild species hybrids. Euphytica. 31:885-893.

Gregory, W.C., Gregory, M.P., Krapovickas, A., Smith, B.W. and Yarbrough, J.A. 1973. Structure and genetic resources of peanuts. 47-133in peanuts-culture and uses. Stillwater, okiahoma, USA, American Peanut Research and Education Association.

Hoehne, F.C. 1940. Leguminosae-Papilionadas Genero Arachis. Flora Brasilica. 25(II). 122:1-20

Husted, L. 1936. Cytological studies of the peanut Arachis II. Chromosome number, morphology. Cytologia. 5: 109-117.

Krapovickas, A. 1969. Evolution of the genus Arachis seminario Advanzado de Genetica Agricola para America Latina, Maracay, Venezuela SAGA/B(d):1-4.

Krapovickas, A. 1973. Evolution of the genus Arachis. In Agricultural Genetics-Selected topics Jerusalem: National Council for Research and Development. 135-151.

Raman, V.S. 1976. Cytogenetics and breeding in Arachis. India Today and Tomorrow's printers and publishers. 84.

Linnaeus, C. Von. 1753. Species Plantarum Laurentii Salviae, Holmiae. 377.

Mendes. A.J.T. 1947. Estudos citologicos no genera Arachis. Bragantia. 7: 257-267.

Smartt, J. 1979. Interspecific Hybridization in the grain legumes- review. Economic Botany. 33: 329-337.

Simpson, C.E. and Davis, K.S. 1983. Meiotic behaviour of the male fertile triploid Arachis L. hybrid. Crop Science. 23: 581-584.

Singh, A.K. 1985. Genetic introgression from compatible wild species into cultivated groundnut. In proc. of an International workshop on Cytogenetics of Arachis, 31 Oct.2 Nov. 1883. ICRISAT. 107-117.

singh, A.K. and Moss, J.P. 1984. Utilization of wild relatives in genetic improvement of Arachis hypogaea part V. Genome analysis in section Arachis and its implications in gene transfer. Theoretical and Applied Genetics 68:1-10.

Singh, A.K. and Moss, J.P. 1982. Utilization of wild relatives in genetic improvement of Arachis hypogaea part 2. Chromosome complements of species in section Arachis. Theoretical and Applied Genetics 61:305-314.

Peters, R.J., Simpson, C.E., and Smith, O.D. 1982. Fertility, Cytological stability and phenotypic traits in backcross progeny of an Arachis amphidiploid. Crop Science. 22:357-361.

Hermann, F.J. 1954. A synopsis of the genus Arachis Agricultural Monograph no 19 Washington, D.C. USA, US Government Printing Office.

Smartt, J. 1964. Cross compatibility relationships between the cultivated peanut Arachis hypogaea L. and other species of the genus Arachis Ph.D. thesis., North Carolina State University, Raleigh, North Carolina, USA.

Gregory, W.C. and Gregory, M.P. 1976. Groundnut Arachis hypogaea- in Evolution of crop plants. 151-154. London, UK, Longman.

Smartt, J and Stalkar, H.T. 1982. Speciation and Cytogenetics in Arachis. Peanut Science and Technology. 21-49.

Gregory, W.C., Gregory, M.P, Krapovickas, A., Smith, B.W. and Yarbrougl., J.A. 1973. Structure and Genetic resources of peanuts. IN Peanut-culture and uses, stillwater, oklahoma, USA: American peanut Research and Education Association. 47-133.

Stalkar, H.T. and C.E. Simpson. 1995. Genetic resources in Arachis. In: H.E. Pattee, and H.T. Stalkar. Advances in Peanut Science, 14-53. American Peanut Research and Educational Society, Stillwater, OK, USA.

Milla, S., 2003. Relationships and utilization of Arachis germplasm in peanut improvement. Ph.D Dissertation, NCSU, 1-150.

Mallikarjuna, N., S. Chandra and D. Jadhav.2003. Genetic relationship among Arachis species based on molecular data. Int. Arachis Newsletter 23, 19-21.

Krapovickas , A., A. Fernandez and P. Seeligman. 1974. Recuperacion de la fertilidad un hibrido interspecific esteril de Arachis (Leguminosae) Bonplandia 3: 129-142.

Krapovickas, A. and W.C. Gregory. 1994. Taxonomy of the genus Arachis. Bonplandia 8, 186

David J. Bertioli Guillermo Seijo Fabio O. Freitas José F. M Valls[a4], Soraya C. M. Leal-Bertioli and Marcio C. Moretzsohn. An overview of peanut and its wild relatives. Plant Genetic Resources (2011), 9 : pp 134-149

Stalkar, H.T. 1983. Cytotaxonomy of Arachis. Proceedings of an international workshop on cytogenetics of Arachis, 31Oct-2 Nov. ICRISAT, Patancheru, AP India

Bera, A.K., Rathnakumar, A.L and Radhakrishnan, T. 2004. Cytogenetics and Utilization of wild Arachis. In. Book ' Groundnut Research in India'. NRCG, Junagadh Pp:104-116.

Volume: 03 Issue No: 11

A SCIENTIFIC TECHNIQUE OF AONLA CULTIVATION

Article ID: AG-VO3-I11-11

*Priyanka Kumawat
M.Sc.(Hoticulture)
*Corresponding Author Email ID: priyankakmt.jpr@gmail.com

Introduction

Emblica officinalis or Indian gooseberry is native to the indian subcontinent .India ranks first in the world in area and production of this crop apart from India . Naturally growing trees are found in different parts of the world like Shrilanka , Japan etc.

Objective :

High quality commercial cultivation of the crop .

Area and production :

Anola is mostly cultivated in the states of U.P., Maharastra, Gujarat, Rajasthan, A.P., T.N. etc.

Economic importance:

Fruit is a good source of vitamin c . The fruit has medicinal importance : It has pungent , cooling , diuretic and laxative properties ,dry fruits are useful in , diarrhea , dysentery , anemia , jaundice and cough. Anola is used in native medicines (ayurvedic system) Triphla and chyawanprash. The fruits are commonly used for marmalades, pickles, candies, jellies and jams. Aparts from fruits, leaves, bark and even seeds are also being used for various purposes.

Demand and supply:

Domestic consumers provide the major market for aonla. The growing popularity of alternative medicine and herbal products along with increasing health awareness among people is driving the need for aonla in both domestic and international markets.

Varieties: Banarasi, Francis, Chakaiya, Hathijhool, Krishna, Kanchan, Neelam, Amrit, Anand 1 and Anand 2, Gujrat aonla – 1

Climate and soil:

Aonla considered a sub tropical plant. During flower initiation time warm climate is preferable. Aonla is a suitable crop for arid and semi arid regions. Tree are hardy and suitable for wasteland and marginal lands.

Anola cane be grow on slightly acidic to saline sodic conditions of 6.5-9.5 pH range.

Land preparation:

the land prepared by plough, leveling it and removing weeds.

Propagation:

Aonla is propagated through through seed as well as vegetative methods, inarching and patch budding are widely employed in aonla. Good success is obtained during June to September with patch ,shield and forket budding methods. Through patch budding more than 90% success is obtained by rootstock under irrigated hot arid ecosystem for rootstock purpose, six months to one year old seedling are used in general.

Planting:

Field should be ploughed and leveled well in advance. Pit size 1-1.5 meter cube are taken at a spacing of 7 to 10 m both ways. Good healthy budded or grafted plants are selected and planting is done at onset of monsoon. In areas with irrigation facilities. Planting can be taken up during February- March also. Planting with spacing of 8x8 m is also practiced in certain areas. Aonla plants exhibit self-incompatibility resulting in non bearing condition. Hence planting of a single variety is not advisable, instead two varieties planted in alternate rows are advisable to avoid such problems.


Manures and fertilizer:

Dosage of fertilizer should be determined based on climatic conditions, age of plants. For a one year old plant, 100 gm nitrogen , 50 gm phosphorus and 100 gm potassium should be applied apart from 10 kg farm yard manure. Doses should increased as age advances. For a mature tree, 50 kg farmyard manure, 1500 g nitrogen, 750 gm phosphorus and 1000 gm potassium /plant/annum is the general recommendation. Full dose of organic manure, phosphorus and half of nitrogen and potassium should be applied one month before expected flowering time and remaining half nitrogen and potassium should be applied in rainy season.

Training and pruning:

Modified central leader system of training is recommended for better performance of aonla. Primary branches, 2-4 well spaced ones should be allowed at about one meter height regular pruning consists of removal of unwanted, unhealthy, diseased, overlapping and damaged shoots.

Irrigation:

Aonla is generally grown without irrigation, since it is a hardy crop with standing drought. During establishment period, watering in summer will reduce mortality and results in development of a good vegetative growth. In older plants, irrigation during full bloom and fruit setting stages will increases fruit set and yield. In salt affected soils, irrigation during dry period at an interval of 10-15 days is highly beneficial. Basin method or pitcher irrigation method is the general practice whereas alternate drip drip method is more suitable for aonla.

Intercropping:

Three-tier system with aonla +beer+ phalsa or aonla + onion /garlic/brinjal are also followed in a few areas.

Insect pests: Leaf rolling caterpillar, shoot gall maker, mealy bug and pomegranate butterfly are major pests in aonla production. The pests cane be managed through clean cultivation avoiding the over crowding of branches, spraying with malathion or monocrotophos or endosulphan depending on the type of pest infestation.

Diseases:

The crop is susceptible to diseases like ring rust, fruit rot, leaf rot, etc. Timely treatment and control measure are needed.

Disorder:

Necrosis, a physiological disorder has been observed in aonla fruits. This particular disorder has been observed mostly in case of Banarasi and Francis varieties.

Flowering, fruit-set and yield: Seedling take about 6-8 years to start bearing and 10-12 years to yield commercial crops. Vegetatively propagated plants start flowering by third year onwards attaining commercial yielding stage by 6-8 years. Under good management conditions productive life of an aonla tree is about 50-60 years. Average yield may be about 100-150 kg/tree/annum.

Grading:

The fruits are harvested manually and sorted according to their size. Fruits are graded into three types on the basis of their size. The large sized fruits are mostly used for preparing chyawanprash and triphla.

Storage:

Fruits can be sorted for a period of 6-9 days under ordinary condition.

Packing:

Bamboo baskets are mostly used for carrying the produce from farm to local market.

Refrence:

T. Radha, Lila Mathev, K. Ajith Kumar.2020. Horticulture book

www.nhb.gov.in.

Volume: 03 Issue No: 11

INTEGRATED FARMING SYSTEM – A NOVEL APPROACH FOR LIVELIHOOD SECURITY

Article ID: AG-VO3-I11-12

***Dr.T. Parthipan**
Assistant Professor (Agronomy), Agricultural Research Station,
Tamil Nadu Agricultural University, Thanjavur – 613501, Tamil Nadu, India
*Corresponding Author Email ID: parthipan.t@tnau.ac.in

Introduction

Integrated Farming System (IFS) is the scientific integration of interdependent farm activities such as crops, livestock, fish, poultry, honey bee, agro forestry for the efficient use of inputs and higher productivity. It is based on the concept that waste from one component becomes an input for another part of the system. Technologies developed for individual crop became economically not viable and sustainable. Hence the farmer has to link two or more allied enterprises to enhance his income. In this context farming system play a vital role.

Need for Integrated Farming System:

- Yield and income from the crop is uncertain due to uncertainty in rainfall.
- The farm labourers are underemployed as the crop season is confined to four months only.
- Natural resource degradation i.e. soil and nutrient loss due to water and wind erosion.

Under such situations the farming system approach forms the only solution to the poor, marginal and small farmers of India.

Principles in developing sustainable farming systems

- Sustainable agricultural system must be economically viable, dynamic and adoptable to changing needs and priority to renewable natural resources.
- Meet the needs of the present and future generations.
- Prevent the soil degradation.

- Integrated control mechanisms.
- Avoid over exploitation of forests, pastures, etc.

Benefits of integrated Framing System

Productivity:

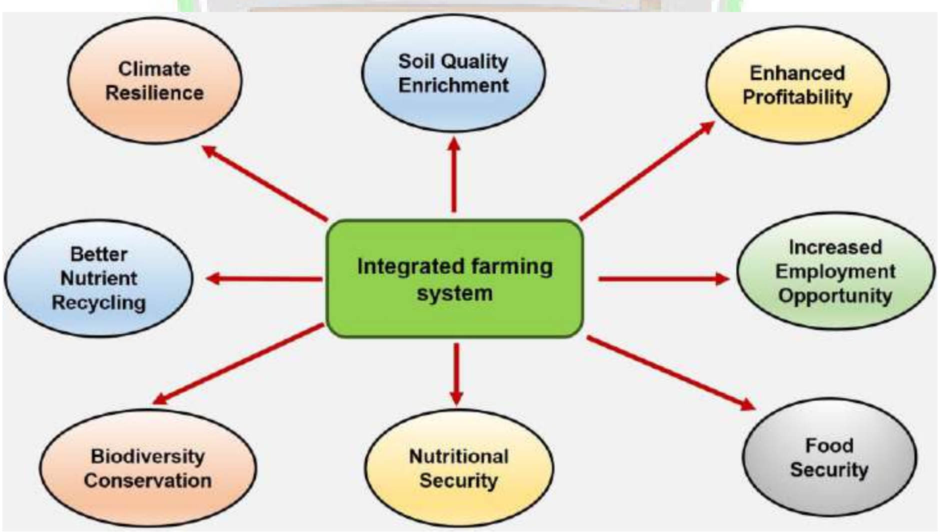
IFS provide an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises. Time concept by crop intensification, and space concept by building up of vertical dimension through crops and allied enterprises are the ways to increase productivity indicated above.

Profitability:

The system as a whole provides opportunity to make use of the produce/waste material of one component as input on another component at the least cost. Thus by reduction of cost of production of individual components, the profitability per rupee invested is much enhanced

Potentiality:

Of late with an enthusiasm to produce more and more within the land area available to meet the requirement of additional population recorded at 2.2% every year huge quantum of inorganic fertilizers inorganic pesticides, fungicides, herbicides etc. are dumped.



Thus there is every likelihood of soil and environment becoming polluted and the productivity of the soil would automatically be reduced in the years to come. In IFS organic supplementation through effective utilisation of by-products of linked components as manures is possible and thus it will certainly provide an opportunity to sustain the potentiality of the production base viz., soil for much longer periods.

Balanced Food:

In IFS, we link components of varied nature enabling to produce different sources of nutrition viz., protein, carbohydrate, fat, minerals, vitamins etc. form the same unit area. This will provide an opportunity to solve the mal nutrition problem that exists in the diet of the Indian farmers.

Pollution from environment:

In the process of production in the crop-based activity, some of the organics are let as waste material and such materials when ignored as such will pollute the environment on decomposition. Similarly application of huge quantity of fertilizer, pesticide, fungicide and herbicide pollute the soil, water and environment to an alarming level. In the case of integrated Farming system, waste materials are effectively utilized by linking appropriate components and thus utilising the by products as organic manures. Thus IFS absolutely helps in avoiding environmental pollution on longer run.

Recycling:

IFS establish its stability due to effective recycling of produces/waste material of any one of the component as input on the other component linked in the program. Thus by way recycling their own material at the farm level, the farmer could able to reduce the cost of production which enables ultimately to increase the net income of the farm as a whole. Moreover it also helps in reducing the environmental pollution expected out of decomposition of organic residues of the farm activity.

Money round the year:

Unlike conventional crop activity where the money is expected only at the time of disposal of the economic produce received after five to fifteen months depending upon the duration of the crop, the IFS provides flow of money to the farmer round the year ;by way of disposal of eggs, milk, edible mushroom, honey, cocoons of silkworm etc. This will help the resource poor farmer to get away from the money lenders and from other financing agencies.

Solve energy crisis:

In IFS by way of effective recycling technique the organic wastes available in the system can be utilised to generate biogas. Though this may not be a source for complete supplementation, at least to certain extent the energy crisis anticipated can be solved.

Solve fodder crisis:

In IFS each and every unit of land area is effectively utilised. Growing of perennial fodder legume trees in the borders and watercourses is a recommended practice in IFS. This practice not only helps in supplementing legume fodder but also enriches soil nutrient by fixing the atmospheric nitrogen.

Solve fuel and timber crisis:

In IFS by linking agro-forestry appropriately the production level of fuel-wood and industrial wood can be enhanced without detrimental effect on crop activity in the field level.

Avoid degradation of forests:

There is a vast gap between the demand and production level as far as fuel wood and timber are concerned. This will naturally induce the users to encroach on the forest area nearby illegally to bridge the gap. By linking agro-forestry in IFS, the degradation of forest area could be minimised to certain extent by supplementation of fuel and timber wood. By way of preserving the natural eco-system in the catchment areas, precious built up soil can also be preserved from erosion danger.

Employment generation:

Combining crop enterprises with livestock enterprises to take advantage to complementary and supplementary relationships between them, would increase the labour requirements tremendously and can help in solving the problem of under employment to a great extend. IFS provide enough scope to employ family labour round the year.

Improves literacy*:*

The farmer, who adopts IFS by combining different components like fishery, sericulture, mushroom cultivation, apiary, spawn production, dairy, poultry, agri-horticulture, Agro-forestry-biogas production etc., becomes an expert in each and every aspects of individual component on long-range adoption. This expertise will help the farmer to face any challenge in their activity.

Provides opportunity for Agri-oriented Industries:

When once the produces of different components linked in IFS are increased to commercial level and if there is glut in the market, leads to the development of side industries for preserving the by products.

Standard of living of the farmer increased:

When once provisions are made in the farm level to generate bio-energy, produce edible mushroom, fruits, eggs, milk, honey, vegetables etc., for the family use of the farmer apart from commercial purposes through IFS, creates a feeling among the farmers that they are no way inferior to other professionals in the region. When they feel that the standard of living is on par with others and this will act as a booster tonic to continue agricultural profession without any reluctance.

Conclusion

Integrated farming systems, a holistic approach to farming aimed at meeting the multiple demands (impart farm resilience, farmer livelihoods, food security, ecosystem services and making farms adaptive and resilient, etc.). Hence, IFS would help us achieve multi-faceted objectives like doubling farmers' income, ensure food security and promote environmental sustainability.

Volume: 03 Issue No: 11

EMPOWERING AGRICULTURAL COMMUNITIES: DIGITAL LITERACY INTEGRATION IN AGRICULTURAL EXTENSION SERVICES

Article ID: AG-V03-I11-13

Dr. Deepali Suryawanshi * and Phool Singh**

* Assistant Professor, Department of Agricultural Extension and Communication, ITM University Gwalior Madhya Pradesh
** Assistant Professor, Department of Agronomy, ITM University Gwalior Madhya Pradesh.

*Corresponding Author Email ID: deepsuryaa@gmail.com

Abstract

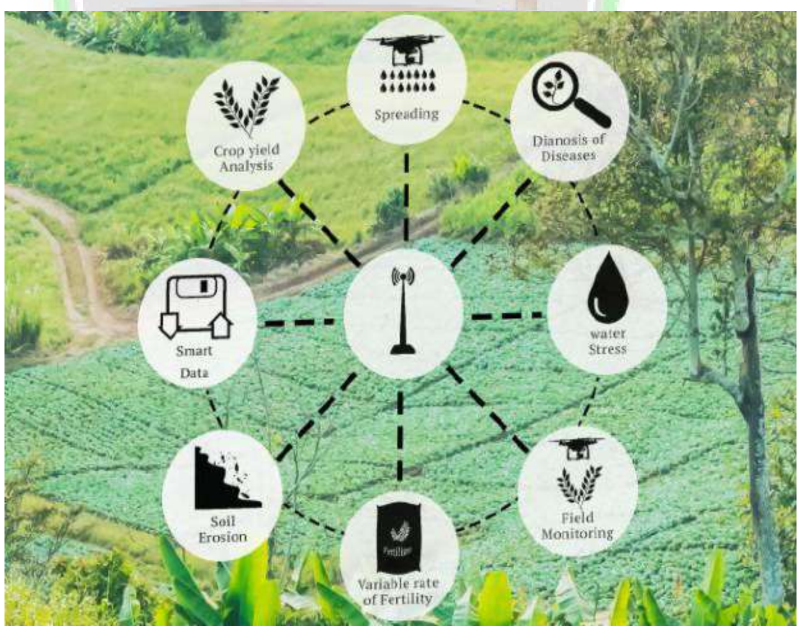
In the modern era, digital literacy has emerged as a vital tool for transforming traditional agricultural practices and fostering sustainable rural development. This abstract explores the profound impact of integrating digital literacy into agricultural extension services. By equipping farmers with digital skills, this integration enhances access to real-time information, enables direct market participation, promotes financial inclusion, and encourages the adoption of precision agriculture techniques. However, challenges such as limited connectivity, digital illiteracy, language barriers, and infrastructure gaps must be addressed to ensure equitable access. Strategies, including tailored training programs, public- private partnerships, offline solutions, demonstration farms, and peer-to-peer learning, play a pivotal role in promoting digital literacy among farmers. Highlighting successful case studies. like India's e-Krishak Mitra and Kenya's M-Shamba. this abstract underscores the transformative potential of digital literacy in agricultural extension services. Through thoughtful implementation and strategic collaborations, digital literacy can empower farming communities, bridge knowledge gaps, and pave the way for a more prosperous and sustainable agricultural future.

Key words: - Rural development, Digital illiteracy, M-Shamba, Demonstration farms

Introduction:

The agricultural sector, an essential pillar of global sustenance and economic stability, stands at a crossroads of transformation. In an era characterized by rapid technological advancement and digital innovation, the integration of digital literacy into agricultural extension services has emerged as a powerful catalyst for change. This introduction delves into the significance of this integration, exploring how digital literacy empowers farming communities, enhances access to information, improves market participation, fosters financial inclusion, and promotes the adoption of sustainable farming techniques.

Agricultural extension services have long served as a vital conduit for disseminating knowledge, innovations, and best practices to farmers. The primary aim has been to bridge the gap between scientific research and on-ground implementation, thereby increasing agricultural productivity and rural development. However, with the advent of the digital age. the landscape of agricultural extension has witnessed a paradigm shift. The transformation is driven by the recognition that digital literacy is not just an ancillary skill but a transformative force capable of reshaping the way farmers engage with information, markets, and technology.



Digital Literacy and Access to Information:

Access to timely and relevant information is the bedrock of effective decision-making in agriculture. With digital literacy, farmers can harness the power of the internet to access a plethora of resources that were once beyond their reach. Real-time weather forecasts, crop management techniques, pest control strategies, and market trends are now just a click away. This empowerment allows farmers to make informed decisions that positively impact yield, reduce losses, and contribute to sustainable land use.

Market Participation and Direct Engagement:

The integration of digital literacy has redefined the way farmers participate in markets. Online platforms and mobile applications have dismantled geographical barriers, enabling direct interaction between farmers and buyers. Farmers can showcase their produce, negotiate prices, and secure sales without the need for intermediaries. This not only enhances profit margins but also empowers farmers to assert greater control over their livelihoods.

Financial Inclusion and Digital Empowerment:

In the past, limited access to financial services posed a significant obstacle for farmers, often resulting in reduced access to credit and restricted financial management options. Digital literacy has revolutionized this landscape by introducing mobile hanking, digital payment systems, and microfinance opportunities, Farmers can now manage their finances efficiently, access credit for agricultural inputs, and engage in secure transactions, thus promoting financial inclusion and economies empowerment.

Sustainable Agriculture through Precision Techniques:

The digital revolution has given rise to precision agriculture, an approach that optimizes resource utilization and reduces environmental impact. Through digital literacy, farmers can leverage Geographic Information Systems (GIS), drones, and sensor networks to monitor soil conditions, irrigation levels, and crop health. This data-driven approach enables precise application of fertilizers, pesticides, and water, leading to improved resource efficiency, reduced costs, and ecologically sound practices.

Challenges and the Path Forward:

While the integration of digital literacy holds immense promise, it is not without challenges. Limited internet connectivity in rural areas, digital illiteracy among older generations, language barriers, and inadequate infrastructure pose hurdles that must be overcome to ensure equitable access. Tailored training programs, strategic public-private partnerships, offline solutions, demonstration farms, and peer-to-peer learning are vital strategies that can promote digital literacy among farmers.

The Digital Dividend: Enhancing Agricultural Practices:

Access to Information: Digital literacy equips farmers with the ability to access a wealth of real-time information, ranging from weather forecasts and pest management strategies to crop cultivation techniques and market trends. This access empowers farmers to make informed decisions, resulting in improved productivity and yield optimization.

Market Participation: Digital platforms enable farmers to directly engage with markets, transcending geographical constraints. Online marketplaces and mobile applications empower farmers to showcase their produce, negotiate prices, and secure sales, thereby reducing the dependency on intermediaries.

Financial Inclusion: Digital literacy paves the way for financial inclusion by providing farmers with access to digital banking, mobile payment systems, and microfinance options. This inclusion enhances their ability to manage finances, access credit, and transact securely.

Precision Agriculture: Cutting-edge technologies like Geographic Information Systems.

(GIS), drones, and sensor networks facilitate precision agriculture. Digital literacy enables farmers to utilize these tools, leading to optimized resource utilization, reduced input costs. and sustainable agricultural practices.

Climate Resilience: Digital literacy offers farmers access to climate-smart farming practices, timely weather updates, and adaptive strategies. This knowledge equips them to mitigate the effects of climate change and adapt their practices accordingly.

Challenges on the Digital Horizon:

Limited Connectivity: Rural areas often suffer from inadequate internet connectivity, impeding farmers' access to online resources and services. Initiatives to expand network coverage are essential to ensure equitable access.

Digital Illiteracy: Many farmers, particularly those from older generations, lack familiarity with digital devices and technologies. Comprehensive training programs are imperative to address this barrier.

Language and Content: Digital resources must be available in local languages and culturally relevant formats to ensure effective communication and comprehension among farmers.

Infrastructure: Access to devices like smartphones and computers, as well as reliable electricity, remains a challenge in some rural areas. Infrastructure development is pivotal for effective digital engagement.

Strategies for Cultivating Digital Literacy:

Tailored Training Programs: Customized digital literacy training programs should be developed, catering to the unique needs and demographics of the farming community.

Public-Private Partnerships: Collaborative efforts between government agencies, non-governmental organizations (NGOs), and private sector entities can amplify the reach and impact of digital literacy initiatives.

Offline Solutions: In regions with limited internet connectivity, offline solutions such as pre-loaded devices with relevant content can be employed to disseminate information.

Demonstration Farms: Establishing model farms that showcase effective use of digital tools can inspire other farmers to adopt similar practices.

Peer-to-Peer Learning: Encouraging digitally literate farmers to mentor their peer's fosters knowledge sharing and community empowerment.

Case Studies:

e-Krishak Mitra in India: This program delivers digital agricultural advice to farmers' vin mobile applications, offering personalized recommendations for crop management.

M-Shamba in Kenya: A mobile platform providing weather forecasts, market prices, and agronomic guidance to smallholder fürmers, enhancing decision-making.

Conclusion:

In the pursuit of sustainable agricultural development, the integration of digital literacy into agricultural extension services stands as a beacon of progress and empowerment. The journey embarked upon by farming communities and extension professionals alike is one that holds immense promise for a future characterized by innovation, resilience, and prosperity. As digital literacy penetrates the fabric of agricultural practices, it empowers farmers with unprecedented access to a wealth of information, transforming their decision-making processes and catalyzing productivity gains. The evolution from relying solely on traditional knowledge sources to leveraging real-time weather forecasts, market trends, and precision farming techniques exemplifies the transformative potential of digital literacy. Moreover, the seamless connectivity afforded by digital platforms has unshackled farmers from the confines of geographic limitations, enabling them to participate directly in markets and transcend intermediaries. This direct engagement bolsters their income, fosters entrepreneurship, and enhances their

Volume: 03 Issue No: 11

VERMICOMPOSTING TECHNOLOGY AND ITS BENEFITS

Article ID: AG-VO3-I11-14

Dr.R.Abishek[1*]

[1]Assistant Professor, Department of Soil Science And Agricultural Chemistry, Kumaraguru Institute of Agriculture, Erode, Tamil Nadu-638315, India

*Corresponding Author Email ID: abishek.ravichandran111@gmail.com

Introduction

Vermicomposting is a sustainable and eco-friendly method of recycling organic waste materials using earthworms. This technology has gained popularity worldwide due to its numerous environmental and agricultural benefits. In this chapter, we will explore the principles of vermicomposting, the key components of the process, and the significant advantages it offers.


.

Figure 1. *Eisenia fetida,* -Red wigglers

Principles of Vermicomposting

1. Earthworm Selection

The success of vermicomposting largely depends on the choice of earthworm species. Eisenia fetida, also known as red wigglers, is the most commonly used species for this purpose. These worms are highly efficient at breaking down organic matter and producing nutrient-rich castings

2. Organic Waste Selection

Vermicomposting is suitable for a wide range of organic materials, including kitchen scraps, yard waste, agricultural residues, and paper products. Materials such as fruit and vegetable peels, coffee grounds, leaves, and shredded cardboard are excellent choices.

3. Controlled Environment

To optimize the vermicomposting process, a controlled environment is necessary. This typically involves a container or bin with suitable bedding material, adequate aeration, and moisture levels. Maintaining the right conditions ensures that earthworms thrive and break down organic matter efficiently.

4. Feeding and Maintenance

Earthworms require a consistent supply of organic waste to sustain their population and facilitate decomposition. Regular maintenance tasks include checking moisture levels, monitoring temperature, and ensuring proper aeration.

Key Components of Vermicomposting

1. Vermicompost Bedding

The bedding serves as a habitat for earthworms and helps retain moisture. Common bedding materials include shredded newspaper, cardboard, coconut coir, and peat moss. The bedding also provides a carbon source, which balances the carbon-to-nitrogen ratio in the composting process.

2. Earthworms

Eisenia fetida, as mentioned earlier, are the preferred species for vermicomposting due to their efficiency in consuming organic matter and producing nutrient-rich castings. A healthy population of earthworms is essential for successful vermicomposting.

3. Organic Waste

The organic waste materials you feed to the earthworms are the raw materials for vermicomposting. These materials will eventually be transformed into valuable vermicompost, which is rich in nutrients and beneficial microorganisms.

4. Moisture Control

Maintaining the right moisture level (usually around 70-80%) is crucial for vermicomposting. Too much moisture can lead to anaerobic conditions, while too little moisture can hinder earthworm activity. Regularly checking and adjusting moisture levels is essential.

Benefits of Vermicomposting

1. Nutrient-Rich Vermicompost

Vermicompost is an exceptional organic fertilizer. It is rich in essential plant nutrients such as nitrogen, phosphorus, potassium, and micronutrients. These nutrients are readily available to plants, promoting healthy growth and increased crop yields.

2. Soil Health Improvement

Adding vermicompost to soil enhances its structure, water-holding capacity, and aeration. It also encourages beneficial soil microorganisms, leading to improved soil health and reduced susceptibility to diseases.

3. Waste Reduction

Vermicomposting helps divert organic waste from landfills, reducing the environmental burden of waste disposal. It is an effective way to recycle kitchen scraps and yard waste, contributing to waste reduction goals.

4. Sustainable Agriculture

By using vermicompost as a natural fertilizer, farmers can reduce their reliance on synthetic chemicals, promoting sustainable and environmentally friendly agricultural practices.

5. Cost Savings

For both homeowners and farmers, vermicomposting can lead to cost savings. Reduced fertilizer expenses, improved crop yields, and lower waste disposal costs all contribute to financial benefits.

Conclusion

Vermicomposting is a technology that embodies the principles of sustainability and resource efficiency. It offers a practical solution to manage organic waste, improve soil health, and promote sustainable agriculture. By harnessing the power of earthworms and organic matter, we can create a more environmentally friendly and economically viable approach to waste management and agriculture. As society continues to seek eco-friendly solutions, vermicomposting will undoubtedly play a vital role in our sustainable future.

Volume: 03 Issue No: 11

A BOON OR A CURSE? AN OVERVIEW AT THE CURRENT STATE OF ULTRA-PROCESSED FOOD

Article ID: AG-V03-I11-15

Er. Jambamma[*1], Dr. P.Reddypriya[2] and Er. Ashwini, Y[3].

[1,2]Assistant Professor, [3]TA, Agricultural College, Aswaraopet-507301, B. Kothagudem (Dist.)

Jayashankar Telangana State Agricultural University, Telangana, India

*Corresponding author: Department of Agricultural Engineering

*Corresponding Author Email ID: jammu2011@gmail.com

Abstract

The most widely used food processing system in the world, the NOVA system, divides food processing systems into four categories. In the world that is globalizing and liberalizing the fastest, food processing is commonplace and is done everywhere to address food needs. Foods categorized as group 1 through group 3 that have undergone mild processing appear to benefit both the economy and public health. Group 4 foods are highly/ultra-processed, have increased fat and sugar content, chemical additives, and an appealing look, mouth-melting texture, taste, and flavor profile that primarily draws in young people for repeated consumption. A recent study looked at the harmful effects of eating too much ultra-processed food, although these foods cannot be completely avoided. Rather, consuming in moderation can help reduce adverse consequences.

Introduction:

Over time, food consumption practices have evolved to meet the needs of modern consumers, prioritizing food safety, shelf life extension, and convenience. This evolution can be seen from the early days of raw food consumption to the present where processed foods have become the norm. The advancement of food technology and the rise in popularity of enhanced processed food tastes, textures, and flavors have led to an increased consumption of palatable food. The degree of processing can have significant implications for a food's nutritional value, healthfulness, and impact on diets.

To safeguard public health and promote dietary goals, developed countries have established relevant authorities or organizations that categorize foods depending on levels of processing. These food classification systems, which are increasingly being utilized as a foundation for epidemiological research, were developed to provide people with accurate information about the food they eat.

What are Food Processing-Food Classification Systems?

Food processing is widespread and transforms food from its natural state. The impact of various processed foods on food quality, diet, and human health can be either beneficial or detrimental. The significance of general verdicts on food processing is either minimal or insignificant. Food scientists and technologists, along with food manufacturers, accurately emphasize the advantages of conventional processes such as drying, skimming, non-alcoholic fermenting, freezing, pasteurization, and vacuum-packing.

Conversely, the evidence supporting the deleterious effects of processes like charring, alcoholic fermenting, salt-pickling, hydrogenation, and sugaring (as in soft drinks or "soda") is overwhelming or clear. There are seven different food processing classification systems currently used in various countries as listed below.

2007: The National Institute of Public Health (NIPH) of Mexico proposed the first classification system.

2009: International Agency for Research on Cancer (IARC) of In Europe.

2011: The International Food Policy Research Institute (IFPRI) of Guatemala, a food classification system developed by Asfaw.

2012: The International Food Information Council Foundation (IFIC) of the United States of America (USA) food classification system based on processing level.

2015: The University of North Carolina (UNC) of United States of America (USA) with modified category names and representative foods of the American diet.

2015: The Centre for Epidemiological Studies in Health and Nutrition at the School of Public Health, University of São Paulo (NOVA) of Brazil on the role of industrial processing in nutrition and human health. This classification has been the most used worldwide for the classification of processed foods.

2018: Food Standard Australia New Zealand proposed the dichotomization of foods and beverages as not processed or processed.

Table 1. Processed foods classification groups as per NOVA system (de Araújo, *et al.*, 2022)

Degree of Processing	Definition	Examples
Unprocessed or Minimally processed food (Group 1)	Minimal processing is used to preserve the foods, and to make them suitable for storage, facilitate their culinary preparation, enhance their nutritional quality, and easier to digest.	✓ Fresh, dried, chilled, frozen, vacuum-packed vegetables & fruits, cereals & pulses, fungi. ✓ Fresh, dried, chilled, frozen meats, poultry, fish, seafood and eggs ✓ Unsalted nuts and seeds, ✓ Fresh and dried spices, herbs and pasta. ✓ Flours of corn or wheat ✓ Fresh, pasteurized or powdered milk, yogurt ,tea, coffee, drinking water.
Processed culinary ingredients (Group 2)	Highly durable but usually not consumed by themselves.	✓ Salt, sugar and syrups, honey, plant oils, animal fats, corn starch.
Processed food (Group 3)	Ready-to-consume, by themselves or in combinations.	✓ Canned vegetables, cereals or pulses. ✓ Canned fruits added sugar. ✓ Salted nuts, meats, fish. ✓ Cheeses, and breads.
Ultra-processed food (Group 4)	Formulations of industrial ingredients and substances derived from foods or else created in laboratories, and typically contain little or even no whole foods.	✓ Baked products: loaf bread, rolls, cookies, cakes ✓ Frozen products : pies, pasta dishes Breaded chicken or fish extracts like nuggets, sausage, hamburgers, ✓ Soft drinks, ‘energy’ drinks, mayonnaise ✓ Other foods: ‘packet snacks’, ice cream, chocolates, candies, ‘breakfast cereals’ and ‘cereal bars’, ‘instant’ soups and noodles.

What are Ultra processed foods?

Ultra-processed foods are highly processed and typically contain many additives, including preservatives, sweeteners, colorings, and flavor enhancers. These foods often bear little resemblance to their original natural ingredients and are typically ready-to-eat or require minimal cooking. These foods are often designed to be convenient, long-lasting, and highly palatable, but they are also associated with several health concerns. Here are some characteristics and examples of ultra-processed foods:

Characteristics of Ultra-Processed Foods:

1. High in Chemical Additives: Ultra-processed foods contain a wide range of artificial chemical additives, such as colors, flavors, sweeteners, and preservatives, to enhance their taste, appearance, and shelf life.
2. High in Unhealthy Fats and Sugars: Ultra-processed foods often contain unhealthy trans fats, saturated fats, and high levels of added sugars, making them palatable but raising concerns about their impact on health.
3. Long Shelf Life: Engineered to have a long shelf life, these foods are protected against spoilage and degradation through preservatives and advanced packaging methods.
4. Convenient: Designed for quick and easy consumption, ultra-processed foods come in ready-to-eat or microwaveable forms, such as packaged snacks and instant noodles
5. Low in Whole Ingredients: Ultra-processed foods typically contain few or no whole or minimally processed ingredients, instead consisting of various derivatives and refined components.
6. Low in Essential Nutrients: These foods tend to be low in vitamins, minerals, and fiber, while high in calories, unhealthy fats, added sugars, and salt.

How do processed foods affect our health?

A minimal process and processed (group-3) practices improve quality, increase foods nutrition, shelf life with or without change of food natural state. This practice uses least degree food processing technologies but contains only one or two preservatives, such as salt sugar, oil and other additive. The current prospects in food processing technology have significantly improved and now include advanced technologies such as 3D food printing, IoT, and artificial intelligence/machine learning, which are on the verge of revolutionizing the industry with the 5th industrial revolution. These technologies are now easily accessible as a source.

Ultra processed foods in group 4 undergo ultra-level modifications to their original form, and it is likely that they contain higher levels of saturated and trans-fats (9 calories per gram), proteins (4 calories per gram), sugar (4 calories per gram), sodium, artificial colors, preservatives, synthetic additives, and stabilizers.

In the modern day, eating habits of the younger and working-age population in cities and towns have changed away from home-cooked meals and toward foods that are enticing, quick, easy, delicious, and heavily processed.

A recent research examined the effect of processed foods on public health by providing equal calorie amounts of unprocessed and ultra-processed food diets to the participants for two weeks. The study discovered that the participants consumed more calories from ultra-processed food due to its taste and appetizing properties, resulting in an average weight gain of two pounds. The researchers suggested that limiting the intake of ultra-processed foods may be an effective method for treating obesity (Hall, *et al.*, 2019). Furthermore, another study found that long-term consumption of ultra-processed food diets may increase the risk of cardiovascular disease, coronary heart disease, cerebrovascular disease, and diabetes (Srour, *et al*., 2019).

Learn to recognize processed foods

Whenever possible, try to avoid or limit ultra-processed foods. Consider the examples in this table to help you quickly determine if a food is minimally processed, processed, or ultra-processed.

Table 2. Some examples of processed foods classifications

Minimally processed	Processed	Ultra-processed
Carrot	Carrot juice	Carrot cake
Peas	Canned peas	Instant Pea soup
Potato	Potato bakes	Potato fries
Mushroom	Canned Slice Mushroom	Instant mushroom soup
Orange	Orange juice	Orange candy
Apple	Apple juice	Apple pie
Wheat/corn	Flour	Cookies or bread or pasta, chips, noodles
Meat	Canned meat	Nuggets/sausage/hamburgers

www.health.harvard.edu

Conclusion

Globalization and liberalization have allowed food-processing technologies to cross all global boundaries, envisioning a brighter future for the food industry. Among food processing, some foods that are processed at the ultra-level are majorly linked to chronic diseases among all age groups over extensive, limitless, and regular consumption. Avoiding these foods is not possible, whereas calculated quantity and periodic consumption can certainly avoid its adverse consequences on health.

References:

de Araújo, T. P., de Moraes, M. M., Afonso, C., Santos, C., & Rodrigues, S. S. (2022). Food processing: Comparison of different food classification systems. Nutrients, 14(4), 729.

Hall, K. D., Ayuketah, A., Brychta, R., Cai, H., Cassimatis, T., Chen, K. Y., ... & Zhou, M. (2019). Ultra-processed diets cause excess calorie intake and weight gain: an inpatient randomized controlled trial of ad libitum food intake. *Cell metabolism*, *30*(1), 67-77.

Moubarac, J. C., Parra, D. C., Cannon, G., & Monteiro, C. A. (2014). Food classification systems based on food processing: significance and implications for policies and actions: a systematic literature review and assessment. *Current obesity reports*, *3*, 256-272.

Srour, B., Fezeu, L. K., Kesse-Guyot, E., Allès, B., Méjean, C., Andrianasolo, R. M., ... & Touvier, M. (2019). Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). *bmj*, *365*.

https://www.health.harvard.edu/blog/what-are-ultra-processed-foods-and-are-they-bad-for-our-health-2020010918605

Volume: 03 Issue No: 11

THE BROILER CHICKEN – MYTHS UNFOLDED

Article ID: AG-VO3-I11-16

V.B. Raghavendran[1]*, R. Prabhu[2] and S. Saravanan[3]

[1, 3] Assistant Professor (V&AS), Department of Agronomy, ADAC&RI, Trichy and ICAR-KVK, Madurai, Tamil Nadu, India

[2] Technical Manager, AVIAGEN, India

*Corresponding Author Email ID: raghavamour@gmail.com

Introduction

Once upon a time, a beautiful chick sat outside a farm, engrossed in a newspaper, looking confused and poking at the pages. Suddenly, a shrine appeared in front of the chick, asking about the reason for its bewildered state. The chicken, momentarily lost in thought, quickly regained its composure and explained that it was perplexed after reading some articles in the newspaper. God smiled and offered to clarify all the doubts within minutes. Delighted, the chicken proceeded to list its concerns. The conversation unfolded as follows:

Chicken: "My ancestors used to reach 1 kg body weight in four months, but nowadays, I'm reaching 2 kg in just 35 days. How is this possible?"

God: "I created this world with a biological cycle called the 'food chain,' in which all living creatures peacefully coexist. This cycle regulates the population control of all species. However, when humans became more intelligent, they escaped the food chain and multiplied rapidly. Due to this population increase, they required more food to sustain themselves. With their intelligence, they dominated other species and began controlled breeding of plants and animals to meet their needs. To satisfy their high demands, they turned to crossbreeding, resulting in new varieties of plants, animals, birds, and seafood that yield more grains, fruits, milk, meat, and eggs. Your increased growth is a consequence of human knowledge development."

Chicken: "Many humans believe that chickens, like myself, grow quickly due to the use of hormones. Am I growing rapidly because of hormones?"

God: "As I mentioned earlier, your accelerated growth is not a result of hormones. Similar to how cows now produce 25 litres of milk compared to the previous 2 litres, or how goats give birth to more kids and gain weight within four months, you too experience faster growth due to crossbreeding."

Chicken: "Am I regularly given injections throughout my life to increase my body weight?"

God: "Yes, you are indeed given injections regularly, but these are vaccinations. Just as we give vaccinations to human babies on their first day, you are vaccinated against Marek's Disease. As you grow, you become more susceptible to various viruses, and vaccinations are crucial to minimize the occurrence of diseases. Hence, you receive various vaccines at regular intervals."

Chicken: "In the daily newspapers, I see live broiler prices listed as Rs 56 or Rs 78 per kg. However, in chicken shops, consumers pay Rs 120 to Rs 150 per kg for broiler meat. Why is there such a price difference, and where does the extra money go?"

God: "While I created and granted equal rights to all living creatures, humans gained the upper hand and dominated others. Similarly, middlemen, whether individuals or chains of people, always tend to exert control over producers and take more money under the guise of transportation, wastage, mortality, and risk. The middlemen spend a significant amount on transportation, wastage, and mortality. In the newspaper, you see Rs 78 per kg for live weight, but the producer receives Rs 70 per kg after deducting the wastage of head, neck, intestine, feathers, and feet. Researchers have identified that the standard weight loss during transportation is 0.2% to 0.5% per hour. Even if the transport takes 12 hours, the weight loss amounts to 6%, which equals 60 grams of meat or Rs 4.15. The middleman spends Rs 2.50 per kg for transport, resulting in an overall cost of Rs 10 per kg for middlemen. If the middleman owns a retail shop, they charge Rs 40 per kg, and the values vary when transferred to different parties. These values are subject to change over time."

Chicken: "If the consumption is very low, do middlemen take risks to recoup their money?"

God: "When chicken prices are very low, producers often sell chickens locally, in sandy areas or villages, at farm live prices. During such times, producers and integrators can sell their chicken directly to people. However, producers and traders always aim for larger markets, such as cities and towns, much like educated individuals who prefer not to venture into villages. By increasing the availability of chicken in villages, you can boost consumption."

Chicken: "How can chicken consumption be increased?"

God: "Most media outlets tend to spread negative propaganda against chicken consumption. Creating awareness among people about the benefits of chicken is crucial. Strengthening the supply chain and increasing the availability of chicken in villages are important steps. Involving self-help groups and rural youths can strengthen the supply chain in villages, creating more employment opportunities at the local level while reducing the influence of middlemen. Encouraging chicken farming in all areas will minimize transportation, lower transportation costs, and increase availability. By reducing the control of middlemen, chicken meat can be offered to consumers at a lower price."

Chicken: "Is the broiler industry using excessive antibiotics?"

God: "I am not here to blame anyone in this world, but when it comes to the usage of antibiotics, common perception suggests that they are often irrationally used in the medical field. However, in the poultry industry, antibiotics are used only when absolutely necessary, taking into consideration the drug's shelf life. Under the prevailing conditions in India, the presence of antibiotic residues in poultry meat is very minimal."

Chicken: "I thank you for clarifying all my doubts. Why don't you convey these explanations directly to the people so they can also dispel their doubts?"

God: "In India, middlemen often have more influence and respect than even the gods. Therefore, I need to find suitable intermediaries like cricketers, cinema actors, or religious priests to convey this message effectively. Only then it will reach the people."

Volume: 03 Issue No: 11

PACKAGE OF PRACTICES IN GINGER

Article ID: AG-VO3-I11-17

J.E. Adeline Vinila*, T.Sumathi and B.Muralidharan

Horticultural College and Research Institute

Tamil Nadu Agricultural University, Coimbatore,Tamil Nadu, India

*Corresponding Author Email ID: vinivinila@rediffmail.com

Introduction

Ginger (*Zingiber officinale Rosc*) one of the oldest known spices, is an important spices crop of the world and it belongs to the family Zingiberaceae. Ginger is known for its distinct flavor and pungency since ancient times. In India, ginger occupies an important place as it is a source for foreign exchange. Ginger of commerce constitutes both fresh and dry rhizome of *Zingiber officinale.* India is the largest producer, consumer and exporter of ginger and it is the largest producer of dry ginger in the world. Indian dry ginger is known in the export market as Cochin ginger and Calicut ginger. In quality, Indian ginger is next only to Jamaican ginger, which is considered to be the best in the world. Ginger is used in cooking for its aroma, flavour and pungency and also used in the production of ginger beer, ginger wine, cordials and carbonated drinks in confectionery, pickles and pharmaceutical preparations. The essential oil and oleoresin are used in the manufacture of flavouring essences and in perfumery.

Origin and Distribution

Ginger is a native of tropical South or South East Asia but was under cultivation in India as well as in China from ancient times. Ginger was grown on west coast of India from time immemorial and later on its cultivation spread to various other parts mainly to Bengal and North Eastern India. Main ginger growing countries are India, China, Jamaica, Taiwan, Sierra Leone, Nigeria, Figi, Mauritius, Indonesia, Brazil, Costa Rica, Ghana, Malaysia, Bangladesh, Philippines, Sri Lanka, Trinidad, Uganda, Hawaii, Guatemala and many Pacific ocean islands.

Climate

Ginger requires a warm and humid climate. The plant thrives well in the tropics from sea level to an altitude of 1500 m in the Himalayas. Optimum elevation for cultivation of ginger ranges between 300 and 900 m. A well distributed rainfall (150 – 300 cm) during growing season and dry spells during land preparation as well as before harvest are required for large scale cultivation of crop. In areas receiving less rainfall, the crop needs regular irrigation.

Soil

Ginger can be grown in a wide range of well drained soils like sandy loam or clay loam, red loam or lateritic loam. A friable loamy soil rich in humus is ideal for ginger cultivation. However being an exhaustive crop, soils should be rich in fertility. It is very sensitive to water-logging and therefore such situations should be avoided. The ideal soil pH range for the crop is 5.5 to 6.5.

Varieties:

The local cultivars are usually named after the areas where they are cultivated. Some of the prominent indigenous cultivars are Maran, Kuruppampadi, Ernad, Wayanad, Himachal and Nadia. The exotic cultivar 'Rio-de-Janeiro' is very popular among ginger cultivators.

Improved varieties developed from different research stations/institutes and released for cultivation are given below:

Variety	Pedigree	Av. yield (kg/ha)	Dry recovery %	Oleoresin %	Crude fibre %	Essential oil %	Duration	Salient features
Suprabha	Clonal selection from Kunduli local	16.6	20.5	8.9	4.4	1.9	229	Plumpy rhizome, less fibre, wide adaptability, suitable for both early and late sowing.
Suruchi	Clonal selection	11.6	23.5	10.9	3.8	2.0	218	Profuse tillering,bold

	from Kunduli local							rhizome, early maturing, suitable for both rainfed and irrigated condition.
Suravi	Induced mutant from Rudrapur local	17.5	23.6	10.2	4.0	2.1	225	Plumpy rhizome, dark skinned yellow fleshed, suitable for both irrigated and rainfed conditions.
Himgiri	Clonal selection from Himachal	13.5	20.2	4.29	1.6	6.05	230	Best for green ginger less susceptible to rhizome rot disease, suitable for rainfed condition.
IISR Varada	Selection from germplasm	22.66	19.5	6.7	3.29-4.50	1.7	200	High yielder, high quality bold rhizome, low fibre content. Wide adaptability and tolerant to diseases.
IISR Mahima	Selection from germplasm	23.2	23	4.5	3.26	1.72	200	High yielder,plumpy extra bold rhizomes, resistant to *M. Incognita and M. javanica* pathotype
IISR Rejatha	Selection from	22.4	20.8	6.3	4	2.36	200	High yielder,plumpy and

	germplasm							bold rhizome
Athira	Somoclonal Varient of Maran	21.0	0.0	0.0	3.4	0.0	200	High yielder, high quality bold rhizome
Karthika	-	19.0	0.0	0.0	0.0	0.0	200	High yielder and high pungency for extraction of oleoresin.

Season

The best time for planting ginger in West Coat of India is during the first fortnight of May with the receipt of pre monsoon showers, while in North Eastern states, it is during April. Under irrigated conditions, it can be planted well in advance during the middle of February or early March.

Propagation

Ginger is propagated by portions of rhizomes known as seed rhizomes. Carefully preserved seed rhizomes are cut into small pieces of 2.5-5.0 cm length weighing 20-25 g each having one or two good buds.

Land preparation

The land should be ploughed 4-5 times to bring the soil to a fine tilth. Beds of 1 m width, 15 cm height and 3 m length, or of any convenient length, are prepared at 40 cm spacing. About 2,000 beds of 3 m x 1 m size are prepared in one hectare of land. In case of irrigated crop, the ridges are formed 40 cm apart and the width of the channels between the beds is about 30 cm. The seed rate varies from region to region and with the method of cultivation adopted. In plains, the seed rate varies from 1500 to 1800 kg/ha. At higher altitudes the seed rate may vary from 2000 to 2500 kg/ha. The seed rhizomes are treated with mancozeb 0.3% (3 g/L of water) for 30 minutes and shade dried for 3-4 hours.

Planting

Planting of ginger is recommended on raised beds (in order to facilitate drainage) at a spacing of 20 x 20 cm or 25 x 25 cm with the viable bud facing upwards. Seed rhizome is placed

3.5-5.0 cm deep in pit and soil is pressed over it, followed by light irrigation. The crop prefers light shade for good growth, but shade is not absolutely necessary.

Manures and fertilizers

As ginger is a heavy feeder, it should be well manured. At the time of planting, 25-30 tonnes of well rotten FYM or compost per hectare and neem cake @ 2 t/ha has to be applied as basal dressing along with full dose of P and K (50 kg P_2O_5 and 25 kg K_2O). 75 kg N has to be applied in two equal split doses at 40 and 90 days after planting. Application of neem cake at the time of planting helps to reduce the incidence of soft-rot disease and increases the yield. The plants are to be earthed up, after each top dressing with the fertilizers and beds are to be rectified. In zinc deficient soils, basal application of zinc 6 kg /ha (30kg of zinc sulphate) gives good yield.

Mulching

Mulching of beds with green leaves or organic waste is an important and essential operation for ginger.

- It serves as a good source of organic manure
- Prevents washing of soil
- Conserves soil moisture
- Reduce weed growth
- Improves the physical properties of the soil.

First mulching is done at the time of planting with 12.5 tonnes of green leaves and the second and third mulching is done after 40th and 90th day after planting with 5 tonnes of green leaves per hectare coinciding with weeding, top dressing and earthing up. Daincha can be raised in the interspaces of beds immediately after planting ginger and they can be uprooted before second mulching and may be used for second mulching after earthing up.

Irrigation

Ginger is cultivated as a rainfed crop in heavy rainfall areas, as irrigated crop in maidan areas. Water requirement of ginger is 1,320-1,520 mm during its complete crop cycle. Irrigations are given at an interval of 10 days with a total of 16-18 irrigations are required during cropping period. Irrigation is withheld 15-20 days before harvesting of the crop. Light irrigation is given before harvesting the rhizome.

Weeding

Weeding is done just before fertilizer application and mulching. Two to three weedings are done depending on the intensity of weed growth. Proper drainage channels are to be provided when there is stagnation of water.

Crop Rotation and Inter/mixed cropping

Ginger is grown both as a pure crop and as an intercrop or in rotation with other crops. In Kerala, it is grown as an intercrop with coconut, arecanut and coffee. In irrigated areas, ginger is grown in rotation with chillies and vegetables. In Kerala as well as in Sri Lanka, ginger forms a component of homestead farming, and is grown mixed with a variety of crops. Ginger is a very successful crop component in intercropping and multi-cropping systems. It is intercropped with crops such as cabbage, beans, cucumber, pineapple, tapioca, taro, *Dioscorea* and *Amorphophallus*.

PLANT PROTECTION

Pests

Shoot borer *(Conogethespunctiferalis)*

Shoot borer is the most serious pest of ginger. The larvae bore in to pseudostems and feed on the internal tissues resulting in yellowing and drying of infested pseudostems. Spraying Malathion (0.1 %) during July to October at monthly intervals is effective in controlling the pest infestation.

Rhizome scale *(Aspidiella hartii*)

The rhizome scale infests rhizomes of ginger in the field and in storage. They feed on plant sap and when the rhizomes are severely infested, they become shrivelled and desiccated and fail to germinate. Soaking seed rhizomes in Quinalphos (0.1%) before storing and sowing is effective in controlling the pest infestation.

Minor pests

The larvae of leaf roller *(Udaspes folus)* cut and fold leaves of ginger and feed from within especially during the monsoon season. A spray with Carbaryl (0.1 %) may be undertaken when the infestation is severe. Root grubs occasionally feed on tender rhizomes, roots and bases of pseudostems causing yellowing and wilting of shoots. The pest can be controlled by drenching the soil around the root region with Chlorpyriphos 0.075%.

Diseases

Soft rot or Rhizome rot (*Pythium aphanidernatum)*

Collar region exhibits rotting and it spreads to the rhizome and root. Leaves exhibit yellowing symptoms. To prevent the disease incidence,

- good drainage should be provided in the field
- healthy, disease free seed rhizomes should be selected
- Seed rhizomes should be treated with 0.3% mancozeb for 30 minutes before storage and planting
- Application of neem cake @ 2t/ha as basal dressing
- Application of *Trichoderma harzianum* @ 1kg/bed
- Drench the beds with 0.3 % mancozeb

Bacterial wilt (*Pseudomonas solanacearum)*

Affected pseudostem or rhizome shows milky ooze on gentle pressing. Seed treatment with 200 ppm streptocycline for 30 minutes can be done for effective management of the disease.

Nematodes (*Meloidogyne, Radopholus, PRatylenchus)*

Stunting, chlorosis, poor tillering, necrosis are common aerial symptoms. For the management of the disease, seed rhizomes can be treated with hot water (50˚C), sterilization of the bed for 40 days and incorporation of *Pochonia chlamydosporia* (a bio control agent) @ 20g/bed at the time of sowing.

Harvesting and Yield

Ginger harvesting is done from 6th month onwards for marketing the produce as green ginger. The rhizomes are thoroughly washed in water two to three times to remove the soil and dirt and sun dried for a day.

For dry ginger, the crop is harvested between 245 to 260 days. When the leaves turn yellow and starts drying gradually the clumps are lifted carefully with a spade or digging fork and the adhering soil is removed. The average yield per hectare varies from 15 to 25 tonnes. Fresh yield - 20-25 t/ha. Dry ginger recovery - 16-25 % of fresh ginger.

Volume: 03 Issue No: 11

ADVANCES IN WEED MANAGEMENT

Article ID: AG-V03-I11-18

S, Sowmiya[1*], M. Hemalatha[2], M. Joseph[3] and J. Bhuvaneswari[4]

[1*]Ph.D Scholar, VOC AC&RI, Killikulam,[2]Professor and Head, VOC AC&RI, Killikulam

[3]Professor, VOC AC&RI, Killikulam,

[4]Assistant Professor, VOC AC&RI, TNAU, Killikulam, Tamil Nadu, India

*Corresponding Author Email ID: kokisowmani97@gmail.com

Introduction

Weeds are one of the most important biological constraints in agricultural production systems. They negatively affect crop growth and yield by competing with crops for nutrients, sunlight, space, and water. Therefore, the management of weeds in all agroecosystems is imperative to sustain our crop productivity and to ensure food security for the burgeoning population. Agriculture has promoted new methods, which also directly or indirectly affect weed control programs.

Innovative Weed Management Practice

The Innovative weed management are Mulching, Solarization, Thermal weed control, Remote sensing in weed management, Robotics in weed management, Laser technology in weed management, Residue management of herbicides, Herbigation, RNA interference technology in weed management, Nanoherbicides, Bioherbicides and Mycoherbicides

Mulching

Mulching blocks seed germination by intercepting light, and modifying soil temperature. The mulch physically hinders the germination of weed seed emergence. Some mulch releases natural substances that inhibit the growth of weed seedlings. **Organic mulch materials** are Straw, Fresh or old hay, Tree leaves, Rice or buckwheat hulls and other crop residues.

Paddy straw mulching

SOLARIZATION

Solarization is a hydrothermal process in which moist soil is covered by transparent plastic film for 4-9 weeks. It is widely adapted in integrated weed management and recommended for sustainable agricultural systems.

Solarization

THERMAL WEED CONTROL

The methods of Thermal weed control are Fire, Directed flaming, Hot water, steam, Microwave, Infrared, ultraviolet radiation, Electrocution, and freezing. Heating results in the coagulation of proteins and bursting of protoplasm due to expansion, which kills the tissue. Weeds can also be killed by exposure to very low temperatures. By exposing terrestrial weeds to freezing using dry ice or liquid nitrogen, weeds can be removed (Uma Maheswari *et al.*, 2019).

In flaming, aboveground tissues of weeds had died, and re-growth began earlier. But, Hot foam was generally better at damaging the weed meristem (Luisa Martelloni *et al.*, 2020).

Directed flaming

Steam weed control

REMOTE SENSING IN WEED MANAGEMENT

Remote sensing is the art and science of obtaining useful information about an object without being in physical contact between the object and the sensor. Remote sensing uses the electromagnetic spectrum to image the land, ocean, and atmosphere. Remote sensing as a weed-scouting tool, takes a picture of the entire field that can be observed in a single image.

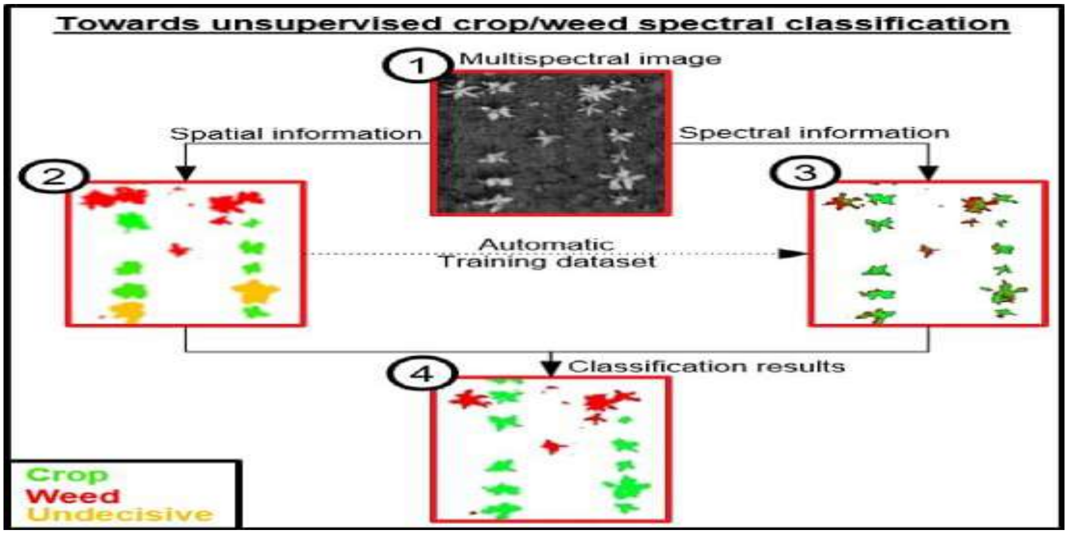
Four major steps in the weed detection system (Pejman *et al.*, 2019)

- Color-based greenness identification (High density of plants with the undesired presence of weeds is challenging since the intensity or color contrast between weed and crop helps to monitor).
- Texture extraction

- Feature vector generation
- Classification.

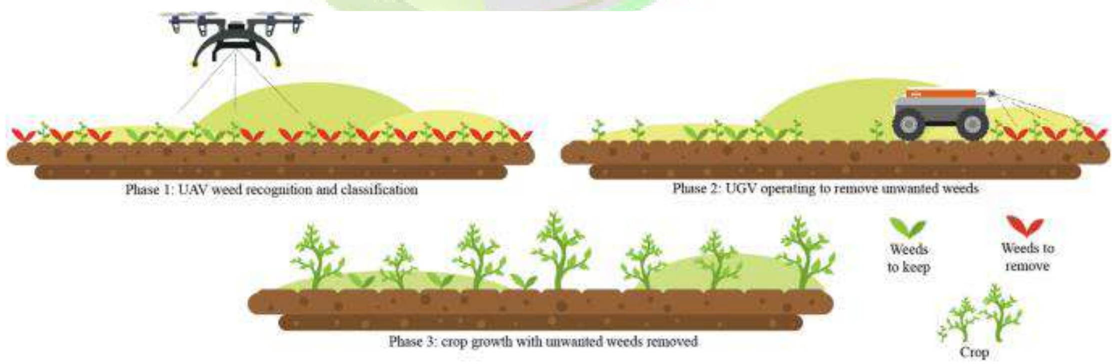
Weed patches identification by different types of cameras (multispectral, RGB, hyperspectral) (Marco Esposito *et al.*, 2021)

Crop	Weed	Type of camera	Main results
Zea mays	*Chenopodium album*	Multispectral camera	Discriminate monocotyledons (crop) Vs Dicotyledons (weed)
Triticum sp.	*Cirsium arvense*	RGB camera	Discriminate crop Vs weed
Sorghum sp.	*Portulaca oleracea*	Hyperspectral camera	Discriminate crop Vs weed
Glycine max	*Echinochloa crusgalli*	Multispectral camera	Assessment of crop injury from dicamba



Weed spectral classification

The use of UAVs and machine learning techniques allow for the identification of weed patches in a cultivated field with accuracy and can improve weed management sustainability. Weed patches identification by UAVs can facilitate integrated weed management (IWM), reducing both the selection pressure Vs herbicide-resistant weeds and herbicides diffusion in the environment. Imaging analysis can help in the study of weed dynamics in the field, as well as their interaction with the crop. By image analysis, different machine learning techniques will be able to provide a reliable overview of the level and type of infestation. Specific algorithms can be trained to manage weeds removal by Autonomous Weeding Robot (AWR), via herbicide spray or mechanical methods (Marco Esposito *et al.*, 2021).



ROBOTICS IN WEED MANAGEMENT

Robotic technology reduces agriculture's current dependency on herbicides, improving its sustainability and reducing its environmental impact. Agricultural robots have great potential to deliver weed control technologies that are much more adaptable even down to the plant scale. They potentially could direct chemical or cultivation tools to directly target weed plants.

Examples

Tertill, RIPPA, Hortibot, SwagBot V, ASTERIX, AGBOT II**.**

SMART WEED KILLING ROBOTS

TERTILL

AGBOT II

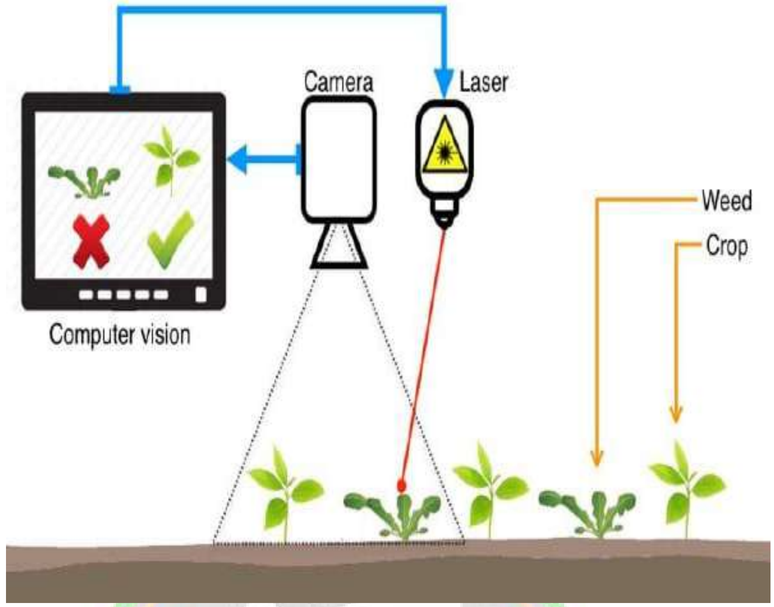
RIPPA

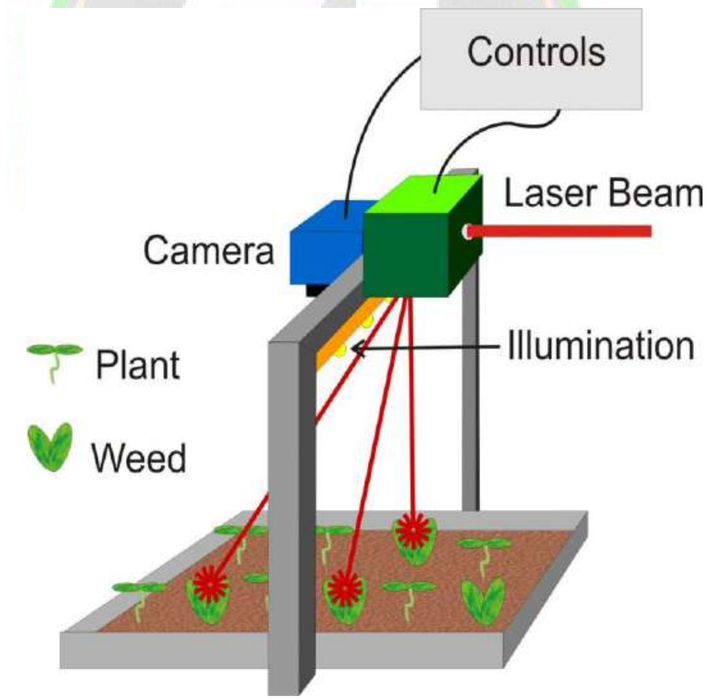
HORTIBOT

SWAGBOT

ASTERIX

LASER TECHNOLOGY IN WEED MANAGEMENT





RESIDUE MANAGEMENT OF HERBICIDES

Chlorinated herbicides do not degrade quickly and can persist in the soil for weeks, months, or years following application. The use of residual herbicides can be beneficial as the residues prevent the growth of sensitive weed species throughout the season. Residual herbicide activity is also described in terms of half-life, the half-life varies by herbicides and ranges from a few days to a year.

Herbigation is an effective method of applying herbicides through irrigation systems. Success of good habitation programmes depends upon good management, uniform water applications and knowledge of the movement of herbicides in the soil. It reduces the occurrence of herbicide-resistant biotypes in weeds by using a single herbicide. Compatible herbicide combinations control the weeds in a single pass.

NANOHERBICIDES

Nanoherbicides are formulated by exploiting the nanotechnological potential for effectual delivery of chemical or biological pesticides with the help of nanosized preparations or nanomaterials-based herbicide formulations. The development of specific herbicide molecule encapsulated with nanoparticles aims at specific receptors present at the root of the targeted weed. The developed nanoparticle enters the root system of the weed and gets translocated to perform its action which in turn inhibits the glycolysis of the plant root system. The targeted action creates starvation of the plant and thus kills it.

BIOHERBICIDES

A bioherbicide is a biologically based control agent for weeds. Bioherbicides are made up of microorganisms (e.g. bacteria, viruses, fungi) and certain insects (e.g. parasitic wasps, painted lady butterflies) that can target very specific weeds. Bioherbicides may be compounds derived from microbes such as fungi, bacteria or protozoa; or phytotoxic plant residues, extracts or single compounds derived from other plant species.

A mycoherbicide is an herbicide based on a fungus. It works by producing toxic compounds that dissolve the cell walls of targeted plants. Mycoherbicides can reproduce themselves and linger in the soil for many years to destroy replanted crops.

Example: Devine, Collego, Bipolaris

Conclusion

The advances in weed management includes efficient use of herbicides, laser technology, site-specific management, herbicide interaction, use of bioherbicide, mycoherbicide, herbicide-resistant crops, robotics, drones, remote sensing, nano technology, etc. Out of these methods, the most adaptable method is the efficient use of herbicides. This can be easily practiced by the farmers in the field when compared to other methods. Biological methods and non-chemical weed management are useful for maintaining good soil health and also environmental quality.

References

Balafoutis, A.T., van Evert, F.K. & Fountas, S. (2020) Smart farming technology trends: economic and environmental effects, labor impact, and adoption readiness. *Agronomy*, **10**,743.

Barnes, A.P., Soto, I., Eory, V., Beck, B., Balafoutis, A.T., Sánchez, B. et al. (2019) Influencing factors and incentives on the intention to adopt precision agricultural technologies within arable farming systems. *Environmental Science and Policy*, **93**, 66–74.

Gonzalez-de-Santos, P., Ribeiro, A., Fernandez-Quintanilla, C., Lopez-Granados, F., Brandstoetter, M., Tomic, S. et al. (2017) Fleets of robots for environmentally-safe pest control in agriculture. *Precision Agriculture*, **18**, 574–614.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

UNDERUTILIZED VEGETABLES - HOOKER CHIVES AND SPINY CORIANDER

Article ID: AG-V03-I11-19

[1]P. Syam Sundar Reddy* and P. Sudheer Kumar Reddy,

[1]Professor and Ph.D. Scholar

Department of Vegetable Science, Dr. YSRHU-College of Horticulture, Anantharajupeta, Annamayya Dist.516105

*Corresponding Author Email ID: syamhort@yahoo.in

Introduction

Underutilized vegetables are becoming more widely and effectively deployed to address malnutrition, poverty and economic prosperity. They constitute essential biological assets of the rural poor and can contribute to improving the well-being of millions of tribal populations. Underutilized vegetables are rich in vitamins, minerals and other health promoting factors including high antioxidant activity. They play a major role in the diversification of diet leading to more balanced source of micronutrients. Furthermore, underutilized vegetables possess resistance to several biotic and abiotic stress the underutilized vegetable crops can also provide nutrition to the poor by meeting the nutrient requirements of vulnerable groups too. A number of vegetables and particularly underutilized vegetables crops such as *Allium hookeri*, Spiny coriander are natural and rich source of vitamins, minerals and antioxidants.

1. Hooker Chives – *Allium hookeri*

Hooker Chives is a bulbous herb with thick, fleshy roots. Bulbs are clustered and cylindrical. Leaves are linear, shorter than or almost equalling the flowering scape, 0.5-1 cm wide, midvein distinct. Scape usually arises from base of bulb, 20-60 cm tall, usually without leaf sheaths, sometimes with flowers are borne in hemispheric to spherical, many flowered umbels. Flower-stalks are nearly equal, 2-3 time as long as the petals. Tepals are white or greenish yellow to yellow, lance shaped, 4-7.5 × 1-1.5 mm, tip long-pointed, sometimes unequally 2-lobed. Filaments are very narrow, tapering above, slightly shorter than or equalling the tepals, fused at base and fixed to perianth segments.

A rich well drained soil is used for its cultivation in the full sun. The plant is propagated by seed which is sown in spring or autumn. Mostly by bulb or individual cloves which is planted in spring or autumn. The plant after harvesting is left to dry in the sun before being stored at 3-5°C (37 – 41 °F).

Medicinal uses

The leaves, bulbs and roots are used to treat a range of common health problems including coughs and colds, vomiting and skin rashes. They are applied externally as an antiseptic on wounds. Although no other specific mention of medicinal uses has been seen for this species, members of this genus are in general very healthy additions to the diet. They contain sulphur compounds (which give them their onion flavour) and when added to the diet on a regular basis they help reduce blood cholesterol levels, act as a tonic to the digestive system and also tonify the circulatory system. The bulbs are crushed and applied on burns, boils and wounded parts. The bulb and the leaves are used for hypertension, diabetes, helminthiasis, chronic colitis, gastritis, angina pectoris, bacterial and fungal infection, arterio sclerosis, rheumatoid arthritis and cancer.

Propagation

1. Seed: Prick out the seedlings into individual pots when they are large enough to handle. Grow them on in the greenhouse for at least their first winter and plant them out into their permanent positions in spring once they are growing vigorously and are large enough.


.

2. Division: The plants divide successfully at any time in the growing season, pot up the divisions in a cold frame or greenhouse until they are growing well and then plant them out into their permanent positions

Fig 1: Vegetative stage and flowering of Allium hookeri

2. Spiny coriander- Eryngium foetidum

Eryngium foetidum L. (Umbelliferae-Apiaceae) is known by several local, common names, such as Mexican coriander, spirit weed, fit weed, cilantro, bhandhania and shado beni. The plant is indigenous to Tropical America and the West Indies where it is used as medicine and food. It has become naturalized and often is cultivated across South Asia, the Pacific islands, Tropical Africa and the warmer southern parts of Europe. The indigenous people of Northeast India use the plant for food some having domesticated the plant in their kitchen gardens and orchards.

E. foetidum is a biennial, pungently smelling, tropical herb which grows best in wet or moist conditions on open banks or in pastures. The roots are fleshy, the stems solitary and frequently branched. The whole plant is glabrous and strongly scented. The oblanceolate leaves have toothed margins, yellowish spines are 8-20 cm long, and grow in a basal rosette pattern. Whitish inflorescences are borne on long shoots (30-50 cm) as a conspicuous apical turf. The fruit is globose to ovoid and is covered with rounded protrusions of 1-2 mm long.

Despite the widespread use of this herb for food and as an ethnomedicinal agent, only recently has there been a proliferation of phytochemical investigations on the plant. Most of these investigations were on the volatile essential oils where close to forty compounds have been identified. There remains a lack of information on the more polar constituents which are likely to be extracted in the traditional teas used as medicine. Similarly, only a few of the purported pharmacological properties of the plant extract have been investigated and these were either *in vitro* or in animal models.

Nutritional composition

The aerial parts of the herb are a rich source of calcium, iron, riboflavin, carotene, vitamins A, B, and C and essential oils. The fresh leaves contain over 85% moisture, 3.3% protein, 0.6% fat, 6.5% carbohydrate, 1.7% ash, 0.06% phosphorus and 0.02% iron.

Propagation

Propagation of the species occurs through the seeds or reuse of clumps, which can be transplanted to the soil. Seeds are obtained from bolting plants planted in the previous months, which are usually chosen and separated for reproduction. Seedlings and botanical material can be acquired through exchanges between local residents, as this plant is autogamous and produces seeds in abundance, typical of the genus Eryngium, thus facilitating the reproduction of the species

Botanical aspects

E. foetidum belongs to Apiaceae Lindley (Umbelliferae Juss.), a family with approximately 400 genera and 4,000 species, occurring mainly in tropical and subtropical regions, with largest distribution in Neotropical regions. In Brazil, 15 genera and 91 species are recognized. According to Boldrini, the genus Eryngium L. has 250 species distributed in Eurasia, North Africa, North, Central and South America, and Australia. It is composed of herbaceous plants that preferentially colonize terrestrial, rock, and aquatic substrates.

Antifungal Activity

E. foetidum leaves and found antifungal activity for *C. albicans*, with high inhibition. is shows that substances produced by the species can be useful to treat diseases caused by this pathogen, such as infections of the gynecological tract. It also ratifies the efficiency of this plant when used for this purpose in traditional communities.

Anti-Inflammatory activity

The suppression of the pro-inflammatory process and a high potential of the plant to be used as a food supplement to reduce the risk of cancer associated with inflammation.

Fig 2: Spiny coriander (*E. foetidum*)

Other activities have been reported for the species, such as anticlastogenicity, antilarval, anticancer, antidiabetic, and toxicological activities.

Volume: 03 Issue No: 11

A TENSIOMETER - A TOOL FOR MONITORING SOIL MOISTURE AND SCHEDULING IRRIGATION

Article ID: AG-VO3-I11-20

Dr. Devi, M.*

Associate Professor, Department Crop Protection (Agrl. Entomology), MIT College of Agriculture and Technology, Musiri, Tamil Nadu, India

*Corresponding Author Email ID: deviagri84@gmail.com

Introduction

Similar to aerobic animals, insects must obtain oxygen from their environment and eliminate carbon dioxide respired by their cells. This is **gas exchange** through series of gas filled tubes providing surface area for gaseous exchange (Respiration strictly refers to oxygen-consuming, cellular metabolic processes). Air is supplied directly to the tissue and no haemolymph (blood) is involved in the respiratory role. Gas exchange occurs by means of internal air-filled **tracheae**. These tubes branch and ramify through the body. The finest branches called **tracheloe** contact all internal organs and tissues and are numerous in tissues with high oxygen requirements. Air usually enters the tracheae via **spiracular openings** positioned laterally on the body. No insect has more than ten pairs (two thoracic and eight abdominal).

Based on the **number and location** of functional spiracles respiratory system is

Classified as follows

1.	Holopneustic	10 pairs, 2 in thorax and 8 in abdomen. e.g. grasshopper
2.	Hemipneustic	Out of 10 pairs, one or two non functional
3.	Peripneustic	9 pairs - 1 in thorax 8 in abdomen. e.g. Caterpillar
4	Hypopneustic	10 pairs - 7 functional (1 thorax + 6 abdominal), 3 non functional. e.g. head louse

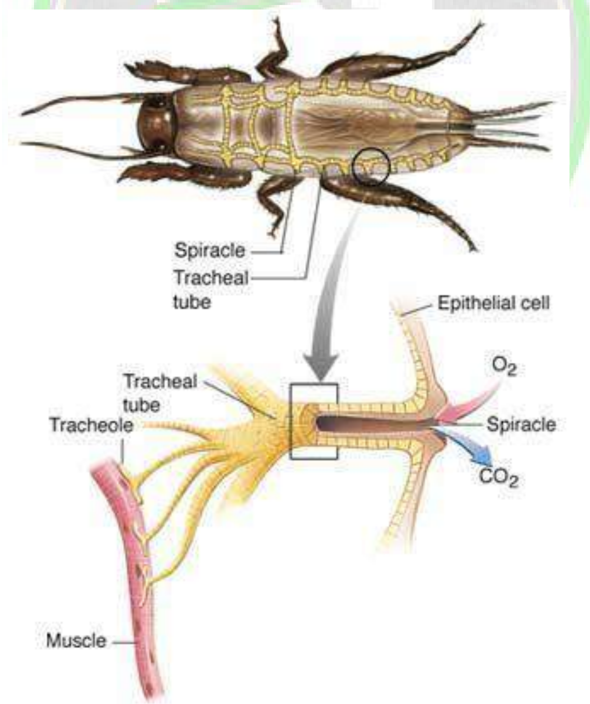
5.	Amphipneustic	2 pairs - One anterior, one posterior, e.g. maggot
6.	Propneustic	1 pair -anterior pair e.g. Puparium
7.	Metapneustic	1 pair - posterior pair e.g.Wriggler
8.	Apneustic	All spiracles closed, closed tracheal system e.g. naiad of may fly.

ORGANS OF RESPIRATION SPIRACLES

Spiracles have a chamber or **atrium** with a opening and closing mechanism called **valve**. This regulates air passage and minimise water loss. Each spiracle is set in a sclerotized cuticular plate called a **peritreme**. Tracheae are invaginations of the epidermis and thus their lining is continuous with the body cuticle. The ringed appearance of the tracheae is due to the spiral ridges called **taenidia**. This allows the tracheae to be flexible but resist compression. The cuticular linings of the tracheae are shed when the insect moults, but not the linings of tracheoles.

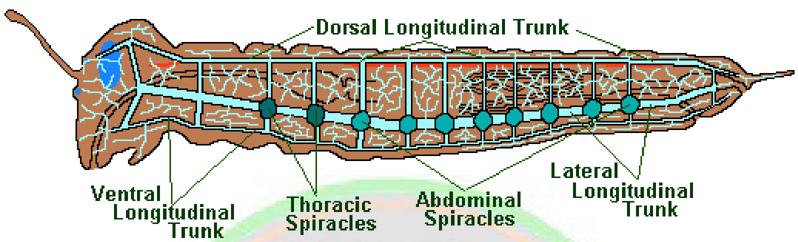
.

Respiration process in insect.

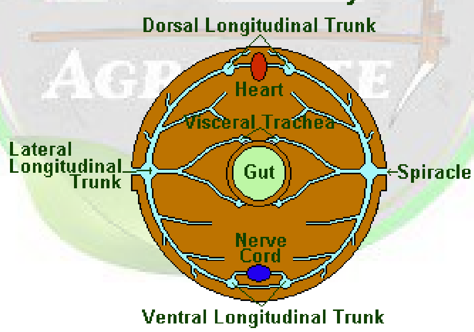


Tracheoles are less than 1 mm in diameter; they end blindly and closely contact the respiring tissues. Taenidia and waxlayer is absent. Cuticulin layer is permeable to gases. It is intracellular in nature, but enclosed only in the cytoplasm of tracheal and cell called **tracheoblast**. Gaseous exchange occurs across tracheoles.There are four tracheal trunks viz., lateral, dorsal, ventral and visceral, helping in the passage of air.In the trachea, thin walled-collapsable sac like dilations are present, called as **airsacs** where taenidia is absent. Airsacs acts as oxygen reservoir. Provide buoyancy to flying and aquatic insects. Provide space for growing organs. Acts as sound resonator and heat insulators

Diagramatic Representation of the Insect Tracheal System



Diagramatic Representation in TS of the Insect Tracheal System



Mechanism of respiration

Oxygen enters the spiracle and passes through the length of the tracheae to the tracheoles and into the target cells by a combination of **ventilation and diffusion** along a concentration gradient, from high in the external air to low in the tissue. Where as the net movement of oxygen molecules in the tracheal system is inwards (**Inspiration**), the net movement of CO_2 and water vapour molecules is outwards,(**Expiration**).

Respiration in aquatic insects

1. Closed tracheal system

In some aquatic and many endoparasitic larvae spiracles are absent and the tracheae divide peripherally to form a network. This covers the body surface, allowing cutaneous gas exchange. e.g. Gills : Tracheated thin outgrowth of body wall.

Lamellate gills - mayfly naiad Filamentous gills - damselfly naiad Rectal gills - dragonfly naiad

2. Open tracheal system

i. Air store: Air bubble stored beneath wings acts as physical gill, e.g. water bug.

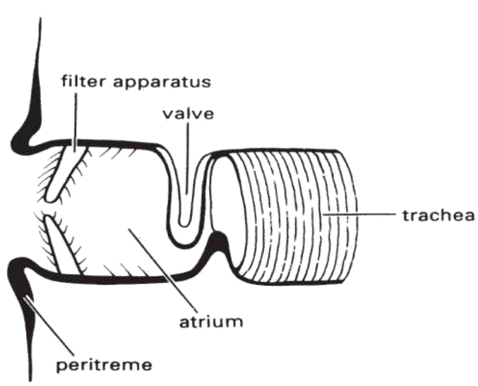
ii. Respiratory siphon - e.g. Wriggler

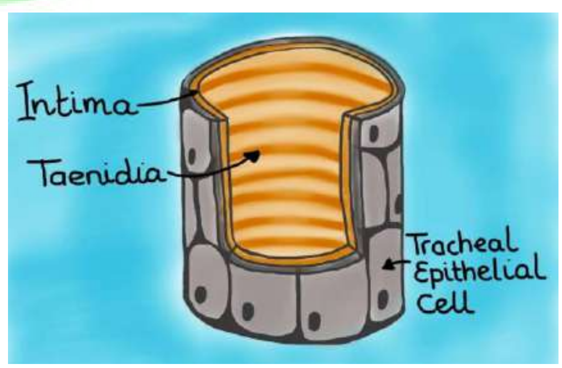
iii. Caudal breathing tube -e.g. Water scorpion

iv. **Plastron:** Closely set hydrofuge hairs of epicuticle hold a thin film of air indefinitely.

RESPIRATION IN ENDOPARASITIC INSECTS

The majority of endoparasites obtain some oxygen by diffusion through the cuticle from the host tissues. Other insects, and particularly older, actively growing larvae, communicate with the outside air either through the body wall of the host or via its respiratory system. The majority of these insects are metapneustic or amphipneustic, using the posterior spiracles to obtain their oxygen.





HAEMOGLOBIN

Most insects have no respiratory pigments, but a few have haemoglobin in solution in the blood. The best known examples are the aquatic larvae of Chironomus and related insects, the aquatic bug Anisops, and the endoparasitic larvae of Gasterophilus (Diptera). The molecular weight of the haemoglobin in insects is about half that found in vertebrates indicating that insect haemoglobin probably consists of only 2 haem groups.

CUTANEOUS RESPIRATION

Some gaseous exchange takes place through the cuticle of most insects, but this does not amount to very much of the total respiration. On the other hand, Protura and most Collembola have no tracheal system and must depend on cutaneous respiration together with transport from the body surface to the tissures by the haemolymph. Cutaneous respiration is also important in eggs, aquatic insects, and endoparasitic insects.

Volume: 03 Issue No: 11

ARTIFICIAL INTELLIGENCE IN AGRICULTURE

Article ID: AG-VO3-I11-21

K Adithya, S Rathika* and T Ramesh

Anbil Dharmalingam Agricultural College and Research Institute,

Tamil Nadu Agricultural University, Tiruchirapalli-620 027. Tamil Nadu

*Corresponding Author Email ID: rathikaselvaraj@gmail.com

Introduction

Artificial intelligence (AI) refers to the intelligence demonstrated by machines or computer systems, which resembles human intelligence. It involves the development of computer algorithms and models that enable machines to perform tasks that would typically require human intelligence, such as problem-solving, decision-making, learning, and understanding natural language. AI encompasses various techniques, including machine learning, deep learning, natural language processing, computer vision, and robotics.

Artificial Intelligence is one of the emerging technologies which tries to simulate human reasoning in AI systems. **John McCarthy** invented the term Artificial Intelligence in the year 1950.

COMPONENTS OF AI

The components of AI include

- Machine Learning
- Natural Language Processing
- Computer Vision
- Robotics
- Expert Systems

These components enable machines to learn, understand, and interact with the world around them in ways that were previously impossible.

AI IN AGRICULTURE

- Artificial intelligence (AI) has many applications in agriculture, including crop monitoring, precision farming, and weather forecasting.
- **Crop monitoring** involves using AI algorithms to analyze data from sensors and drones to detect and diagnose plant diseases, pests and nutrient deficiencies. This allows farmers to take action to protect their crops in a timely manner.
- **Precision farming** involves using AI algorithms to optimize planting, fertilizing and harvesting based on data from weather forecasts, soil sensors and other sources. This can help farmers to increase yields while reducing costs.
- **Weather forecasting** involves using AI algorithms to analyze data from weather stations and satellites to predict weather patterns and make decisions about planting, harvesting and other activities.
- AI is also used to predict crop yields, improve irrigation systems and optimize livestock managemen**t**. Overall, AI can help farmers to increase productivity, reduce costs and protect the environment.
- AI is great for using millions of samples or a big database to draw connections between various observations in agricultural industry. For example, when drought happens in a region, the water quality and quantity is affected.
- Land subsidence is related to the underground aquifers impacted. Certain plant species thrive at the same time as others perish.
- Specific farming equipment and practices help and others are destructive. AI learns this and so can transfer the knowledge from one area to another so the correct measures can be instituted.
- Ideas for the usage of chemical pesticides, suggestion for mono cropping or mixed cropping, access the robots, drones for agriculture and finally “soil health”, “food safety” and “water equity” all require the guidance that AI will provide.

CURRENT TREND

- The global artificial intelligence (AI) in agriculture market is expected to reach $8.38 billion by 2027, growing at a CAGR of 24.8% from 2022 to 2027.
- The increasing demand for food, changing climate conditions, and the need for increased productivity are driving the adoption of AI in agriculture.

- Machine learning, computer vision, and predictive analytics are the key technologies used in AI applications for precision farming, livestock monitoring, drone analytics, agriculture robots, and more.
- Key players in the market include IBM, Intel, Microsoft, SAP, and Agribotix, among others. The market is analyzed across regions such as North America, Europe, Asia,Pacific, South America, and the Middle East and Africa.
- The report provides insights into market dynamics, competitive landscape, market trends, and future growth opportunities.

APPLICATIONS OF AI

The latest advances in artificial intelligence and machine learning have prompted engineers to assess if there could be productive usage of the same in agriculture – and the results have been rewarding.

Preparation of Field

There are technologies that are able to correctly assess the field layout, and guide a tractor (with or without a driver) to prepare the field in such a manner so as to maximize production. These technologies can work without a driver and accurately assess the lay of the land to maximize land usage.

Sowing of Seeds

AI-based robotic applications have now made it possible to sow seeds in a straight line with adequate space between them, replacing seed-drills and manual sowing.


Spraying of Agrochemicals

Pesticides, herbicides, and other agrochemicals are usually sprayed all over the plants and sometimes even randomly around un-affected areas. Current innovations in image-based analytics have made it possible for drone-based sprayers to target infected areas of the plant.

Diagnosis of Diseases

New age AI-based apps have made it possible for farmers to click photos of crops that are infected with diseases and get a probability score of the infected disease on a real-time basis.

Assessment of Nutrient Deficiency

As in the case of diagnosing diseases, here too, the farmer has to click photographs of crops to gets a probability score of nutrient deficiency on a real-time basis. However, a physical test is recommended for correct diagnosis.

Application of Fertilizers

Now it is possible for users to map the lay of the land basis the existing soil nutrients. This is very useful for the application of Urea, DAP, MOP, SSP, and separate doses of N, P & K which can be appropriately applied on the ground without compromising soil health.

a. Planting Drone

b. Irrigation Drone

c. Soil Analysis Drone

d. Crop Monitoring Drone

e. Crop Spraying Drone

f. Health Assessment Drones

Deployment of Irrigation

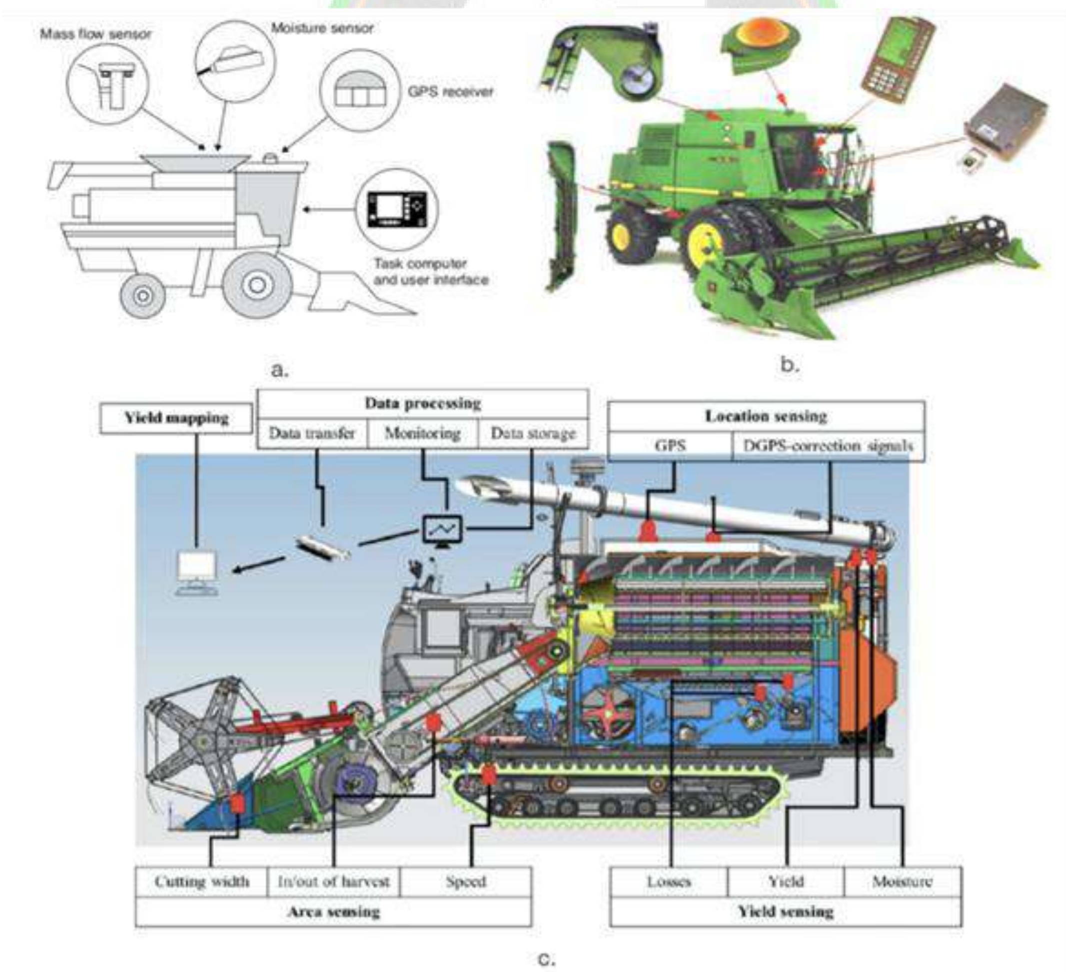
Technologies to monitor water release timing, flow, quantum, and speed ensure that water is used most productively basis past data of soil health and soil nutrients.

Assessment of Yield

There are technologies that look at environmental factors and soil conditions to predict yields for the coming seasons. There are also image-based technologies that look at images of plantations – palm, rubber, sugarcane, tea, coffee, coconuts, apples, mangoes, etc. and give an approximation of production.

Harvesting of Crops

Machines can now harvest crops more precisely and more cleanly. This is again done by looking at images and cutting crops so as to maximize yield.



Advantages of AI

1) Reduction in human error -accuracy with a greater degree of precision.
2) Takes risks instead of humans
3) Available 24x7
4) Helping in repetitive jobs
5) Digital assistance (chatbots, AI based customer care services)
6) Faster decision making
7) Daily applications (Google assistants)
8) New inventions (Agri bots, Multi-purpose drones)

Disadvantages of AI

1) High costs of creation
2) Making humans lazy
3) Unemployment
4) Unable to understand human feelings or needs
5) Lack out of box thinking

Conclusion

AI effectively works based on the data collected or observed using the available technologies in the agriculture. In the critical thinking or decision-making human intelligence involves major role than that of decision provided by the computer. For better results farmers may also be considered for the decision or ideas provided by the AI along with the practical situations and resources availability than solely depending on the AI.

Though AI makes the agriculture easier compared to the conventional methods it increases the problem of unemployment of both skilled and unskilled labour whose survival entirely depend on the farming.

References

Ahirwar, S., Swarnkar, R., Bhukya, S., Namwade, G., 2019. Application of drone in agriculture. Int. J. Curr. Microbiol. App. Sci., 8 (1), 2500–2505.

Manivannan, L., Priyadharshini, M.S., 2016. Agricultural robot. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 5(1) : 153–156.

Tanha Talaviya, Dhara Shah, Hiteshri Yagnik, Nivedita Patel, Manan Shah, 2020. Implementation of artificial intelligence in agriculture for optimization of irrigation and application of pesticides and herbicides. KeAi communications Co Ltd. Artificial Intelligence in Agriculture, 4: 58-73.

Volume: 03 Issue No: 11

ALLELOPATHY A SUSTAINABLE APPROACH

Article ID: AG-VO3-I11-22

Anand Kumar Jain*, Pradeep Kumar and Abhinaw Kumar Singh

Department of Agronomy

V.K.S.College of Agriculture, Dumraon -802136

*Corresponding Author Email ID: dranandkumarjain@gmail.com

Introduction

Allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms. Allelochemicals are a subset of secondary metabolites, which are not required for metabolism (i.e. growth, development and reproduction) of the allelopathic organism. The term allelopathy or Teletoxy was introduced by Molisch (1937). Parthenium daughter plants exhibiting teletoxy to its parent plants is known as autotoxy. The word allelopathy is derived from Greek – allelo, meaning each other and patho, an expression of sufferance of disease. Allelopathy is characteristic of certain plants, algae, bacteria, coral, and fungi. Allelopathic interactions are an important factor in determining species distribution and abundance within plant communities, and are also thought to be important in the success of many invasive plants. Allelochemicals are found to be released to environment in appreciable quantities via root exudates, leaf leachates, roots and other degrading plant residues, which include a wide range of phenolic acids such as benzoic (1) and cinnamic acids (2), alkaloids (3), terpenoids (4) and others. These compounds are known to modify growth, development of plants, including germination and early seedling growth. Allelochemicals are released in the form of: Vapour (released from plants as vapour): Some weeds release volati.

Nature of Allelopathy

Commonly cited effects of allelopathy include reduced seed germination and seedling growth. Like synthetic herbicides, there is no common mode of action or physiological target site for all allelochemicals. However, known sites of action for some allelochemicals include cell division, pollen germination, nutrient uptake, photosynthesis, and specific enzyme function. For example, one study that examined the effect of an allelochemical known in velvetbean, 3-(3‟,4‟-dihydroxyphenyl)-l-alanine (l-DOPA), indicated that the inhibition by this compound is due to adverse effects on amino acid metabolism and iron concentration equilibrium.

Allelopathic Chemicals

- Phenolic acids
- Coumarins- block mitosis in onion by forming multinucleate cells
- Terpinoids
- Flavinoids
- Scopulatens- inhibits photosynthesis without significant effect on respiration

Ways of releasing allelochemicals

Allelopathic chemicals are released from the plants as:

- Vapour- from roots and leaves from stomata
- Foliar lechate
- Root exudates
- Breakdown/decomposition product of dead plant parts
- Seed extract

1. **Volatilization:** Allelopathic tress release a chemical in a gas form through small openings in their leaves.
2. **Leaching:** Some plants store protective chemicals in their leaves. When the leaves fall n the ground, they decompose and give off chemicals that protect the plant. Water soluble phytotoxin may be leached from roots and above ground plant parts or they may be actively exuded from living roots. Rye and quack grass release allelopathic chemicals from rhizomes or cut leaves.
3. **Exudation:** Some plants release defensive chemicals into the soil through their roots. The released chemicals are absorbed by the roots of nearby trees. Exuding compounds are selectively to other plants. Exudates are usually phenolic compounds

(e.g. coumarins) that tend to inhibit development.

Types of allelopathy

1. **Weeds on crop:**

❖ *Agropyron repens* (Quack grass) generate ethylene in rhizomes due to microbial activity in soil, which interferes with uptake of nitrogen and potassium in maize and ultimately decrease in yield of it.

❖ *Avena fatua* (Wild oat) residues inhibit germination of certain herbaceous species like wheat.

❖ *Cynaodon dactylon* (Bermuda grass) residues remains in the field inhibits seed germination, root and top growth of barley.

❖ *Sorghum halpense* (Jhonson grass) is a perennial weed in sugarcane, soybean, maize etc. Root exudates from decaying Jhonson grass is found to have inhibitory effect on these crops.

2. ***Weed on weed:***

❖ *Imperata cylindrica* (Cogon weed) inhibits the emergence and growth of annual broad leaf weed, i.e., *Borreria hispada* by exudation of inhibitory substance through rhizomes.

❖ *Sorghum halpense* (Jhonson grass)- living and decaying rhizomes inhibit the growth of *Setaria viridis* (Giant Foxtail), *Digitaria Sanguinalis* (Large carb grass) and *Amaranthus spinosus* (Spiny amaranth).

3. ***Crop on weed:***

❖ Oat, pea, wheat suppress the growth of *Chenopodium album* (Lambsquater).

❖ *Coffea arabica* (Coffee) release 1,3,7 trimethylxanthin which inhibits germination of *Amaranthus spinosus* (Spiny amaranth).

Factors affecting allelopathic effect

1. **Varieties:** There can be great deal of difference in the strength of allelopathic effects between different crop varieties.
2. **Specificity:** The crop which shows strong allelopathic effect against one weed may show little or no effect against other weeds.
3. **Autotoxicity:** Sometimes plant species may also suppress the germination and growth of its own species. Eg. Lucerne

4. **Crops on crop effect:** Residues from allelopathic crops can hinder germination and growth of following crops as well as weeds.
5. **Environmental factors:** Low fertility increases allelopathic effects due to more production of allelochemiocals. Warm, wet condition can cause faster decline of allelopathic effect as against slowest decline under cold and wet condition.

Because is difficult to separate the effects of competition (e.g. for light, water and/or nutrients) from allelopathic effects in the field some researchers doubt the importance of allelopathy in practical terms. For day to day crop management it is of less importance whether a weed suppressing effect is due to allelopathy or not. This distinction will however, be important in developing a successful research programme.

Volume: 03 Issue No: 11

UZHAVAN APP - A GAME CHANGER IN FARMERS' LIVES

Article ID: AG-V03-I11-23

Sujatha P* and Thangaraj K
Associate Professor (Mathematics), Agricultural College and Research Institute
TNAU, Eachangkottai, Thanjavur, Tamil Nadu, India
*Corresponding Author Email ID: sujathap@tnau.ac.in

Introduction

"A farmer is a magician who creates money out of mud," says Amit Kalantri. However, this is not the case for Indian farmers due to their lack of information on various farmer welfare schemes, crop insurance, stock positions of fertilizers in the shops of their region, updated prices of vegetables and other agricultural produces, custom hire centres for agricultural machinery, and so on, for which Tamil Nadu Government's Uzhavan Mobile Application, comes in handy to resolve all issues and to help farmers to improve their lives.

Information Technology in Agriculture

Information technology, like most fields, plays an important role in impacting farmers' life through a real-time, user-friendly, bi-lingual mobile application called Uzhavan App. It is an android-based mobile application that provides timely agricultural information, such as the components of all agricultural schemes offered by the Tamil Nadu government, details about crop insurance, the availability of farm inputs such as seeds and fertilisers, the nearby outlets of private and cooperative agricultural inputs and stock positions, information on Customer Hiring Centre for hiring farm machinery, and information on current market conditions, weather, and other factors.

Real-time Information

The mobile software supports farmers by giving them up-to-date information and motivating them to start farming right away. It is undeniable that this mobile application service aids in resolving issues brought on by seasonal difficulties, late input deliveries, a shortage of farm equipment, and natural calamities. In order to maximise crop production, farmers can reduce risks associated with unpredictable weather conditions by planning their cultivation and marketing strategies and using the Uzhavan App. Due to its bilingual availability in Tamil and English, the Uzhavan App's democratisation of knowledge empowers farmers regardless of their level of education.

Integrated with Market

Uzhavan App offers current data on agricultural pricing, demand and supply trends, which is used as the foundational data to decide whether to sell their products. With better market knowledge, farmers may negotiate better deals and avoid being taken advantage of by middlemen, which ultimately results in more money for the farmers' enhanced financial stability.

Financial Inclusion

The Uzhavan App bridges the farmers with financial institutions and insurance providers, enabling them to enhance their financial security by applying for loans, accessing credit, and accessing insurance through the Uzhavan App. This process ensures the safety net against unforeseen events.

Efficient Resource Management

This App helps farmers register in advance to participate in training and demonstration programs conducted under the Agricultural Technology Management Agency (ATMA) scheme. In this e-market platform with no intermediates, a farmer can sell his products to a registered seller to a registered buyer.By early detection of disease symptoms and pest attacks with artificial intelligence-enabled technology, a farmer can prevent economic loss by visiting local agriculture officers and uploading a picture of the affected crop.The digital tools of this application and data-driven decision-making eliminate the hurdles to technological growth.

Mutual Sharing of Knowledge

This App encourages the users by facilitating information sharing and pearl learning through the forums and discussion boards of this application forms can connect and mutually share their experience for better farming practices. This collaboration helps the farmers to overcome the challenges and grow together mutually. This desire to be a part of a larger community encourages the users for the adoption of best practises.

Language and Accessibility

Those with little knowledge of gadgets can access this App efficiently with local Vernacular and English; even marginalized farmers can access the facility. Uzhavan app is proof of the revolutionary impact of technology in agriculture. This App brings in a new year of sustainable, profitable, and socially inclusive agriculture with access to information financial inclusion market intelligence market in the creation and essence of community.

Conclusion

Hence, the Uzhavan app becomes an integral part of the farming community not only for knowledge-sharing but also to improve the standards of the lives of farmers. The well-structured Technological Solutions help to make a positive impact.

Volume: 03 Issue No: 11

EFFECTS ON N6-BENZYLAMINOPURINE AND KINETIN ON IN VITRO SHOOT MULTIPLICATION, NODULE-LIKE MERISTEM PROLIFERATION AND PLANT REGENERATION OF GRAND NAINE BANANA PLANT (*Musa Spp*.).

Article ID: AG-VO3-I11-24

Ms.K.V.Parvathi[1] and Dr.G.Subashini[2]

[1]Assist. Professor (Biotechnology), Adhiyamaan College of Agriculture & Research, Athimugam, Hosur, Tamil Nadu, India

[2]Assist. Professor (Department of Genetics and Plant Breeding) in ZAHRS, Mudigere, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (KSNUAHS).

*Corresponding Author Email ID: lakshmivenkat757@gmail.com

Introduction

Regeneration of banana plantlets through meristem culture offers a unique scope for developing disease-free planting materials. In vitro culture of meristem results in a hard meristematic ball-like structure in regeneration media containing different concentrations of BAP and Kinetin. The cultured meristem first turned brown in color in 4-5 days and 30-40 days later a green globular coat mass grew from which plantlets were developed. We observed that a hard ball-like structure developed from meristem explant in MS media supplemented with 6.0 mg/l BAP. They also noticed that single shoot regeneration from meristem explant was thinner than shoot derived from shoot tip. We observed that some ball-like structures formed at the base of the shoot during shoot multiplication. These ball-like structures are suitable for in vitro germplasm conservation.

Effect of different concentrations and combinations of BAP and Kinetin on multiple shoot proliferation from meristem-derived explant

The results obtained from this experiment have been presented and discussed under the following headings:

1.1.1 Number of shoots per explant

A variable number of shoots were produced per explant in MS media supplemented with different concentrations of BAP and Kinetin.

Data were recorded at 10, 20, and 30 days after inoculation and results have been presented in Table 4.

Table 4. Effect of different concentrations of BAP and Kinetin on shoot multiplication of rand naine banana at different days after inoculation.

CYTOKININ	TREATMENT BAP AND KIN (MG/L)	Mean no of shoots		
		10 DAYS	20 DAYS	30 DAYS
MS + BAP	2.0	1.1 ± 0.23	2.1 ± 0.54	2.00 ± 0.25
	3.0	1.3 ± 0.25	2.8 ± 0.55	2.25 ± 0.5
	6.0	1.0 ± 0.27	3.2 ± 0.39	2.50± 075
MS + BAP + Kinetin	1.0+1.0	2.5 ± 0.52	3.4 ± 0.72	2.97± 0.93
	3.0 + 3.0	2.75 ± 0.50	3.4 ± 0.85	3.75 ± 0.56
	6.0 + 3.0	2.0 ± 0.70	3.0 ± 0.55	4.25 ± 0.97

The effect of different concentrations of BAP and KIN on shoot regeneration and proliferation were statistically significant at a 1% level of significance. Among the different concentrations, 6.0 mg/l BAP + 3.0 mg/l KIN showed the highest shoot proliferation of 2.0, 3.0, and 4.25 shoots per explant at 10, 20, and 30 Days.

1.1.2. Shoot multiplication at different cytokinin concentrations of grand naine banana

Fig. 1. Multiple shoots produced from meristem explant cultured on MS medium supplemented with 6.0 mg/l BAP + 3.0 mg/l kinetin at 10 days after inoculation.

Fig. 2. Multiple shoots produced from meristem explant cultured on MS medium supplemented with 6.0 mg/l BAP + 3.0 mg/l KINETIN at 20 days after inoculation.

Fig. 3. Multiple shoots produced from meristem explant cultured on MS medium supplemented with 6.0 mg/l BAP + 3.0 mg/l KINETIN at 30 days after inoculation.

1.1.3 SHOOT INITIATION

In the present study, in vitro culture of the banana shoots, and tips result in a hard meristematic ball-like structure in initiation media containing different concentrations of BAP and kinetin. The cultured shoot tip turned brown in color from the initial creamy white a few days after inoculation. Four weeks later, the external leaf primordia of explants turned green and a globular hard coat mass grew from which plantlets were developed. Among the treatment combination considered, the maximum shoot tip initiation response was obtained from explants cultured on MS medium supplemented with 5.0 to 6.0 mg/l BAP alone for the *Grand naine* banana variety. Furthermore, we observed the color change of culture meristems to brown in 4 to 5 days and the development of a green hard ball-like structure after 10 to 30 days of inoculation.

1.1.4 SHOOT MULTIPLICATION

After 6 weeks of culture initiation, when shoots with at least one leaf emerged, sliced or unsliced shoots were transferred on a multiplication medium. The results of the number of shoots obtained from each propagule and the shoot multiplication and leaf length, leaf width. The highest shoot multiplication rate was obtained on MS medium supplemented with a combination of BAP and Kinetin at different concentrations for the *Grand naine* banana variety. Using the average multiplication rate the for G9 variety, the mean number of shoots per explant was obtained after subcultures the for G9 banana. Adenine-based cytokinin particularly BAP is the most commonly preferred cytokinin to affect shoot multiplication rate in several *Musa sp.*

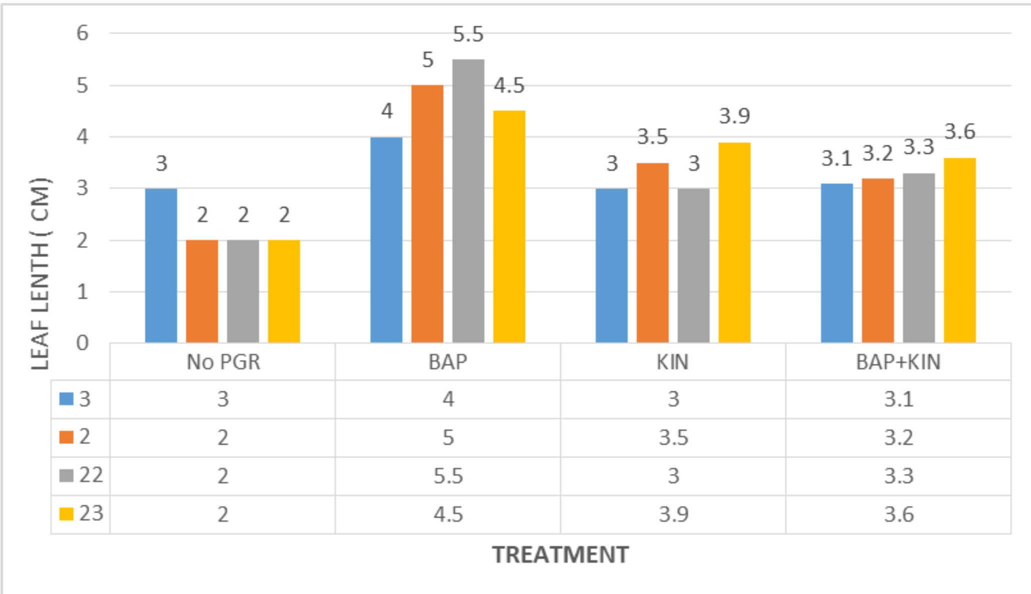
Table.5 Effect of BAP on elongation of shoot length

MS medium composition	**Shoot length (cm)**
0.2	3.3 ± 0.27
0.4	4.3 ± 0.55
0.6	5.2 ± 0.25
0.8	5.2 ± 0.65
1.0	4.6 ± 0.23

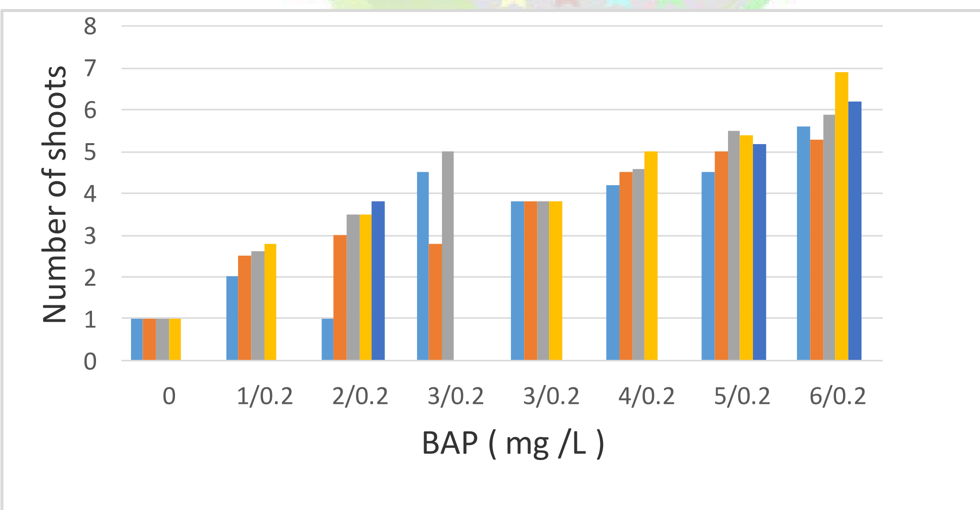
1.1.5. Effect of BAP with KIN on the Induction of highly Proliferating Nodule-like Meristems from Scalps

After 30 days of culture, 4 developmental patterns of scalps were observed for grain nine banana; (a) necrotic material, (b) multiple shoots 1 cm or more than 1 cm in height, (c) a mixture of shoots 1 cm, more than 1 cm, and less than 1 cm in height, and (d) compact multiple shoots less than 1 cm in height (designated as proliferating nodule-like meristems). Figure. A shows the developmental pattern of scalps for the *Grand naine* banana var. Fig.B shows the number of shoots and leaf length induction increased with increasing BAP concentration. The greatest mean induction of 100% was significantly higher ($p<0.05$) with BAP/kin of 3.0 mg L−1 for *Grand naine* var banana in the in vitro condition. Fig. C shows the Mean leaf width of plants regenerated from scalps of bananas of grand naine after 30 days of culture on medium lacking plant growth regulators (no PGR), or supplemented with 1 mg L-1 or 0.2 mg L-1KIN alone.

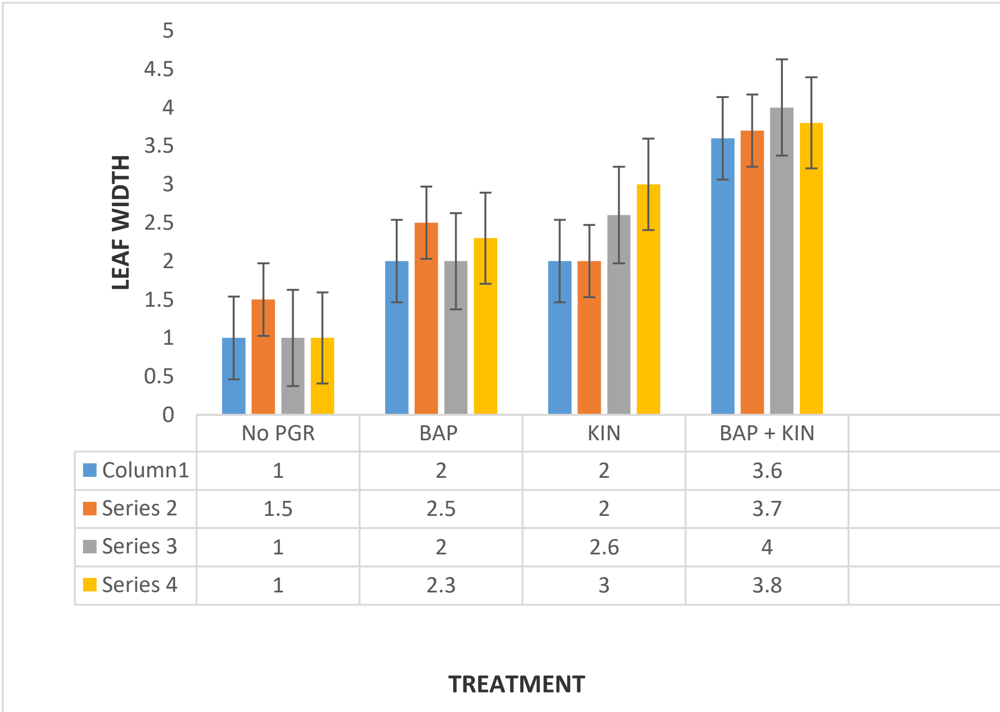
(A)



(B)



(C)



1.1.6 DISCUSSION

The selection of MS medium and different concentrations of growth regulator combinations in this investigation was based on our study shoot multiplication of the *Grand naine* banana variety. The MS medium supplemented with BAP and KIN showed different results for increasing shoot length which was significantly influenced by different concentrations. The effect of different concentrations of KIN and BAP on the shoot length of *Grand naine* banana variety. The longest shoot was produced by the treatment concentrations of 6.0 mg/l BAP + 3.0 mg/l kin (2.0 cm, 3.0 cm, and 4.25 cm) at 10, 20, and 30 Days.

This study was intended to establish an efficient method for shoot multiplication in the *Grand Maine* banana variety through in-vitro micro propagation methods.

CONCLUSION

The in-vitro survival of the explant strongly depends on the measures taken to control the shoot multiplications, shoot length, leaf width, and leaf length. Benzyl aminopurine remains the preferred cytokinin for in vitro banana shoot proliferation, while the use of kinetin appears to be more and more common. Whichever cytokinin is used, the optimal cytokinin concentration for shoot proliferation. All this available information on the in-vitro conditions makes is required. Banana in-vitro organogenesis is possible.

References

A new technique for storage of meristem-tip cultures of Cavendish banana. Plant Cell Tiss. Org. Cult., 25: 179-183. Kotecha, P.M. and S.S. Kadam, 1998. Minor Vegetables.Food and agriculture organination of the united nations. Journal name (KO.W.H HWANG (1991).

A protocol for in vitro propagation of Asiatic hybrids of lily through liquid stationary culture.Invitro Cell. Dev. Biol. Plant,36: 383-391. An improved system for in vitro propagation of banana (Musa acuminate L.) cultivars. Asian J. Plant Sci., 7: 116- 118. Ferdous, M.H., A.A.M. Billah, H. Mehraj, T. Taufique and A.F.M.J. Uddin, 2015.

A review on low-cost micropropagation techniques in bananas. Journal of pharmacognosy and phytochemistry 357-359. Piatezak, E., Wielanek M. and Wysokinska, H. 2005. Liquid culture system for shoot multiplication and secondary production in micropropagated plants of Centaurium erythraea. Rafn. Plant Sci., 168:431-437. Prakash, S., Hoque, MI., Brinks, T. 2001.

Abraham A. (2009). Agricultural biotechnology research and development in Ethiopia. African J. of Biotechnology Vol. 8 (25), Available online at http://www. academicjournals.org/AJB Arinaitwe C, Rubaihayo P, Magambo M. (2000). Alango Kelta, Sunil T. International journal of current microbiology and applied sciences. (2018).

Agbadje, E.T.A.-E.F., Agbidinoukoun, A., Zandjanakou-Tachin, M., Cacaï, G.T.H., Houedjissin, S.S., and Ahanhanzo, C. (2017). Effect of drying plantain (Musa spp.) suckers before in vitro culture on reduction of lethal browning. Int. J. Agric. Pol. Res. 2017; 5, 192-2000.Onuoha, C., Eze, C., Unamba, C., and UGOCHUKWU, C. (2011). In vitro prevention of browning in plantain culture. Rom. J. Biol. - plant biol. 2011; 56, 123-130. In vitro propagation of banana musa paradisiacal plant using shoot tip Explant. Turkish journal of agri culture food science and technology (2021).

Agrawal A, Swennen R, Panis B. A comparison of four methods for cryopreservation of meristems in bananas (Musa spp.) Cryo-Letters. 2004;25(2):101–110. Studies on in vitro micro propagation in banana alango kelta,sunil T Hajare and Akilu Banjaw.Epexcellent publishers International journal of current microbiology and applied sciences (2018).

Ahmed, S., A. Sharma, B. Bhushan, V.K. Wali, P. Bakshi and A.K. Singh, 2014. Studies on hardening and acclimatization of micro propagated plantlets of banana cv. Grand Naine. The Bioscan., 9: 965-967. Alvard, D., F. Cote and C. Tiesson, 1993. Buah, J. (2014). Suitability of Cassava Starch as a Gelling Agent for the in vitro Culture of Banana Plantlets. Am. J. Food Technol. 2014; 9, 340-349.P. Siva Kumar and M.Visalakshi. Journal of applied hortic ulture.(2021).

Al-Amin, M., Karim, M., Amin, M., Rahman, S., and Mamun, A. (2009). In vitro micropropagation of banana. Bangladesh J. Agril. Res. 2009; 34, 645-659. Fatemeh mahdavi Darvari Afrand Biotech Sariah Meon university putra Malaysia. African journal of Biotechnology (2010).

Alexandrova, (1996) Auxins and other growth regulators such as gibberellins play important roles in the growth and differentiation of cultured cells and tissues. Busing, (1994) The presence of BAP in higher concentrations inhibits the elongation of adventitious meristems and development into complete plants.

An outbreak of bacterial wilt on banana in Uganda. InfoMusa 12:6–8. Verschelde M, D'Haese M, Rayp G, Vandamme E. 2011. School of life saciences, Nelson mandela African Institution of science and Technology Arusha Tazania. American Journal of Plant Sciences (2013).

Anicker, B., Thomas, P., Janakiram, T., Venugopalan, R., and Narayanappa, S.B. (2007). Influence of cytokinin levels on in vitro propagation of shy suckering chrysanthemum "Arka Swarna" and activation of endophytic bacteria. In vitro Cell Dev Biol Plant. 2007, 43, 614-622. Thomas, P., Swarna, G.K., Patil, P., and Rawal, R.D. (2008a). The ubiquitous presence of normally non-culturable endophytic bacteria in field shoot-tips of banana and their gradual activation to quiescent cultivable form in tissue cultures. Plant Cell Tissue Organ Cult. 2008a; 93, 39-54.Buah,.1.N.;Danso, E.;Taoh, K.J; Abole,E.A.; Bediako, E.A.; iedu.; Baidoo,R. Journal Biotechnology.(2010).

Anonymous 2004.Low-cost options for tissue culture technology in developing countries. IAEA- TECDOC1384. International Atomic Energy (IAEA), Austria; Vienna, Aug.26-30, pp:106. Assani, A, Bakry F, Kerbellec F. 2001. Plant regeneration from protoplasts of desert banana Grande Naine (Musa spp., Cavendish Sub-group AAA) via somatic embryogenesis, Plant CellRep.20,482. Baby Latha, A.K., Patel, B.M and Shah.M.Visalakshi. Journal of applied horticulture (2021).

Arias, O. (1993). Commercial micropropagation of banana. In: Biotechnology applications for Banana and Plantain Improvement, INIBAP, p. 139 – 142. Arinaitwe, G., Rubaihayo, P.R. and Magambo, M.J.S. 2000. Proliferation rate effects of cytokinins on banana (Musa spp.) cultivars. Scientia Horticultural, 86 13–21. T.C. Achit. International journal of economic plants (2021).

Arvanitoyannis IS, Mavromatis AG, Grammatikaki-Avgeli G, Sakellariou M. Banana: Cultivars, biotechnological approaches and genetic transformation. International Journal of Food Science and Technology. 2008;43(10):1871–1879. M.H. Mazinani. Asian journal of plant sciences (2008).

ASARECA. 2011. Impacts of an improved seed policy environment in Eastern and Central Africa. Baramburiye J. 2010. Identification of Xanthomonas vasicola (formerly X. campestris pv. musacearum), causative organism of banana Xanthomonas wilt, in Tanzania, Kenya and Burundi. Plant Pathology 59(2):403. Dubois T. 2011. Chavdhary Deepika. International Journal of plant sciences (2008).

Assani A, Bakry F, Kerbellec F, Haicour R, Wenzel G, Foroughi-Wehr B. Production of haploids from anther culture of banana [Musa balbisiana (BB)] Plant Cell Reports. 2003;21(6):511–516. P.Siva Kumar. Joornal of Applied horticulture (2021).

Assessing the Impact of Banana Biotechnology in Kenya. ISAAA Briefs No. 10. ISAAA: Ithaca, NY. 48 pp. Rishirumuhirwa T, Roose E. 1998. The contribution of banana farming systems to sustainable land use in Burundi. Advances in Geo Ecology 31:1197–1204. Robinson JC, Galán Saúco V. 2010.

Volume: 03 Issue No: 11

COMPARATIVE PERFORMANCE OF AREA, PRODUCTION AND PRODUCTIVITY MANGO IN INDIA AND TAMIL NADU

Article ID: AG-V03-I11-25

T.Elenchezhian[1], S.Senthilnathan[1], P.Jeyalakshmi[1], V.Kalirajan[1] T.Rajendran[2] and N.Kiruthika[3]

[1]Agricultural College and Research Institute, TNAU, Killikulam, Vallanadu – 628252.

[2]Tapioca and Castor Research Station, Yethapur, TNAU, Salem – 636 119.

[3]Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore – 641003.

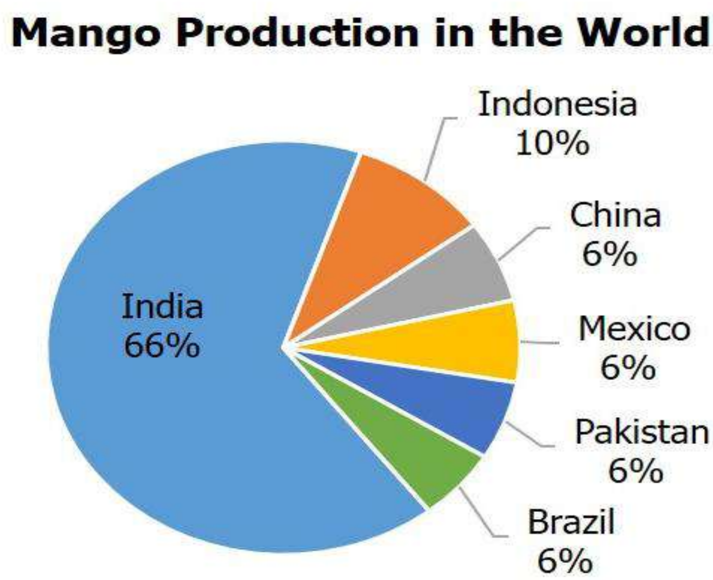
Corresponding Author Email ID:* telenchezhian@gmail.com

Introduction

Mango (*Mangifera indica*) is the king of fruits. It can be grown in a variety of soil and requires comparatively low maintenance costs. Raw mango used for making pickles. The ripe fruits used for desert are also utilised for preparing squashes, syrups, nectars, jams and jellies. Numbers of plants required for one hectare is 100 – 110.

The name 'Mango' is derived from Tamil word 'mangkay' or 'man-gay'. When Portuguese traders settled in Western India, they adopted its name as 'manga'.

The Mango is known as the 'king of fruit' throughout the world. Mangos originated in Nort-East India, Burma and Andaman Islands and bordering Bay of Bengal.



Nutritional value of Mango

Moisture % : 81

Fat % : 0.4

Protein % : 0.6

Fibre % : 0.8

Carbohydrate % : 16.9

K (mg/100g) : 205

Na (mg/100g) : 26

Mg (mg/100g) : 270

P (mg/100g) : 16

S (mg/100g) : 17

Carotene (mg/100g): 2743

C (mg/100g) : 16

Fixed Cost

Tube-well/ pump

Cost of Pipeline

Cost of Drip/Sprinkler

Store & pump house

Labour room

Agriculture Equipment

Variable cost

Land preparation

Digging and filling pits

Plant material

Planting and staking

Cost of FYM

Cost of fertilizers

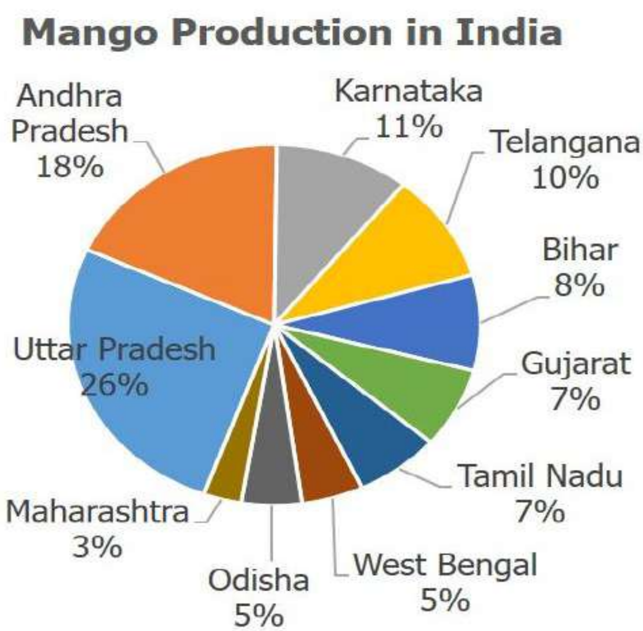
Manures & fertilizers application

Irrigation

Plant protection

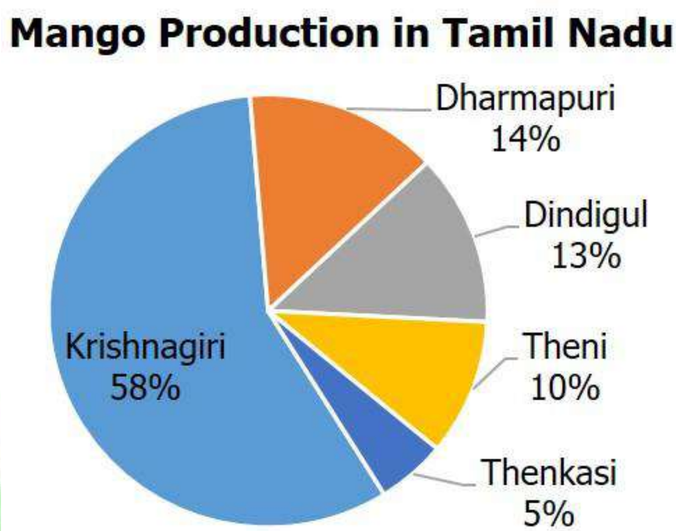
Appl. of plant protection

Intercultural



India is the Largest mango producer in World with 66% . Followed by Indonesia 10% China,Mexico , Pakistan and Brazil which contributes 6% Mango production in The World.

In India , Uttar Pradesh is the first state in the production of Mango. The second largest production State is Andra Pradesh which contributes 18% . Followed by Karnataka 10% , Telangana 10% , Bihar 8% , Gujarat and Tamil Nadu 7% , West Bengal and Odisha 5% , Maharashtra 3% .



Krishnagiri is the largest mango production district in Tamilnadu which contributes 58% . Followed by Dharmapuri 14%, Dindigul 13%, Theni 10% , Thenkasi 5%.

Time of Fruit Maturity in India

February – July : Andhra Pradesh.

April – July : Gujrat, Maharashtra, Tamil Nadu.

May – August : Bihar, Kamataka, MP and West Bengal.

June – August : Uttar Pradesh, Haryana, Punjab and Rajasthan.

July – Sep : Himachal Pradesh and Jammu Kashmir.



Wedge Grafting Flowering Fruiting

Around 5th century B.C., Buddhist monks are believed to have introduced Mango to Malaysia and eastern Asia.

Persian traders took the Mango into the Middle East and Africa, from there Portuguese brought it to Brazil and West Indies.

Mango cultivars arrived in Florida in the 1830's and in California in the 1880's.

In the Hindu culture, hanging fresh Mango leaves outside front door during Ponggol (Hindu New Year) and Deepavali is considered a blessing to house.

Elephant foot yam in mango orchard **Turmeric grown in mango orchard**

A partial list of many medicinal properties are as follows: anti-viral, anti-parasitic, anti-septic, anti-tussive (cough), anti-asthmatic, expectorant, cardiotonic, contraceptive, aphrodisiac, hypotensive, laxative, stomachic (beneficial to digestion).

The fruit of the Mango is called a Drupe - consisting of the *mesocarp* (edible fleshy part) and *endocarp* (large woody, flattened pit).

Mango orchard based poultry **New CISH mango harvester**

Mango is a member of the Anachardiaceae family. Other distant relatives include the cashew, pistachio, Jamaica plum, poison ivy and poison oak.

Grading System

A+ grade >300 g

A grade 250-299 g

B grade 200-249 g

C grade 150-199 g

D grade <150 g

Important varieties grown in Tamil Nadu: Banganpalli, Bangalora, Neelum, Rumani, Mulgoa, Alphonso, Kalepad, Sendurga, Malguavo, Immampasant, Kallmai

The fruits graded according to their size, weight, and colour. During grading, the immature, overripe, damaged and diseased fruits should be discarded. commercially accepted grades are as under

Mango processing

Mango pulp

Mango waste

Volume: 03 Issue No: 11

DISEASES OF CARROT AND THEIR MANAGEMENT

Article ID: AG-VO3-I11-26

R. Thilagavathi[1] and K. Venkatalakshmi[2]

[1]Dept. of Plant Pathology*, [2]Dept. of Agronomy
Agricultural College and Research Institute, TNAU, Kudumiyanmalai, Tamil Nadu
*Corresponding Author Email ID: rthilagaphd@gmail.com

Introduction

Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) is an economically important, most popular vegetable crop in the world. Roots are consumed both as a raw and a cooked vegetable. It is rich in carotene, a precursor of vitamin A and contains appreciable quantities of thiamine and riboflavin. The most abundant antioxidant compounds found in carrots are α- and β-carotene, vitamin E, and anthocyanin. Hence, they are believed to possess various health benefits including the potential to prevent cardiovascular disease and certain types of cancers. The crop is affected by various diseases including Alternaria leaf blight, white mold, powdery mildew, Cercospora leaf blight, bacterial soft rot and cavity spot. Their symptoms and management aspects were given hereunder.

White Mold (*Sclerotinia sclerotiorum*)

White mold is an economically important disease of carrot that can affect late in the growing season and during storage. The losses can be as high as 50% due to *sclerotinia* rot and secondary bacterial soft rot infections. This disease also called as cottony rot, watery soft rot, stem rot, drop, crown rot and blossom blight

Symptoms

Symptoms in the field appear as water-soaked, dark olive-green lesions appear on the foliage at the soil line, expand rapidly over the entire petiole, leaf and rosette with infected tissues. Aerial hyphae appear behind the advancing discolored lesion. Soon becoming covered by abundant cottony, white mycelium and black sclerotia on the crown and other infected parts.

Reduce yield by weakening the tops and rendering mechanical harvest inefficient. In storage, lesions on carrot roots appear as a soft, watery rot with fluffy white mycelia and black sclerotia substantially affect shelf-life and marketable value of carrots.


Causal agent: *Sclerotinia sclerotiorum*

The fungus produces hyaline, septate and branched hyphae. Mycelium may appear fluffy white with black sclerotia (2 to 20 mm). The sclerotia germinate and give rise to cup-shaped structures called apothecia consist of ascus. Ascospores produced in the ascus discharge into the air and are carried by wind.

Survival and Spread:

The fungus produces hardy resistant survival structure called sclerotia. It can survive in soil for many years. Fungus spreads by transport of sclerotia along with contaminated soil or crop debris or irrigation water and by wind-borne ascospores.

Favourable conditions

Sclerotinia is most active when soil temperatures are 15° to 21°C. High soil moisture and a dense canopy are necessary for fungal activity.

Management

Adopt summer ploughing. Crop rotation with non-host crops such as cereals, corn, or cotton will also help reduce sclerotial populations in the soil. Avoid planting carrot into fields with a history of cottony soft rot. Apply green manure followed by soil application of *Trichoderma viride* (*T. asperellum*) 1 Kg / ac. Seed treatment with *T. viride,* 4 g / Kg. Improving ventilation within the crop canopy by effective weed control, increasing row-row spacing, growing on ridges or raised beds and/or cutting excess foliage. Provide rapid cooling of carrots prior to storage. A good sanitation in the field and storage is important to limit the disease spread.

Alternaria leaf blight: *Alternaria dauci*

Symptoms

Symptoms first appear on older leaves as greenish-brown, water-soaked lesions along leaflet margins. Later enlarge and turn brown to black, often develop a yellow halo. As the disease progresses infected leaflets become yellow, collapse, die and appear as if scorched by fire. Severe loss of foliage may occur. Petiole lesions are common, elongate, and can quickly kill entire leaves often results in reduced yields. This fungus also causes damping-off (pre emergence or post emergence) of seedlings.

Figure 1. Symptom development on petiole and leaves (Photo source: Kimberly Cochran)

Causal agent: *Alternaria dauci*

A. dauci produces characteristically dark to olive-brown, septate and branched mycelium. Conidia are usually solitary, long, ellipsoid-to-obclavate, dark olivaceous brown, with 5 - 11 transverse and 1 (rarely 2 - 3) longitudinal or oblique septa with filamentous beak. The conidiophores are olivaceous brown, simple or 1 - 2 geniculate.

Survival and Spread:

After crop harvest, the pathogen, *Alternaria dauci* can survive in seeds, plant debris and volunteer plants. This fungus remains in the pericarp as dormant mycelium and / or spores and on the surface of the seeds as spores. Primary spread of mycelium and spores through infected seed and seedlings, secondary spread through wind, splashing rain, tools or contaminated soils.

Favourable conditions:

Moderate to warm temperature (28°C), extended periods of leaf wetness due to rainfall, dew, or overhead irrigation. Overcrowding of plants

Management:

Adopt crop rotation for 3 – 4 years. Select disease resistant or tolerant cultivars. Treat the seeds by immersing in hot water at 50°C for 20 minutes or Seed treatment with the fungicide, Thiram (4g/kg of seed). Planting on raised beds with wider row spacing to avoid overcrowding of plants. Maintain weed free environment. Foliar spray with the fungicide, Copper Oxychloride (500 g /ac). After harvest, turn the carrot residues under the soil.

Powdery Mildew: *Erysiphe heraclei*

Ssymptoms:

White, powdery fungal growth can initially be found on the older leaves, petioles and stems which then spreads to the newer developing leaves. Infected foliage turns brown, brittle, twist, and die. Severe infection can result in loss of foliage, causing lower yields. In seed crops, infected pedicels may turn brown, causing the florets to die prematurely or may produce poor quality seeds.

Causal agent:

The fungus is considered an obligate biotroph. Mycelium amphigenous, mainly on the upper leaf surface with lobed appressoria. Conidia formed singly on the conidiophore, most subcylindric to cylindric. Fugus produces sexual fruiting body called cleistothecium which bears asci containing ascospores.

Survival and mode of spread:

The fungus survives on overwintered carrots and related weed hosts as cleistothecium. Primary spread is from ascospores from the infected debris. Secondary spread is through air borne conidia**.**

Favourable conditions:

High humidity during evening and morning hours, and dry conditions favours the disease. Temperatures between 13° and 32°C. Plants are more susceptible when growing in shady locations or stressed by drought.

Management

Plant tolerant or plant fast-growing varieties. Adapt crop rotation. Avoid using excessive nitrogen fertilizer. Prevent drought stress by providing ample fertilizer to support strong foliar growth, and mulching to conserve soil moisture. Provide ample water using a sprinkler or hose during the morning hours, which can wash powdery mildew spores from leaves.

Cercospora leaf blight: *Cercospora carotae*

Symptoms

Foliar symptoms are amphigenous, subcircular with light brown center and dark brown border on the margins of leaflets often with a chlorotic halo. During humid weather, the lower surface lesions turn pale gray and are peppered with tiny black spore-producing structures. As the disease develops, lesions increase in size and number, the entire leaflet curl, shrivel and die, creating a burnt appearance. Under heavy disease pressure, severe loss of foliage may occur. The lesions on the petioles are oval shaped with tan centres and brown borders. The petioles may be girdled, causing the leaves to die. When infection occurs later, the fungus commonly infect the flower and invades seed.

Cercospora leaf blight on carrot leaf

Causal agent:

The fungus produces branched, septate and gray mycelium. Conidiophores were simple and straight to subflexuous with a bulbous base. Conidia were solitary, cylindrical to narrowly-obclavate with 2 to 6 septa, and hyaline to subhyaline.

Survival and Spread:

Pathogen survives mainly in plant debris as desiccation-resistant pseudostromata, but can also survive as conidia in debris or seeds. Spreads by wind and rain splash conidia, farm machinery and workers.

Favourable conditions

A significant amount of disease occurs at temperatures from 20 to 30°C and a leaf wetness period longer than 12 hours.

Management

Adopt crop rotation.

Use pathogen free seeds

Select non infested seed bed

Seed treatment with captan 4g/kg

Maintain weed free environment.

After harvest, turn the carrot residue under the soil.

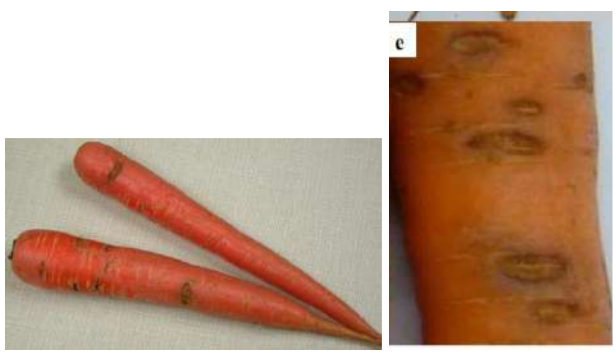
Follow balanced fertilization (Split application of N)

Spray mancozeb @ 400 g/ac or Copper oxychloride 500 g /ac

Cavity spot: *Pythium violae* and *Pythium sulcatum*

Symptoms

Cavity spot often shows up near harvest. It does not tend to reduce yield, however affect the marketability. Infections can take place anywhere along the root surface. Lesions start as pinhead-size sunken spots, become small elliptical, superficial cavities on taproot.



Cavity spot caused by *Pythium* sp., (Photo: S. Livingston)

Causal agent: *Pythium* spp.

The fungus produces hyaline, coenocytic hyphae, thick walled oospore, zoospore. However, most of their isolates not reported to be produce zoospores.

Survival and mode of spread

Pythium overwinters as resting mycelium or as resistant thick-walled oospores in soil. Primary spread through oospores and secondary spread by irrigation water.

Favourbale conditions

Cool and wet weather. Optimum temperature for cavity development is 15^{o}C. Cavity spot severity is maximum at pH 5. Calcium Deficiency.

Management

Avoid fields with a recent history of cavity spot.

Crop rotation

Addition of lime at 6 t / ha can reduce the disease severity upto 50%

Plant carrots on raised beds in well-drained fields.

Avoid over fertilization

Harvest carrots soon after maturity.

Bacterial soft rot: *Pectobacterium carotovorum* subsp. *carotovorum* (syn. *Erwinia carotovora* subsp. *carotovora*)

It is a common disease of carrot, causes major losses in storage.

Symptoms

Bacterial soft rots of carrots occur only when soil conditions are wet or storage conditions are poor. Bacterial soft rot appears as small water-soaked lesions on any part of the carrot, although it is often associated with the eyes. Lesions become sunken, quickly enlarge and coalesce. That leads to soft, watery, and slimy decay of taproot. The decay rapidly consumes the core of the carrot, often leaving the epidermis intact. A foul odor may be associated with soft rot. When the macerated tissue is exposed to the air, it turns tan or gray. Aboveground symptoms include a general yellowing, wilting, and collapse of the foliage.


Causal agent: *Pectobacterium carotovorum* subsp. *carotovorum* (syn. *Erwinia carotovora* subsp. *carotovora*). The bacterium is gram-negative, rod shaped and motile with peritrichus flagella.

Survival and spread*:*

Erwinia spp. are common soil bacteria that survive on crop residues. In the field, disease spreads primarily by soil-borne inoculums, secondarily through irrigation and rain splash. During post harvest handling, these bacteria are readily spread in washing water.

Favourable conditions:

Disease becomes apparent under high soil temperature and moisture. Abundant moisture on the root surface favours disease. Soft rot bacteria enter carrots through wounds.

Control:

Planting on raised beds in poorly drained areas may reduce bacterial infections. Maintain good drainage in field. Use disease free healthy planting material. Harvest crops intended for long-term storage after soil and air temperatures drop. Minimize mechanical damage during harvest and after harvest. Root surface should kept dry and store them at 0°C and 85% to 90% relative humidity. Thoroughly clean and disinfect bins between storage seasons. Infected roots should not be stored along with the healthy roots, Roots can be rinsed with clean, chlorinated water before being placed in a refrigerated holding area.

Volume: 03 Issue No: 11

EXPORT PROCEDURES AND OPPORTUNITIES FOR AGRICULTURAL PRODUCTS

Article ID: AG-VO3-I11-27

N.Kiruthika[1], V.Karthick[1], S.Senthilnathan[2], R.Parimalarangan[1], M.Prahadeeswaran[1] and T.Elenchezhian[2]

[1]Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore – 641003.

[2]VOC Agricultural College and Research Institute, TNAU, Killikulam, Vallanadu – 628252.

*Corresponding Author Email ID: kiruthikaa.natarajan@gmail.com

Introduction

India's foreign trade are regulated by Foreign Trade policy. As per FTD & R act, export is defined as an act of taking out of India any goods by land, sea or air and with proper transaction of money. Exporter gets a request from the potential buyer asking for data with respect to cost, standard and different terms & conditions for transportation of merchandise. The exporter answers with a citation known as a proforma invoice. In the event that the purchaser approves of the parts of terms and conditions, he puts in the request or 'indent' for the merchandise. In the wake of getting the request or indent, the exporter attempts an inquiry with respect to the financial soundness of the importer to evaluate the danger of non-payment by the importer. As indicated by customs laws, the exporter or the export firm should have a fare permit before continuing with export. The following steps are taken after for acquiring the export license, opening record in any approved bank; to acquire import export code (IEC) number from Directorate General Foreign Trade (DGFT) or Regional Import Export Licensing Authority (RIELA); register with suitable export promoting committee, to get enrolled with Export Credit and Guarantee Corporation (ECGC).

After getting the export license the exporter meets with his banker to get pre-dispatch fianance for carrying out production. Exporter, after getting the pre-shipment fund from the bank, looks at to prepare the merchandise according to the importer. The law of India ensures that very selective and incredible quality products are exported out of India. The exporter needs to introduce pre-shipment examination report along with various papers at the time of dispatch.

Furthermore, as demonstrated by the Central Excise Tariff Act, excise duty on the material used as a part of creating the merchandise is to be paid. For a similar cause, exporter applies to the concerned Excise Commissioner in the area with a receipt. Remembering the ultimate objective to get Tariff concessions or diverse exclusions the importer may ask for the exporter to send an authentication of origin. The exporter applies to the logistics organization for the plan of transportation space. He needs to give full information as for the merchandise to be dispatched, conceivable date of shipment and port of destination. The logistics organization issues a transportation course of action. Which is a guideline to the captain of the ship, after accepting an application for dispatching. The merchandise is stuffed and set apart with crucial data like name and address of the importing person, gross and net weight, port of shipment and destination etc. After this, the exporter makes the strategy for the transportation of merchandise to the port. To protect the merchandise amid the ocean travel, the exporter gets great guaranteed with the insurance agency.

Before stacking the merchandise on the ship they must be cleared by the client. For this reason, the exporter makes the bill and submits 5 duplicates of the bill along with:

i. Certificate of origin
ii. Commercial Invoice
iii. Export Order
iv. Letter of credit
v. Certificate of Inspection, where essential.

vi. Marine Insurance Policy.

On presenting the mentioned documents, the director of the concerned port trust approaches to obtain to be sent order which is the guideline to the staff at the entryway of the port to allow the cargo within the dock. After the merchandise have been stacked on the ship, the captain issues mate's receipt to the port administrator which contains data with respect to the vessel, bill, information about the merchandise, date of shipment denotes, the state of the merchandise.The clearing and forwarding specialist (C&F operator) hands over the mate's receipt to the transportation organization for analyzing the cargo. On accepting the cargo the transportation organization issues a bill of lading.

The exporter readies a receipt for the outgoing merchandises. The receipt contains data with respect to the quantity of merchandise sent and the sum to be paid by the importer. It is properly confirmed by the customs. After dispatching the merchandise, the importer is given details by the exporter. Different reports like an attested duplicate of the receipt, bill of lading packing list, Insurance arrangement, certificate of origin, and letter of credit are sent by the exporter through his bank. These records are required by the importing merchant for getting the products cleared from customs.

Documents Used in Export Transactions

A. Documents Related to Goods

- Seller Bill:- It is a seller's bill data about products like amount, a number of packages, blemishes on packing, the name of the ship, port of destination, terms of delivery and payment and so on.
- Certificate of Inspection:- For guaranteeing quality, the government has made an inspection of specific products necessary by some approved organization like trade Inspection board of India (EICI) and so forth. In the wake of reviewing the merchandise, the organization issues a certificate of inspection that the merchandise has been reviewed as required under the export (Quality Control and Inspection) Act, 1963.
- Packing List:- This document is with respect to the number of cases or packs and the details of products contained in these packs. It gives finish insights with respect to the products sent out and the condition in which they are being sent.

- Testament of Origin:- This authentication indicates the nation in which the merchandise is being produced. This authentication empowers the importer to claim levy concessions or different exemption. This declaration is likewise required in the event that when there is a prohibition on imports of a few products in specific nations.

B. Documents Related to Shipment

- **Transportation Bill:** It is the basic document based on which consent is allowed for the export of merchandise by the customs office. It contains details of as to whom the merchandise being sent, the name of the vessel, exporter's name and address, a nation of definite goal and so on.
- **Mate's Receipt:-** This receipt is issued by the captain or mate of the ship to the exporter after the merchandise are stacked on board the ship. It contains the name of the vessel, quantity, marks, condition of the freight at the time of receipt on board the ship and so on.
- **Bill of lading** – It is a record issued by the shipping organization. It goes about as a proof with respect to the acknowledgment of the delivery organization to convey the merchandise to the port of destination. It is additionally referred to as the title to the merchandise and is openly transferable by underwriting and delivery.
- **Airway Bill:** Similar to a shipping bill, it is a record issued by the airline organization on getting the products on board.
- **Cart Ticket:-** Also known as cart chit or gate pass, it is established by the exporter. It contains insights with respect to sending out payload like a number of items, shipping charge number, port of destination and so forth.
- **Marine Insurance Policy:** It is a document containing contract between the exporter and the Insurance Company to reimbursement the safeguarded against the misfortune brought in regard to products presented to the risks of the ocean travel in light of an installment called premium

C. Document Related to Payment

- **Letter of credit:-** It is an assurance letter issued by the importer's bank expressing that it will respect the export bills to the bank of the exporter up to a specific sum.
- **Bill of Exchange**: In export and import exchange, exporter draws the bill on the importer requesting that he pay a predefined money to someone in particular or the

owner of the instrument. The records required by the importer for guaranteeing the title of exported merchandise are passed on to him just when the importer acknowledges this bill.

- **Bank Certificate of Payment:-** It is a declaration that the required documents identifying with the specific export deal have been arranged and payment has been gotten related with the exchange control regulation.

Volume: 03 Issue No: 11

DISEASES OF TAPIOCA (MANIHOT ESCULENTA) AND THEIR MANAGEMENT

Article ID: AG-VO3-I11-28

R. Thilagavathi[1] and K. Venkatalakshmi[2]

[1]Dept. of Plant Pathology*, [2]Dept. of Agronomy
Agricultural College and Research Institute, TNAU, Kudumiyanmalai, Tamil Nadu
*Corresponding Author Email ID: rthilagaphd@gmail.com

Introduction

Manihot esculenta, commonly called cassava / tapioca is a woody shrub belongs to the family Euphorbiaceae. It is being cultivated extensively as an annual crop in tropical and subtropical regions of the world. The plant is hardy and able to tolerate drought and poor soil conditions than most other food plants. It can grow in extremely poor, acidic soils. It is propagated by planting stakes cut from the woody stems of mature plants. Mainly grown for its edible starchy tuberous root and third-largest source of food carbohydrates in the tropics, after rice and maize. It contains small amounts of calcium, phosphorus, and vitamin C. Tubers are predominantly consumed in boiled form and also used as feed, biofuel and in industries. The cone-shaped root is long and tapered, with a firm, homogeneous flesh encased in a detachable rind, the leaves are palmate (hand-shaped) and spirally arranged on stem with petioles. The plant can grows from about one to three meters in height with woody and erect stems. *Cassava* is vulnerable to a broad range of *diseases* caused by fungi, bacteria and viruses. Among them considerable yield loss was observed for the brown leaf spot caused by *Cercosporidium henningsii*, sett rot caused by *Diplodia natalensis*, tuber rot caused by *Phytophthora palmivora* and mosaic caused by *Indian cassava mosaic virus*. Their symptoms and management aspects were given hereunder.

Diseases infecting cassava and their management

1. Brown leaf spot Symptoms

Spots are seen on both the sides of the leaves but more pronounced on upper surface. The spots are circular and brown with a distinct dark brown border. The spots increase in size and become irregular or angular and restricted by leaf margin or veinlets and measure 3 to 12 mm in dia. In the centre of brown spots, greyish growth of conidiophores and conidia are seen during humid condition. Indefinite halo around each spot or blighted area is seen. Leaves turn yellow, dry and drop off.

Fungus: *Cercosporidium henningsii* (Syn. *Cercospora henningsii*, *Cercospora manihotis*; Sexual stage: *Mycosphaerella manihotis*). The conidiophores are pale olivaceous brown. Conidia are cylindrical, pale olivaceous. Perithecia are black produce asci.

Mode of survival and spread: In diseased plant debris. Primary spread is from self-sown cassava and form regrowth in stored stems. Secondary spread is through wind-borne conidia.

Favourable conditions: Temperature of 27^0C, relative humidity of more than 90%, Aug-Sept. months and excessive N application.

Management

Remove and destroy affected leaves.

Adopt balanced fertilization.

Spray copper oxychloride 0.25% or Bordeaux mixture 1.0% at monthly interval.

2. Sett rot / Stem rot

Symptoms

Epidermal blisters are seen on the stem (setts). When blister ruptures black masses of pycnidia are seen on the stem. Vascular discolouration (black) and necrosis leads to stem rot. Rotting of setts leads to failure in germination. Symptoms appear in new plantings, stored cassava stakes and discarded stakes left in the field

Fungus: *Diplodia natalensis*. Pycnidia are black and large. Pycnidiospores are dark brown and two celled. Perithecia are black and globose. Each ascus contain one-celled, 8 ascospores which are colourless or olivaceous.

Mode of survival and spread: In diseased and dried stems and plant debris. Primary spread is from infected setts. Secondary spread is through wind-borne conidia.

Favourable conditions: Dry climate.

Management

Avoid wounds in stem cuttings stored for planting.

Select disease-free healthy setts for planting.

Dip setts in carboxin 0.1% or thiram 0.2% for 15 min.

Tuber rot

Symptoms

There will be no external symptom on the plant. Dark round to irregular water soaked lesions apper an mature tubers. White mycelial mats of the pathogen develop around these lesions. The lesions enlarge causing internal browning oozing of internal fluids and shrivelling of the tubers. The infected tubers emit characteristic foul smell and rot within 5-7 days.

Fungus: *Phytophthora palmivora*

Survival and mode of spread

The rotten tubers left during harvest and ploughed *insitu* serve as inoculum for the next crop and help the pathogen to survive longer periods in the soil. Flooding type of irrigation helps the pathogen for it distribution in the whole field.

Favourable conditions

High rainfall, water logging. Lack of organic mater content and narrow C:N ratio of the soil reduce population of beneficial organisum *viz Trichoderma* spp. favour the pathogen.

Management

Avoid water stagnation by giving good drainage facilities

Spot drench with copper oxychloride @ 2.5 g/l or soil application of *Trichoderma* asperellum @ 1 kg/ac as basal and at 3rd and 6th month after planting

Anthracnose

Symptoms

Deeper cankers affect the pith of the plant resulting in blockage of nutrient translocation to active growing region. On highly susceptible varieties, the depressions spread towards the top of the plant causing wilt and death of plant shoots. The most outstanding effect of the disease is its ability to cause severe stem damage causing canker on stem, necrotic spots and wilting of leaves and dieback on shoot tips. Badly infected stems become brittle and break easily under strong winds.

Fungus: *Colletotrichum gloeosporioides* Penz f.sp *manihotis* Chev

Survival and mode of spread

In diseased and dried stems and plant debris. Primary spread is from infected setts. Secondary spread is through wind-borne conidia.

Favourable conditions: cool and moist conditions, stakes stored in shades during rainy days. *Most favourable temperature for development of the disease is about 21 °C.*

Management

Avoid wounds in stem cuttings stored for planting.

Select disease-free healthy setts for planting.

Dip setts in carboxin 0.1% or thiram 0.2% for 15 min.

3. Cassava mosaic

Symptoms

Mosaic symptoms are first seen on younger leaves. Infected leaves exhibit dark green areas separated by normal green tissues, distortion of lobes, reduced size, misshapen and twisted. Infected plants are stunted. The stems are thin and soft. Tubers are small, show longitudinal splitting, contain high fibre and unfit for consumption. The disease reduces the quality and quantity of tubers and seed-stems. The plants infected soon after germination of setts do not grow further and dies soon.

Virus: *Indian cassava mosaic virus* (ICMV) belongs to Begomovirus with ssDNA.

Mode of survival and spread: In setts, volunteer plants. Primary spread is from infected setts, diseased plants. Secondary spread is through insect vector, whitefly (*Bemisia tabaci*).

Management

- Plant resistant varieties (MnGa-1) or hybrids.
- Plant virus-free planting materials obtained from meristem tip culture or setts from healthy plants.
- Rogue out and destroy infected plants. Place yellow sticky traps at 12 Nos. ha to attract and monitor insect vector population.
- Spray neem oil @ 3 % (with teepol at 1 ml/l) or fish oil rosin soap @ 25 g/l or methyl demeton 25 EC @ 2 ml/l to control vector.
- Avoid extending the crop growth beyond its duration.

Volume: 03 Issue No: 11

TRADE MARK IN AGRIBUSINESS

Article ID: AG-VO3-I11-29

***N.Kiruthika[1], S.Senthilnathan[2], V.Karthick[1], M.Prahadeeswaran[1] , R.Parimalarangan[1] and T.Elenchezhian[2]**

[1]Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore – 641003.

[2]Department of Agricultural Economics, Agricultural College and Research Institute, TNAU, Killikulam, Vallanadu – 628252.

*Corresponding Author E mail ID: kiruthikaa.natarajan@gmail.com

---

Introduction

Trade Mark is a unique symbol which is capable of identifying as well as differentiating products or services of one organization from those of others. The word _Mark stands for a sign, design, phrase, slogan, symbol, name, numeral, devise, or a combination of these. Essentially, the Trademark is anything that identifies a brand to a common consumer.

Criteria for Trademark

- **Distinctiveness -** The goods and services for which the protection is sought should possess enough uniqueness to identify it as a Trademark. It must be capable of identifying the source of goods or services in the target market.
- **Descriptiveness -** The Trademark should not be describing the description of the concerned goods or services. Descriptive marks are unlikely to be protected under Trademark law. However, descriptive words may be registered if they acquire secondary meaning‖, such as the brand name 'Apple' is used by a USA based multinational company that manufactures electronic gadgets.
- Similarity to the prior marks - The mark should be unique and should not be having similarity to the existing marks.

Apply for a Trademark

Any person who is a proprietor of the Trademark is eligible to apply for registration of Trademark. The mark can be filed collectively by two or more applicants and for that purpose, support documents need to be submitted. An organization or association can file for the collective mark and the same can be used by its members. The most appropriate example for this mark is the 'Reliance' symbol, which indicates all products falling under the organization

Designation of Trademark Symbols

™ Represents that the Trademark is unregistered. This mark can be used for promoting the goods of the company.

℠ Represents that the Trademark is unregistered. This mark can be used for promoting brand services.

® Represents a registered Trademark/Service. The applicant of the registered Trademark is its legal owner.

Classification of Trademarks

Goods and Services under Trademarks are classified as per the _Nice Agreement' (1957) administered by WIPO. A total of 149 countries (84 state parties who are signatory to the Agreement and 65 additional states who are following this classification for the Trademarks) and others (African Intellectual Property Organization, African Regional IP Organization and Trademark Office of European Union) are using the same Trademark classification.

Class 1 is for Chemicals for use in industry, science and photography, agriculture, horticulture and forestry; Unprocessed artificial resins, unprocessed plastics; Fire extinguishing and fire prevention compositions; Tempering and soldering preparations; Substances for tanning animal skins and hides; Adhesives for use in industry; Putties and other paste fillers; Compost, manures, fertilizers; Biological preparations for use in industry and science. Class 45 is for legal services; Security services for the physical protection of tangible property and individuals; Personal and social services rendered by others to meet the individuals' needs.

Registration of a Trademark is Not Compulsory

Although, registration of a Trademark is not compulsory, registration provides certain advantages to the proprietor of the Trademark, such as:

- Legal Protection – prevents the exploitation of the Registering Trademark by other companies/organizations/individuals, without proper authorization by the legal owner/s of the Trademark. In case of legal suits, a registered Trademark can serve as a potent evidence of the lawful proprietorship of the Trademark.

- Exclusive Right - grants the Trademark owner full rights to use it in any lawful manner to promote his business.
- Brand Recognition - products/ services are identified by their logo, which helps create brand value over time. A strong brand is a huge pull for new customers and an anchor for existing customers. Registering a Trademark early and using it will create goodwill and generate more business for the brand owner.
- Asset Creation - registered Trademark is an intangible property of the organization. It can be used for enhancing the business of the company as well as drawing new clients and retaining old one by the account of brand identification

Validity of Trademark

In India, a registered Trademark is valid for 10 years. The period can be extended every 10 years, perpetually. As per the Indian Trademarks Act, the renewal request is to be filed in the form 'TM-R' within one year before the expiry of the last registration of the mark.

Types of Trademark Registered in India

Trademark can be a word that must be able to speak, spell and remember. It is highly recommended that one should choose the Trademark like invented word, created words, and unique geographical name. One should refrain from Trademarks like common geographical name, common personal name and the praising words which describe the quality of goods, such as best, perfect, super, etc. To ensure all these characteristics in a Trademark, it is suggested to conduct a market survey to ensure if a similar mark is used in the market.

Trademark Registry

In India, the operations of Trademarks are carried out from five cities i.e. Delhi, Mumbai, Ahmadabad, Kolkata, and Chennai. Each city has been assigned a bunch of states. The businesses located in a particular state can only use the services of the assigned Trademark Registration Office. In the case of foreign applicants, jurisdiction is based on the location of the office of the applicant‘s agent or attorney.

Process for Trademarks Registration

To seek Trademark registration, the proprietor of the Trademark has to fill an application. The proprietor may choose to hire an agent to fill and submit the application on his behalf.

Before applying, the applicant needs to conduct a prior art search to ensure the registration criteria.

Prior Art Search - Prior to applying for Trademark registration, it is always prudent to check whether the intended Trademark is already registered or not. Also, it is ascertained whether the intended Trademark is not similar to the ones already registered. The requisite search can be carried out using various web portals, such as:

- Public search for Trademarks by CGPDTM (https://ipindiaservices.gov.in/tmrpublicsearch/frmmain.aspx).
- WIPO‘s Global Brand Database - Trademark Electronic Search System (TESS). (http://tmsearch.uspto.gov/bin/gate.exe?f=tess&state=4805:za84 7u.1.1)
- MARKARIA Trademark Search Engine (https://trademarksearch.marcaria.com/en/asia/india-trademark-search).
- VAKIL Search (https://vakilsearch.com/trademarksearch/trademarks?search=bajaj).

Once the prior art search is over and the applicant is convinced about the distinctiveness of the Trademark, he can proceed to fill the application form for registration (TM-A). The application is filed at the Trademarks Office subject to the jurisdiction of the applicant. The steps involved in the registration process are as follows:

After the prior art search has been conducted, the applicant can apply for the registration on his own or with the help of a certified agent. The application is assigned an application number within a few days. The application is scrutinized by a professional examiner. If everything is in order, the particulars of the application are published in the official Trademark journal (http://www.ipindia. nic.in/journal-tm.htm). Otherwise, he will send the objections to the applicant for rectification. Based on the satisfactory response, the examiner would recommend the revised application to be published in the journal. If the application is rejected, the applicant may approach the Intellectual Property Division to challenge the rejection of an application by the examiner. Once the Trademark is published in the official journal, the public has an opportunity to file an objection, if any, within 90 days. After hearing both the parties, the officer decides whether to proceed further for the grant of Trademark or disallow the grant of Trademark. In case of unfavourable outcome, the applicant has the right to contest the decision in front of the IPAB.

International Treaties and Conventions

There is a provision to file an international application for the Trademarks to seek protection in other Convention countries. The rules and regulations to file international applications in Convention countries are concluded under the following treaties and agreements administered by WIPO

- The Madrid Agreement for International Registration of Marks (1891)
- The Nice Agreement for International Classification of Goods and Services (1957).
- The Trademark Law Treaty (TLT) (1994)
- Vienna Agreement (1973) for the Classification of Figurative Marks

Volume: 03 Issue No: 11

BREEDING PROSPECTIVE TO DEVELOP RESISTANCE AGAINST ToLCNDV AND PRSV IN CUCURBITS

Article ID: AG-VO3-I11-30

Vibhootee Garg[1] and Vedant Gautam[2]

[1] Ph.D Research Scholar, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)

[2] Ph.D. Research Scholar, Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P.)

*Corresponding Author Email ID: vibhoote007garg@gmail.com

Abstract

Cucurbits viruses are a major global source of economic loss. Potyviruses, Cucumoviruses, Criniviruses, Ipomoviruses, Tobamoviruses and the recently discovered Begomoviruses are the most frequent viral infections that plague this crop family. The four primary cucurbit crops that are grown around the world are squash (*Cucurbita*), watermelon (*Citrullus*), cucumber (*Cucumis*) and melon. Within each species, there is also a great deal of natural variety that offers important sources of genetic resistance to these illnesses. Crossability, intraspecific and intrageneric variety are important considerations for choosing the best breeding techniques. The vast genetic diversity that remains unexplored within these major Cucurbits presents an excellent opportunity to identify new sources of resistance; however, the genetic tools available in these Cucurbits, including genomisc and transcriptomic sequences from references as well as from other varieties, must speed up the search for new resistances. Many breeding programmes have been based on a few of these multi-resistant sources, which increases the risk of resistance breakdown.

Keyword: Potyviruses, Cucumoviruses, Criniviruses, Ipomoviruses, Tobamoviruses, Begomoviruses, genomics, transcriptomic

Introduction

The most significant farmed crops in the world are cucurbits, which are also significant commercially because they add nutritional value to the human diet. Unfortunately, viruses are one of the many diseases that can infect cucurbits and cause serious yield losses in both the quality and quantity of the produce. In several nations throughout the world, there are several viruses which infect cucurbits in the wild or during experiments. (Ali, 2023)

Around 151 million tonnes of cucurbits are produced worldwide and 6.5 million tonnes of cucurbits are produced in India annually, making up around 74% of all output in South Asia. In India, the production of cucurbitaceous vegetables accounts for almost 18% of all veggies. According to Lecoq and Desheiz (2012), more than 59 distinct viruses have been implicated in the development of a range of illnesses in cucurbits. Currently, ToLCNDV and PRSV are two of the most common viruses in cucurbits.

A bipartite begomovirus species known as the tomato leaf curl New Delhi virus (ToLCNDV) is transmitted in nature by the whitefly *Bemisia tabaci* (order Hemiptera, family Aleyrodidae), in a circulative and persistent way. According to reports, the economically significant begomovirus ToLCNDV causes terrible damage to cucurbits.

The papaya tree is the primary host of the pathogenic plant virus known as papaya ringspot virus (PRSV), which belongs to the genus Potyvirus and family Potyviridae. The virus is a non-enveloped, flexible rod-shaped particle that is 12 nm in diameter and 760–800 nm long. It is transferred between plants by mechanical actions like pruning and by several aphid species such as *Myzus persicae*. No evidence of seed transmission has been found.

Symptoms

In India, there are numerous species or strains of tomato leaf curl geminiviruses that cause ToLCNDV diseases. The symptoms of the afflicted plants include significantly stunted growth and leaves that wrinkle, curl upward, become distorted, and have yellow borders. This illness affects both the growth and development of the fruit, and once the plant reaches maturity, the infection becomes more obvious. Whereas, PSRV (Papaya ringspot virus) affected leaves have initially appear as vein-clearing symptoms. A light to dark green mosaic develops, followed by distortion and deep leaf serration. For example in cucumber- leaves tend to be distorted along the margins, in squash- 'Shoe string' appearance of severely affected leaves and in watermelon- the growing terminals tend to stand erect and new leaves are reduced in size.

Genome organization of ToLCNDV and PSRV

The DNA-A component of ToLCNDV comprises six open reading frames (ORFs) (designated AC1, AC2, AC3, AC4, AV1 and AV2) that are responsible for encoding six proteins that are essential for viral replication, transcription of viral genes, pathogenicity, and encapsidation. Two ORFs (BC1 and BV1) on the DNA-B encode two proteins that are necessary for the movement of the virus and its gene products.

The positive-sense single-stranded RNA genome of the papaya ringspot virus (PRSV), which has a single open reading frame (ORF) and a size of 10,349 nucleotides (nt), is a member of the Potyviridae family and genus Potyvirus.

Genetic and resistance sources for ToLCNDV in Cucurbits

S. No.	Crop name	Scientific name	Resistant genotype name	Resistant govern by
	Musk Melon	*Cucumis melo sub sp. agrestis var. momordica*	Mom-Khalnd/Kharbuja Mom-PII24Ind/PI 124112 Mom-PI4I4InD/PI 414723	One major locus in Chromosome 11 and two additional regions chromosome 12 and 2 (Saez *et al.*, 2017)
		Cucumis melo sub sp. agrestis var. wild type	WM-7 WM-9	
		Cucumis melo	IC-274014	1 recessive gene & 2 independent dominant genes (bgm-1, Bgm-2 & Tolcndv) (Romay *et al.*, 2019)
	Sponge gourd	*Luffa cylindrica*	DSG-6 DSG-7	Monogenic dominant (Islam *et al.*, 2011)
	Pumpkin	*Cucurbita moschata*	PI 604506 PI 381814	One major QTL located in Chromosome 8 (Saez *et al.*, 2020)

Genetic and resistance sources for PSRV in Cucurbits

S. No.	Crop name	Scientific name	Resistant genotype name	Resistant govern by
	Cucumber	*Cucumis sativus*	02245	Single recessive gene (Tian *et al.*, 2015)
	Watermelon	*Citrullus lanatus*	PI 244017 PI 244019 PI 485583	Single recessive gene (*prv*) (Guner *et al.*, 2018)
	Dessert Watermelon	*Citrullus colocynthis*	525080 PI 537277 PI 652554 Griffin 14201	Levi *et al.*, (2016)
	Muskmelon	*Cucumis melo*	PI 180280	Single dominant gene (*Prv*) (Webb, 1979)
			B66-5 & WMR 29	Single dominant gene (Pitrat & Lecoq, 1983)
			PI 124112	Single dominant gene (Mc Creight & Fashing- Burdette, 1996)

Steps involved in the breeding for ToLCNDV and PSRV resistance

1. Collection of germplasm.
2. Screening to find possible resistance sources.
3. Verification of resistance using synthetic screening methods.
4. Research into resistance inherited traits.
5. Use of identified sources in resistance breeding programme.

Screening Methods

1. Field screening in disease hotspot
2. Vector transmission

3. Mechanical sap inoculation
4. Agroinoculation
5. Electron microscopy
6. DAS-ELISA
7. Multiplex RT-PCR

Screening based on

1. Vector transmission

a. **Whitefly transmission**

- a whitefly raised on a virus-free host plant.
- 24-hour access to diseased plants is granted.
- White plants that are healthy and 15 days old are permitted access for 24 hours.
- Weekly intervals were used to continue the 7 dpi disease score.

b. **Aphids transmission**

- Aphids raised on healthy host plants that are virus-free (5 aphids/plant)
- Aphids were placed on virus-infected leaves for five to ten minutes during acquisition feeding following a two-hour period of pre-acquisition fasting.
- One by one, these aphids were released onto healthy, 15-day-old plants.
- The test plants were kept in a net house and watched for the emergence of symptoms for three weeks.

2. Mechanical sap inoculation

- Using a mortar and pestle, 1 gram of contaminated leaves was crushed into inoculation buffer.
- The youngest completely developed leaves of the plant, which had previously been dusty with 600 mesh carborundum powder, are inoculated with the resulting homogenate by gently rubbing them with a cotton swab soaked in the crude homogenate.

3. Agroinoculation

- Full-length clones are converted into an agrobacterium strain by means of the mobilization of cloned virus particles into a binary vector.
- Plants were agroinoculated when their cotyledons were completely developed, which was about 7-8 days after germination.
- A needleless syringe was used to apply the bacterium culture to the cotyledon's abaxial surface.

4. Electron microscopy

- A 100 mg sample of leaf tissue from plants that were intentionally infected was macerated in 0.05 M sodium phosphate buffer.
- The supernatant was obtained after the viral extract was centrifuged for five minutes at 12,000 rpm.
- A single droplet of this supernatant was applied to the copper grids covered with formvar.
- After five minutes of drying, the grids were carefully cleaned with double distilled water and dyed with 2% uranyl acetate.
- After removing extra stain, the mounted grids were inspected under a transmission electron microscope.

5. DAS-(Enzyme linked immunosorbent assay) DAS-ELISA

- To each well of the microlitre plate, add a coating buffer containing pure γ-globulin.
- Add PBS-Tween and frozen insects to each well after washing the plate, then use multiple sticks to homogenise the mixture.
- After one hour at 37˚C, rinse with PBS-Tween.
- Add the diluted antibody-enzyme conjugate, then incubate at 37˚C for one hour.
- Add NPP substrate to the plate after cleaning it, then visually evaluate (positive, yellow).

6. Multiplex RT-PCR

- Create the master mix according to the manufacturer's instructions.
- Add the RNA sample to the master mix.
- Perform the RT-PCR at the designated temperature.
- Examine the products that were separated onto a 2% agarose gel and stained with ethidium bromide.

Breeding methods

a. Conventional breeding:- Hybridization, mutagenesis and backcross breeding.

b. Non-Conventional breeding:- Biotechnological approaches

Limitations of conventional breeding

- It takes more time to complete.
- Low heritability.
- The impact of the environment on the onset of illness

- Complex gene activity.
- Identification and screening of resistant lines might be challenging.
- Pathogen population variation and insect biotype.
- Linkage drag.

Marker assisted breeeding

Marker-assisted breeding chooses a plant at an early stage of development to include in a breeding programme using DNA markers linked to desired characteristics. Finding breeds or variants in a breeding programme that express the desired feature is made much faster with this method. A marker is typically a DNA sequence that is found extremely close to the gene of interest and is therefore always inherited with the characteristic. However, the marker could also be the sequence of the gene that causes the trait. Features like high yield, salt tolerance and disease resistance are examples of desirable features.

Marker assisted schemes for resistance breeeding

- Early generation marker assisted selection
- Marker assisted backcrossing

Marker assisted pyramiding

Linkage map of PRSV resistance gene in cucumber

Transgenic approaches

- **Pathogen derived resistance**

Pathogen resistance through gene modification using the pathogen's genome

a) Coat protien

b) Movement protein

c) Replicase

d) Antisense RNA

ToLCNDV and PRSV-W Resistant transgenic development in Cucurbits

S. No.	Crop	Strategy	Gene	Function	Trait	Reference
1.	Muskmelon	Agrobacterium mediated	PRSV-W partial CP gene	Pathogen derived resistance	Resistance to PRSV	Wu *et al.*, (2010)
2.	Watermelon	Agrobacterium mediated	PRSV-W CP gene	Pathogen derived resistance	Resistance to PRSV	Yu *et al.*, (2010)
3.	Muskmelon	Agrobacterium mediated	Movement protein gene	Pathogen derived resistance	Resistance to ToLCNDV	Malik *et al.*, (2011)

Conclusion

A thorough screening process for ToLCNDV and PRSV on individual plants is required in order to assess the resistance level of genotypes that could be employed in a breeding scheme. Finding a trustworthy molecular marker or markers associated with one or more resistance genes will speed up the process of identifying resistant parents and introducing the resistance gene or genes into cultivated cultivars. Through marker-assisted selection, dense genetic maps, target genomic regions, marker-trait associations and QTL/gene identification could be used in ToLCNDV and PRSV breeding programmes.

References

Ali A. 2023. Single-stranded RNA viruses infecting cucurbits. Plant RNA Viruses. Molecular Pathogenesis and Management, 39-56p.

Islam S, Munshi AD, Verma M, Arya L, Mandal B, Behera TK, Kumar R and Lal SK (2011). Screening of Luffa cylindrical Roem for resistance against Tomato leaf curl New Delhi virus, inheritance of resistance, and identification of SRAP markers linked to the single dominant resistance gene. J Hortic Sci Biotechnol 86:661–667.

Lecoq H and Desbiez C. 2012. Viruses of Cucurbit Crops in the Mediterranean Region: An Ever-Changing Picture. Advances in Virus Research, 84:67-126.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

A NEW INITIATIVE TO EUROPEAN VEGETABLE BROCCOLI CULTIVATION IN CHHOTA NAGPUR PLATEAU OF JHARKHAND

Article ID: AG-VO3-I11-31

Bhoopendra Singh[1], Shiv Mangal Prasad[2] and Manish Kumar[3]

SMS (Horticulture)[1] & Technical officer[3]

Krishi Vigyan Kendra (ICAR-NRRI) Koderma, Jharkhand

Principal Scientist (Agronomy) ICAR-NRRI-CRURRS, Hazaribag[2]

*Corresponding Author Email ID: b.singh@icar.gov.in, bhoopendraakola@rediffmail.com

Introduction

Sprouting broccoli is a new potential Cole vegetable crop grown in some areas of Jharkhand where the agro climatic conditions are congenial for its growth and development. There is great demand of broccoli at here in luxury hotels, restaurant, upper middle class family and tourist resorts for the delicacy as it is relished by the tourist. This vegetable is very especially to children, they eat it with great fervour. The broccoli producing farmers of the Chhota Nagpur plateau of Jharkhand area are regularly supplying their produces to the nearest cities and earning lucrative return every year. Farmers can double their income by broccoli cultivating because its market price is very good and it low incidence of pests and diseases The area under the crop is constantly increasing and to meet the quantity as well as quality requirements, there is need to encourage its production.

Uses- The main head is produced terminally on a fleshy, branching, elongated attached stem are the edible part which may be green or purple depending on the variety. Beside, the terminal head, longer, more slender and smaller heads with a portion of fleshy flower-stalks appear in the axel of leaves arc harvested and consumed as human food and vegetables and it is used in different types of chaat along with vegetables.

Nutritive & Medicinal value: Broccoli’s nutritional profile is impressive. It contains high levels of fiber and is a rich source of vitamin C. In fact, just a 100 gram serving of broccoli will provide you with more than 150% of your recommended daily intake of vitamin C. Broccoli is also rich in vitamin A, iron, vitamin K, B-complex vitamins, zinc, phosphorus and phyto-nutrients. Over recent years researchers all over the world have discovered numerous benefits of broccoli, including proper cardiovascular health, cancer prevention and digestive support. Broccoli contains gluco-raphanin, which the body processes into the anti-cancer compound sulforaphane.

Health Benefits of Broccoli

This popular vegetable has a wide variety of nutritional and medicinal benefits, including its ability to prevent many types of cancer, improve our digestive system, lower cholesterol and detoxify the body.

- Cancer Prevention
- Anti-Inflammatory Benefits of Broccoli
- Enhances Detoxification
- Respiratory Relief
- Digestive Benefits of Broccoli
- Cardiovascular Benefits of Broccoli
- Anti-Aging and Immunity Benefits
- Skin Health Benefits of Broccoli
- Broccoli Protects from Bruising
- Weight Loss Benefits of Broccoli
- Eye Care and Cataracts
- Amyotrophic Lateral Sclerosis
- Fights Anemia
- Pregnancy Power Food
- Broccoli Strengthens Bones

Origin: It has been originated in Southern Europe.

Taxonomy- It belongs to the family Crucifereae, genus Brassica, species oleracea and var. italica. Means an arm or branch. Broccoli is an Italian word from the Latin Brachium A main head is produced terminally on a fleshy, branching elongated stem. The plant resemble to cauliflower and forms a kind of head, consisting of green buds and thick, fleshy flower stalks. heads, which can attain a diameter of 15 cm and more, are much looser than those of cauliflower and generally green coloured, while the flower-stalks are longer. The sprouts in the axils of leaves develop strongly, particularly after the central heads have been harvested, and also form bud-clusters.






Glimpses of Broccoli cultivation at farmer's field in Koderma District in Chhota Nagpur plateau of Jharkhand

Cultivars:

Green: Pusa Broccoli KTS-1, Italian Green (Calabrese), Green Star, Green Head.

Purple: DPPB-1 (Palampur Samridhi), Bronzino.

Early: De Cicco, Green Bod and Spartan Early.

Late: Green Mountain, Coastal and Atlantic.

Climate: Broccoli is more adapted to warmer and less humid conditions. It must be grown during the cool months of the year. It is a cool season crop and some cultivars can withstand frost. Average day temperature of 20-25°C at vegetative stage and 15-20°C at heading are optimum. Its heads become loose at higher temperatures

Soil: The soil should have a high organic matter content with friable in nature. Broccoli can tolerate acid soils having pH ranges of 5.5-6.5. It requires moist soil for proper growth while under dry conditions the shoots become fibrous.

Seed rate: Quality seed of 400-500 g/ha is required for transplanted crop and 1-2.5 kg/ha for direct sowing crop in well prepared soil.

Sowing time: The seed is sown in the well prepared nursery bed in the months of September-October and transplanted in the field in October or November.

Spacing: The seedlings are transplanted at 45 x 60 cm spacing depending on the cultivar as well as the soil type.

Manure and fertilizer: A quantity of 20-25t of farm yard manure, 100 kg N, 60-80 kg P and 40-60 kg K per hectare should be applied . Out of which N is to be given in two equal split doses, first as a basal dose and the next after the first harvest.

Irrigation: Generally the crop requires more moisture for getting higher yields, frequent light irrigation should be given at regular intervals.

Harvesting: The central hcad should be harvested at the correct stage and time to avoid opening of buds. The heads should be cut along with few leaves . After sometime the small heads are formed in the axil of leaves which should also be cut and marketed. The central heads mature first, and by removing the main sprouts, the growth of the lateral sprouts is promoted. The lateral heads do not mature at a time and harvesting should be done twice a week. Depending on the cultivar and management practices ,the duration of harvest may lasts for two months.

Grading: Broccoli sprouts is prepared for market by tying in bunches of bud clusters and intended for fresh consumption are often sold in bunches weighing one kg.

Marketing: The quality of harvested sprouts soon declines and they should be marketed as soon as possible. Cooled transport is important and an attractive product is obtained by freezing the sprouts.

Yield: As per the management practices, the broccoli yield depending on varies, soil and climatic condition from 5-10 t/ha

Volume: 03 Issue No: 11

COLORS AND MAKING OF HORSES

Article ID: AG-V03-I11-32

***Dr.S.Usha**

Assistant Professor, Department of Livestock Production Management,

Madras Veterinary College, Chennai- 600 007

*Corresponding Author Email ID: drushavet@gmail.com

Introduction

A good horseman needs a working knowledge of horse colour and patterns. Five basic horse coat colors and the five variations to these colors. These descriptions will be helpful in building the foundation for a working knowledge of horse colour characteristics. The first and most important group is the basic coat colours which are applicable to all horses. These colour terms are all commonly used. White feet may occur with any basic coat colour pattern.

FIVE BASIC HORSE COAT COLORS

The five basic horse coat colors are:

A) Bay

B) Black

C) Brown

D) Chestnut

E) White

A short descriptive discussion of each of the colors follows:

A) Bay - A bay horse is one whose color is hardest to describe, but easiest to distinguish. It is a mixture of red and yellow. being probably as much the color of a loaf of well-baked bread as anything. A light bay shows more yellow, a dark bay more red. The darkest is the mahogany bay, which is almost the color of blood, but without the red overtone. Bays always have black points.

A red bay should never be confused with a chestnut, as bays always have black manes and tails; chestnuts always have red (or occasionally flax) manes and tails. The body color of a mahogany bay and a chestnut can be the same, but the mane and tail provide an easy method of identification.

B) Black - A black horse almost invariably has black eyes, hoofs, and skin. The points are always black. Tan or brown hairs on the muzzle or flank indicates that the horse is not a true black but a seal brown.

C) Brown - A brown horse is one whose coloration is brown. Many brown horses are mistakenly called black, because they are so dark. A close examination of the hair on the muzzle and around the lips will quickly tell whether the horse is brown or black. The mane and tail are always dark.

D) Chestnut - (Sorrel) A chestnut is a horse whose coat is basically red. His mane and tail are normally the same shade as his body. If the mane and tail are lighter in color than the body, the horse is termed a flax or flaxen chestnut. The mane and

E) **White** - The true white horse is born pure white and dies the same color. Very little, if any, seasonal change takes place in his coat color. Age does not affect it. The American Albino Horse Club, Incorporated of Naper, Nebraska registers as "Albinos" white horses of clear white body color, with brown eyes (rarely blue), and pink skin. They also register as "Albinos Type A" horses with a very pale ivory body color and white mane and tail. Their eyes are blue and their skin is pink. Geneticists classify a third group of light-colored horses as 'Albinos Type B". Their body color is a very pale cream; mane and tail darker than body (cinnamon-buff); eyes blue. If during the life of a white horse, hairs of color other than white are found, the chances are that the horse is not white, but grey or roan.

II. FIVE MAJOR VARIATIONS TO COAT COLORS

In addition to the five basic horse colors there are five major variations to these coat colors. These are:

A) Dun (Buckskin)

B) Grey

C) Palomino

D) Pinto

E) Roan

A) Dun - (Buckskin) The dun horse is one whose dominant hair is some shade of yellow. A dun horse may vary from a pale yellow to a dirty canvas color with mane, tail, skin, and hoofs grading from white to black. Duns always have a stripe down their back. There are special colors of dun ranging from cream, the lightest, through palomino color to duns with black points. A coyote dun is one with black points and a black line. A zebra dun is one with black points and a zebra stripe or stripes on legs and withers. A red dun is a dun of reddish orange cast often with a red stripe down his back and a red mane and tail. In the Thoroughbred stud book, these horses are listed as sorrels and sometimes ranchers refer

B) **Grey** - Most so-called white horses are really grey. Many people even call an old grey horse an albino, especially if it has light skin, hoofs, and one or morewhite eyes. Born blue or almost black, more and more

white hairs come into this coat until by the age of 8 or 10 this horse will appear almost white. The dapple

generally comes between the second and fifth year. Young grey horses are often called roan; when he has a

great deal of black still in his coat, he is called steel grey. When small specks of black are present, he is flea-bitten; when more white shows, it is silver grey.

C) Palomino - The Palomino has body which is a golden color, varying from bright copper color, to light yellow, with white mane and tail. True Palominos have no black points. The breed description lists the ideal color to be that of a "newly minted coin."

D) Pinto - (Calico or Paint) A pinto is a spotted horse that has more than one color in or on his coat in large irregular patches or spots. Small non-white spots, up to the size of a silver dollar, embossed on a color other than white, do not necessarily indicate a pinto. For example, many chestnut horses have small black spots on their rumps. A great deal of white on the upper legs or face is a pretty good indication of pinto blood, as is any white spot above the knees and hocks or outside the rectangular area on the face outlined by the ears, eyes and nostrils.

E) Roan - A roan horse is any horse whose coat carries white hairs intermingled with one or more base colors

III. VARIATIONS OF COLOR PATTERNS OF HEAD AND POINTS

A) Head - When discussing or describing an individual horse among many, it is necessary to be more explicit than merely using a general color term with a modifying adjective.

Instead of just saying a dark sorrel, it may be necessary to say the dark sorrel with the blaze face.

1) Star - Designates a small, clearly defined area of white hairs on the forehead.

2) **Snip** - A small patch of white which runs over the muzzle, often to the lips.

3) Stripe - A long narrow band of white working from the forehead down toward the muzzle.

4) Blaze - A white stripe down the face to the lips.

5) Bald Face - One which has white over most of the flat surface of the face, often extending toward the cheeks.

6) **Eyes** and **Face** - Normally horses have a rich brown eye with a black pupil, and no white shows around the edge. When this coloration varies, many adjectives are used to distinguish the difference. When the eyeball is clear, some shade between white and blue, he is normally termed *China-eyed*, *Glass-eyed*, *Cotton-eyed*, or *Blue-eyed*. If one eye is defective, he is called a *Wall-eye*. In some places, Wall-eyed refers to the white in the face covering theeye area. *Orey- eyed* is also used to denote a horse who shows, because of fright, or because his pupil is overly contracted, white around the rim.

7) A **Mealy-mouthed** horse is one whose color is faded out around the mouth, and is found especially in bays and browns. Occasionally this characteristic is called mulish because so many mules are Mealy-mouthed.

B) Feet.

1) Coronet - a white strip covering the coronet bend.

2) Pastern - White extends from the coronet to and including the pastern.

3) Ankle - White extends from the coronet to and including the fetlock.

4) Half Stocking - White extends from the coronet to the middle of the cannon.

5) Full Stocking - white extends from the coronet to and including the knee.

C) Mane and Tail - Black points always indicate a dark mane and tail, while white points or light points refer to a light mane and tail.

1) Flax or flaxen, when applied to mane and/or tail, indicates a straw yellow or dirty white. It is normally caused by a mixture of dark hair in with the white.

2) Silver is used to denote a mane or tail which is white with a few black hairs giving it a silver cast.

3) True white manes and tails have only white hairs.

4) Rat-tailed is a horse having but little hair in its tail

5)Broom-tailed or **Bang-tailed** is a horse with a heavy, coarse tail.

IV. ADDITIONAL DESCRIPTIVE TERMS

There are a number of modifying adjectives used to further describe horse coat colors. Those listed below
will be enough to cover most situations.

1) Black points - black mane, tail and extremities.

2) Calico is the same as patched, although generally applied to the livelier color combinations normally
found among pintos.

3) Cross designates the dark line over the withers from side to side.

4) Dappled means darker spots are embossed on the coat.

5) Dark indicates a predominance of black hair or deep color, with little yellow apparent.

6) Flea-bitten is a gray or roan horse having small black or blue specks or spots on a predominantly
white background.

7) Golden refers to the sheen which, when the light strikes certain shades of dun, chestnut, and bay, makes them seem translucent and golden.

8) Light indicates a predominance of yellow or white hairs.

9) Line-back means a darker ribbon which goes along the back from the mane to the tail. The line may be almost any color, although red and black are most common.

10) Patched indicates large roan spots on some base color.

11) Piebald - black and white spotting only.

12) Pure indicates uniformity, clarity, and depth of colour

13) Ratty indicates lack of uniformity in color

14) Ray - line found along the back of some horses.

15) Red-speckled is a grey or roan horse having and/or withers. bay or chestnut specks or spots on a predominantly white background. If the categories of terms listed in this topic are learned

16) Skewbald - any color except black, with white.

17) Smoky means a blue tinge to the color; it is an obscure tone.

18) Striped indicates black-stripes or bars on the legs.

19) Spotted indicates spots of solid color on some base coat.

20) Toasted implies darker patches, dull finish, or dull, dirty tone.

Volume: 03 Issue No: 11

PLANT GROWTH REGULATORS TOOLS FOR SUSTAINABLE VEGETABLE PRODUCTION

Article ID: AG-VO3-I11-33

Diksha Thakur*,Gubaksh Kaur and S K Singh

***Mata Gujri College, Fatehgarh Sahib, Punjab**

Corresponding Author Email ID:* dikshaaraajput13@gmail.com

Abstract

Science has expanded the possibilities for employing inputs to improve output and food safety as Indian agriculture becomes increasingly industrialized. Because plant growth regulators have an immediate impact on crop output and take up less time, their position becomes more crucial. Even though these are safe from a toxicological and environmental standpoint, the use of growth regulators in the production of vegetables must be particular in how they work. Vegetable crops have a quick physiological activity that, when a growth regulator is applied, finally increases vegetable yield.

Introduction

Plant hormones are also referred to as phytohormones. These hormones, which are tiny chemicals derived from various vital metabolic pathways, aid in controlling the growth of the plant. Thimann first used the term "phytohormone" in 1948 to refer to an organic compound made by plants. Plant Growth Regulators are synthetic in nature (Kamiya, 2010), whereas "Plant Hormones" are natural(Ikuma and Thimann, 1963) . Other than nutrients, plant growth regulators (PGRs) are organic substances that alter physiological processes in plants. PRGs function inside plant cells to stimulate or inhibit particular enzymes or enzyme systems and control plant metabolism. They are also referred to as bio-stimulants or bio-inhibitors. They often come in a variety of forms, such as liquid, powder, paste, etc., and are active at very low concentrations. Specific PGRs are now utilised to alter the rate and pattern of crop growth across all developmental stages, from germination to harvest and post-harvest preservation. It is advantageous to use growth-regulating compounds that benefit main vegetable crops. Plant growth regulators come in five different varieties, including auxins, gibberellins, cytokinins, abscisic acid, and ethylene.

AUXINS

Kogl and Haagen coined the word "auxin" (1931). Avena coleoptiles or Curvature test was used by Went (1928) to isolate auxin from the tips of the plant. He came to the conclusion that growth is impossible without auxin. Although auxins are found throughout the entire plant, they are particularly numerous in the growth tips, including the coleoptile tip, buds, root tips, and leaves. The only naturally occurring auxin in plants is indole acetic acid (IAA), whereas other auxins such as naphthalene acetic acid (NAA), indole butyric acid (IBA), 2-4D (2,4-Dichlorophenoxyacetic acid), MCPA (2-methyl-4-chlorophenoxyacetic acid), TIBA (Triiodobenzoic Acid), etc. are synthetic. The following are a few of the reactions that occur when auxins are administered to various plant sections.

- Applied to cuttings to encourage the development of the roots
- Parthenocarpy is caused by auxins.
- NAA, 2-4 D foliar spray causes crops to bloom.
- To stop potato tubers from sprouting, high concentrations of exogenous auxins like NAA are applied.
- As selective herbicides and weed killers, numerous synthetic auxins are employed. Example: 2-4 D is used to eradicate broadleaf weeds.

GIBBERELLINS

Gibberellins are synthesised in growing seeds as well as in roots and young shoot tissues. Additionally, there are some indications that some biosynthesis may originate from sources like leaves. Scientist Kurosawa from Japan discovered that some rice seedlings grow higher than others in 1926. He found that the pathogenic fungus Gibberella fujikuroi had infected the seedlings. In his research, he discovered that the fungus that causes the rice plant disease "Bakanae" (Foolish seedling of rice) has certain metabolites that may be to blame for the seedlings' accelerated growth (Bisht *et al.* 2018). The following physiological processes are induced by active gibberellins:

- Encourage stem cell growth
- Breaks some plants' seed dormancy, which is necessary for light-dependent germination.

- encourages the synthesis of alpha-amylase in germination of cereal grains
- encourages blossoming and bolting in response to extended days.
- Delay the onset of senescence in leaves and citrus fruits.
- causes dioecious flowers to become male
- contribute to the growth of fruit without seeds (Parthenocarpy).

Table 1: PGR's and their synthesis location

Hormone	**Synthesis location**	**Target tissue**
Auxins	Stem apex, developing fruits	Primary cell wall
Gibberellin	Immature seeds	Internodes, seeds, fruits
Cytokinin	Actively growing regions	Roots, stem, phloem, xylem
Abscisic Acid	Leaves	Stomata
Ethylene	Fruits, flowers, leaves, roots	Buds, seeds, fruits

(Meena, 2015)

Cytokinins

First, they were separated from coconut milk. They are produced in immature fruits, endosperm of seeds, and root apex, where cell division occurs continually. The group of plant growth regulators known as cytokinins is principally responsible for regulating cell division in the root and shoot systems of plants. Skoog tested in 1995 and found that when Nicotiana tabaccum pith tissues were removed from the vascular tissues, the pith tissues thrived without cell division. There are a variety of synthetic cytokinins, including 1,3-diphenylurea, 6-benzylamino purine (BAP), kinetin, 6-(benzyl-amino)-9-(2-tetrahydropyranyl)-9H-purine (PBA), and 6-benzylamino purine (BAP) (Kaur *et al.* 2018). the following physiological processes are induced by cytokinins:

- encouraging cell division
- slowing of senescence (at low concentrations)
- morphogenesis in tissue culture is stimulated
- stimulates lateral bud growth and leaf extension through cell division and enlargement.
- stimulation of the process that turns etioplasts into chloroplasts, or the synthesis of chlorophyll

Ethylene

This hormone is a gaseous plant hormone that is produced in all plant organs from the amino acid methionine. The colourless, flammable gas known as ethylene is a tiny hydrocarbon that can be found in ripe fruits, flowers, leaves, and stem nodes. Oxygen is necessary for ethylene synthesis since carbon dioxide inhibits it (Divyaksi and Singh, 2021). These are known effects of ethylene on plant processes:

- encourage the growth and differentiation of the shoots and roots.
- encourages dormancy release/growth
- encourages fruit and leaf abscission
- promotes the introduction of flowers
- Dioecious flowers' induction of femaleness
- stimulates the ageing of leaves, flower emergence, and floral senescence.
- encourages fruit to ripen

Abscisic Acid (ABA)

It is also known as "Dormin" or the "plant stress hormone." It functions as an inhibitory chemical substance that has a direct impact on bud growth, seed development, and bud dormancy. It is present in plants naturally and has an inhibiting impact. It prevents the synthesis of protein and mRNA (Meena, 2015). The following are the physiological effects of abscisic acid:

- encourages stomata to close
- notably in response to a lack of water
- induces dormancy in seeds and buds.
- restricts the growth of shoots but has minimal effects on roots
- cause plant abscission

Important Roles of Plant Growth Regulators

Germination: The process by which an embryo-containing seed emerges from dormancy to begin growing a plant. Auxins and GAs, two PGRs that are applied externally, can be used to break dormancy, which is the period in which biological activity are at rest or paused. In Okra IAA and NAA at 20 ppm improve seed germination, while greater germination of tomato seeds is achieved using GA3 at 0.5 mg/l and 2,4-D at 0.5 mg/l (Prajapati *et al.* 2015).

Rooting: Root-promoting substances, sometimes known as "rooting hormones," are frequently applied to stem cuttings using a variety of techniques. As rooting hormones, auxins are employed.

Callus Induction: Cytokinins and auxins are utilised in plant tissue culture for explant callus induction.

Growth Inhibitor: To "inhibit" growth is to "halt" it. It inhibits apical growth and encourages lateral bud development, resulting in branching, more densely packed plants with more flowers and fruits. These substances are also used to store suckers for a long time.

Growth Retardant: To "retard" is to "slow" growth. These substances control the plant's shoot growth, making the plant stronger, more compact, and more colorful as a result.

Thinner: Thinning is the practise of lessening flower/fruit density, which aids in improving fruit size and quality while preserving tree structure. Estimating load for the ideal crop, or the optimum number of fruits to be maintained after thinning, is necessary to maximise crop quality and output.

Parthenocarpy: In the absence of pollination and fertilization, an ovary develops into a seedless fruit, a process known as parthenocarpy. It may happen naturally or it may be purposely caused by exogenous hormone application or their increased endogenous level (Dhatt and Kaur, 2016). Application of 2, 4-D at 50 ppm during anthesis improved the ability of Kakrol to induce parthenocarpy fruit (Chowdhury *et al*. 2007).

Chemical Pruning: Plant height is restricted through the process of pruning. Other names for it include pinching and sucking. New branch growth is aided by pruning. Chemical pruning typically uses growth inhibitors.

Defoliant: Any drug, or combination of compounds, intended to cause the leaves or foliage of a plant to fall off, either directly or indirectly through abscission. Defoliation is a form of treatment that simply results in a plant's leaves falling off. These are used on cotton in order to enhance and simplify mechanised harvesting.

Desiccant: any compound, or combination of substances, designed to accelerate the drying of plant tissues artificially. In contrast to defoliants, which are used for comparable purposes, desiccant causes green foliage to lose water. This expedited drying process results in the elimination of leaves. Desiccation is the technique of treatment that quickly destroys the leaves.

Fruit Ripener: The process of ripening, which is the last phase of fruit growth, involves a number of physiological and biochemical processes, primarily to alter the fruit's appearance and flavour by modifying its colour, texture, scent, and flavour. Fruit ripeners are chemicals that can speed up fruit ripening and artificially ripen fruits for commercial purposes. Application of ethephon at a concentration of 1000 mg/l during the turning stage of the earliest fruits caused early ripening, increasing fruit yield by 30-35 percent.

Constraints

- New plant growth regulators are exceedingly expensive to develop, which makes them quite expensive.
- Some artificial plant growth regulators pose risks to human health. like Dominozide
- Inadequate understanding of toxicity and the mechanism of action.
- Market potential is insufficient.
- Identifying the ideal crop stage at which to apply growth regulators can be challenging.

Precautions in Growth Regulator Application

- Spraying growth-promoting agents is best done in the evening.
- Don't spray during windy conditions.
- Spray should be even and soak the leaves on both surfaces.
- It is crucial to use growth agents at the right period of plant development.
- Before use, the chemical must be thoroughly dissolved.
- Use only brand-new chemical solutions.
- PGRs should only be used at the recommended concentration.
- Always create solutions using distilled water only.
- A hand automizer can assure a fine spray.
- After each spray, clean the equipment or pump.

Future thrust

- PGRs are less time-consuming and have an immediate impact on crop development programmes.
- Applications of PGRs must provide the user with measurable benefits.
- PGRs must act specifically and be safe for the environment and toxicology.
- Industries interested in PGR development should be knowledgeable about the most recent scientific advancements in PGR production.

➢ It is important to acknowledge plant growth regulators as more than just academic curiosities. In addition to being fascinating, they are also advantageous to cultivate, distribute, and make.

➢ More research is needed to develop simple, economical and technical viable production systems of PGR's.

References:

Arteca R N. 2015. Olericulture. Introduction to Horticultural Science, 2nd Edition. Nelson Education. pp. 189.

Bisht T S, Rawat Laxmi, Chakraborty Binayak and Yadav Vikas. 2018. A recent advances in use of plant growth regulators (PGRs) in fruit crops - A Review. *International Journal Current Microbiology Applied Sci*ence **7**(05): 1307-1336

Chowdhury R N, Rasul M G, Islam A K M A, Mian M A K and Ahmed J U.2007. Effect of plant growth regulators for induction of parthenocarpic fruit in Kakrol (*Momordica dioica* Roxb.). *Bangladesh Journal Plant Breeding Genetics* **20**(2): 17-22.

Dhatt A S and Kaur G .2016. Parthenocarpy: A potential trait to exploit in vegetable crops- A Review. *Agricultural Reviews* **37**(4) 2016: 300-308.

Divyaksi and Singh S. 2021. Role of plant growth regulators in vegetable production-A Review. *Just Agriculture* **01**(10):1-5

Hazra P and Som M G. 2015. Vegetables Science. *International Journal of Current Microbiology and Applied Sciences*.109-113. https://dx.doi.org/10.1016/j.biopha.2017.05.012

Ikuma H and Thimann K V. 1963. The role of the seed coats in germination of photosensitive lettuce seeds. *Plant and Cell Physiology* **4**(2): 169-185. https://doi.org/10.1093/oxfordjournals.pcp.a078995

Kamiya Y. 2010. Plant hormones: versatile regulators of plant growth and development. https://dx.doi.org/10.1146/annurev.arplant.60.03.1110.10000

Kaur P, Mal D, Sheokand A S, Singh L and Datta S. 2018. Role of plant growth regulators in vegetable production- A Review. *International Journal Current Microbiology Applied Sci*ence **7**(06): 2177- 2183.

Kogl F and Haagen-Smits A J. 1931. Mitteilung uber pfl anzliche wachstumsstoffe. Uber die vhemie des euchsstoffs. *Proceedings Koninklijke Nederlandse Akademie van Wetenschappen* **34**:1411-1416.

Kurosawa E. 1926. Experimental studies on the nature of the substance excreted by the bakanae‘ fungus. *Trans Nat Hist Soc Formos* **16**:213–227

Meena O P. 2015. Role of plant growth regulators in vegetable production- A Review. *International Journal of Agricultural Science and Research* **5**:71-83.

Prajapati S, Jamkar T, Singh O, Raypuriya N, Mandloi R, and Jain P. 2015. Plant growth regulators in vegetable production. *Plant Archives* **15**(2): 619-626.

Went F W. 1928. Wuchsstoff und Wachstum. *Receuil des Travaux Botaniques Neerlandais*. **25**:1-116.

Volume: 03 Issue No: 11

CROP RESIDUE MANAGEMENT

Article ID: AG-VO3-I11-34

T Sanjay Kumar, S Rathika* and T Ramesh
Anbil Dharmalingam Agricultural College and Research Institute,
Tamil Nadu Agricultural University, Tiruchirapalli-620 027, Tamil Nadu
*Corresponding Author Email ID: rathikaselvaraj@gmail.com

Introduction

India is an agrarian economy with vast majority of land is used for farming and a wide range of crops are cultivated. The huge volume of crop residues is produced both on-farm and off-farm. It is estimated that approximately 500-550 Mt of crop residues were produced per year in the country. These crop residues are used for animal feeding, soil mulching, bio-manure making, thatching for rural homes and fuel for domestic and industrial use.

Crop residues

- Crop residue means any vegetative material remaining after harvesting, including leaves, stalks, roots.
- Crop residue means vegetative matter remaining on the soil surface after harvest, which is capable of minimizing rainfall impact energy to reduce soil erosion potential.
- Crop residue means Straw or Stubble of any other crop.

Generation of crop residues in India

The Ministry of New and Renewable Energy has estimated that about 500 Mt of crop residues are generated every year. The generation of crop residues is highest in Uttar Pradesh (60 Mt) followed by Punjab (51 Mt) and Maharashtra (46 Mt). Among different crops, cereals generate maximum residues (352 Mt), followed by fibres (66 Mt), oilseeds (29 Mt), pulses (13 Mt) and sugarcane (12 Mt). The cereal crops (rice, wheat, maize, millets) contribute 70% while rice crop alone contributes 34% to the crop residues.

Wheat ranks second with 22% of the crop residues whereas fibre crops contribute 13% to the crop residues generated from all crops.

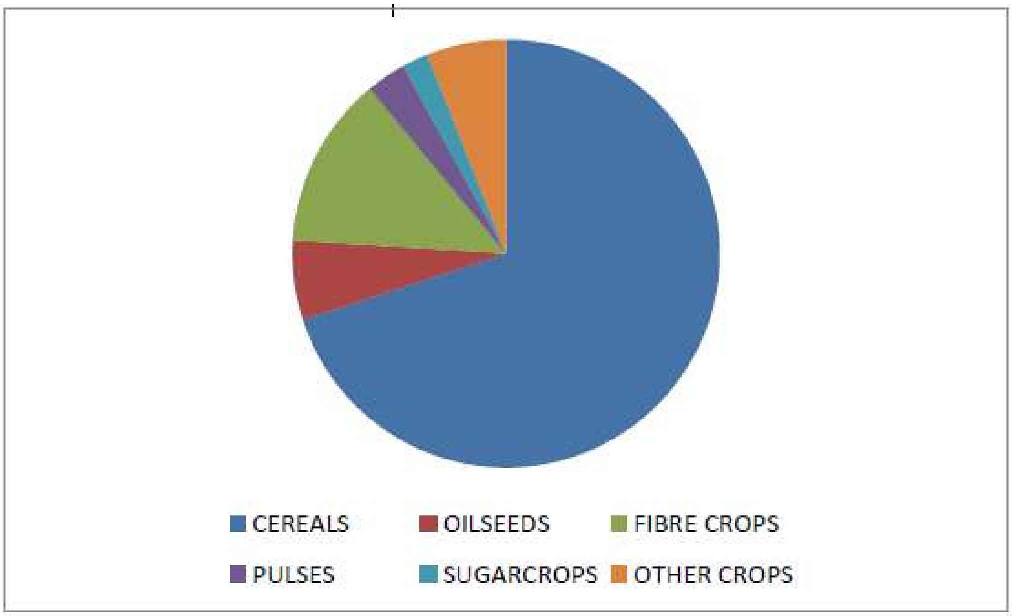


Fig. 1. Residue generation by different crops in India

Crop residue management

Crop residue management refers to the practice of handling and utilizing the plant material left after harvesting a crop. Crop residues include the stems, leaves, husks, and other parts of plants that are not harvested as primary products. Proper management of crop residues is crucial for sustainable agriculture and land productivity.

MANAGEMENT OF CROP RESIDUES

1) *Livestock feed*

In India, the crop residues are traditionally utilized as animal feed as such or by supplementing with some additives.

2) *Compost making*

Crop residues are used as animal bedding and are then heaped in dung pits. In the animal shed each kilogram of straw absorbs about 2-3 kg of urine, which enriches it with N. The residues of rice crop from one hectare land, on composting, give about 3 tons of manure as rich in nutrients as farmyard manure (FYM).

3) *Energy source*

Biomass can be efficiently utilized as a source of energy and is of interest worldwide because of its environmental advantages. In recent years, there has been an increase in the usage of crop residues for energy generation and as substitute for fossil fuels. In comparison with other renewable energy sources such as solar and wind, biomass source is storable, inexpensive, energy-efficient and environment-friendly.

4) *Bio-oil production*

Bio-oil can be produced from crop residues by the process of fast pyrolysis, which requires temperature of biomass to be raised to 400-500°C within a few seconds, resulting in a remarkable change in the thermal disintegration process. About 75% of dry weight of biomass is converted into condensable vapours. If the condensate is cooled quickly within a couple of seconds, it yields a dark brown viscous liquid commonly known as bio-oil.

5) *Bio-fuel*

Theoretical estimates of ethanol production from different feedstock (corn grain, rice straw, wheat straw, bagasse and saw dust) vary from 382 to 471 l t^{-1} of dry matter. The technology of ethanol production from crop residues is, however, evolving in India. There are a few limiting steps in the process of conversion of crop residues into alcohol, which need to be improved. High energy requiring operating conditions, costly hydrolytic cellulase enzyme.

6) Bio-methanation

The process of bio-methanation utilizes crop residues in a non-destructive way to extract high quality fuel gas and produce manure to be recycled in soil. Biomass such as rice straw can be converted into biogas, a mixture of carbon dioxide and methane, which can be used as fuel. Biogas of 300 m^3 with 55-60% of methane can be obtained per ton of dry rice straw.

ANOTHER IMPROTANT MANAGEMENT PRACTICES

Conservation Tillage

Conservation tillage involves reducing or eliminating conventional ploughing and using minimum soil disturbance. It helps to maintain crop residues on the soil surface, protecting against erosion and improving soil moisture retention. Conservation tillage methods include no-till, strip-till, and reduced-till practices.

Mulching

Crop residues can be used as mulch by spreading them on the soil surface around growing plants. Mulching helps to reduce soil erosion, conserve soil moisture, control weeds, and regulate soil temperature.

Organic materials like crop residues gradually decompose, enriching the soil with organic matter and nutrients.

Crop rotation and Cover crops

Integrating crop rotation and cover crops can contribute to effective crop residue management. Rotating different crops helps break disease and pest cycles and improves soil health. Cover crops, such as legumes or grasses, planted during fallow periods, can provide additional crop residues and improve soil quality.

Nutrient cycling

Crop residues contain valuable nutrients, and their incorporation into the soil can help replenish nutrient levels for subsequent crops.

Crop residues management strategies in different countries

One major handicap in using large amounts of straw is the high cost and labour requirement for its collection and transportation. Some countries have developed strategies for successful management of crop residues to avoid on-farm burning.

- In China, where about 700 Mt crop residues are generated annually, 31% of crop residues are left in the field, 31% are used for animal feed, 19% are used for bioenergy generation and 15% are used as fertilizer.
- In USA on farm burning has been regulated in some of the states. For example, in California farmers require a permit for crop residues burning, which can be carried out only on 'burndays' determined by the local authorities in consultation with the California Air Resource Board. The crop residues are also required to be shredded and piled where possible.
- The crop residues are used as a source of energy in some countries like Indonesia, Nepal, Thailand, Malaysia, Philippines, Indonesia and Nigeria; for composting in Philippines, Israel and China.
- Animal feed in Lebanon, Pakistan, Syria, Iraq, Israel, Tanzania, China and countries in Africa.
- For mushroom cultivation in Vietnam and even burnt on-farm in China, USA, Philippines and Indonesia.

CONCLUSION

Crop residue management practices vary depending on the crop type, climate, soil conditions, and local agricultural systems. It is essential to consider factors like nutrient requirements, soil erosion potential, and crop production goals when deciding on the appropriate management approach for crop residues.

References

Reshma Shinde, Dhirendra Kumar Shahi, Prabhakar Mahapatra, Chandra Shekhar Singh, Sushanta Kumar Naik, Nandkishore Thombare and Arun Kumar Singh. 2022. Management of crop residues with special reference to the on-farm utilization methods: A review. *Industrial Crops and Products*, 181, 114772.

Volume: 03 Issue No: 11

CLIMATE - SMART AGRICULTURE

Article ID: AG-V03-I11-35

***Dr. RAGHU R S**

Assistant Professor, Malla Reddy University, Hyderabad, Telangana - 500100

*Corresponding Author Email ID: raghuagri7593@gmail.com

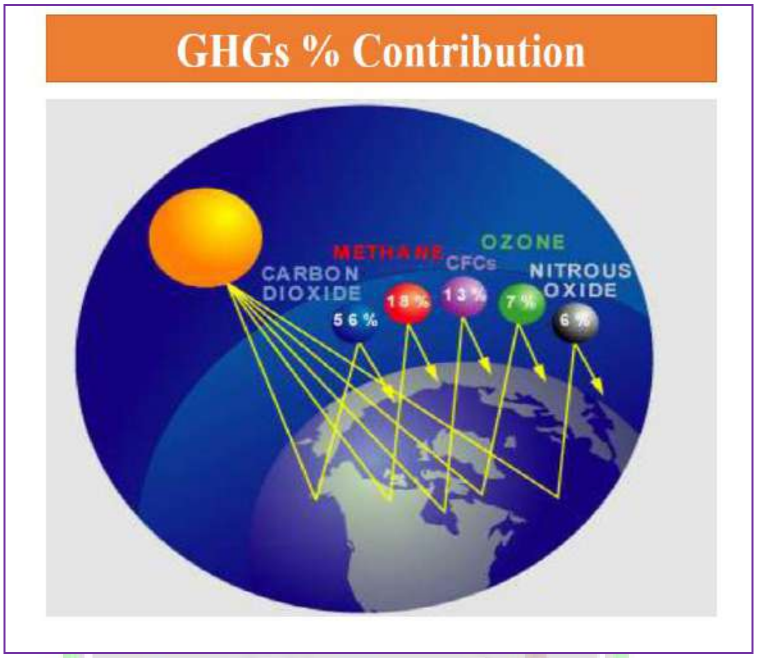
Introduction

Climate change, which is widely accepted as the single most pressing issue facing society on a global basis, affects agricultural performance by altering the range and magnitude of climatic parameters which in turn affect the food security. Climate change is defined as a change in the state of the climate that can be identified by changes in the mean and or the variability of its properties and that persists for an extended period typically decades or longer. Climate change caused by both natural (continental drift, volcanoes, the earth's tilt, ocean currents) and man-made activities (industrial pollution, burning of fossil fuels, deforestation and agriculture). Climate change multiplies the challenges of achieving the needed growth and improvements in agricultural systems and its effects are already being felt. Climate-Smart Agriculture (CSA) is an approach to dealing with these interlinked challenges in a holistic and effective manner. The concept of CSA was first launched by FAO in 2010 in a background paper prepared for the Hague Conference on Agriculture, Food Security and Climate Change. The objectives of CSA include sustainably increasing agricultural productivity, adapting and building resilience agricultural systems to climate change and reducing and/or removing greenhouse gas emissions.

Impact of climate change and GHGs in agriculture

1. Reduction in crop yield.
2. Shortage of water
3. Irregularities in onset of monsoon, drought, flood and cyclone
4. Rise in sea level

5. Decline in soil fertility
6. Loss of biodiversity
7. Problems of pests, weeds and diseases



Greenhouse gas emission from different sector

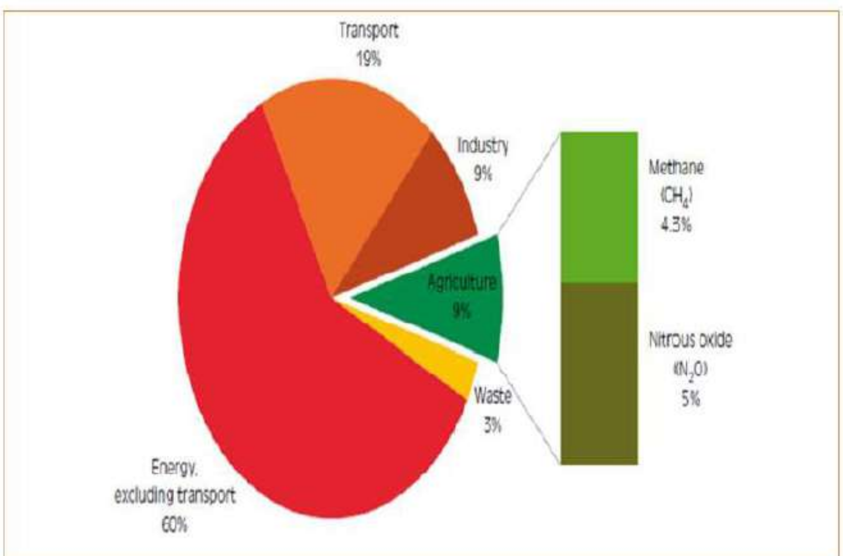


Fig.2 : GHGs from agricultural sector

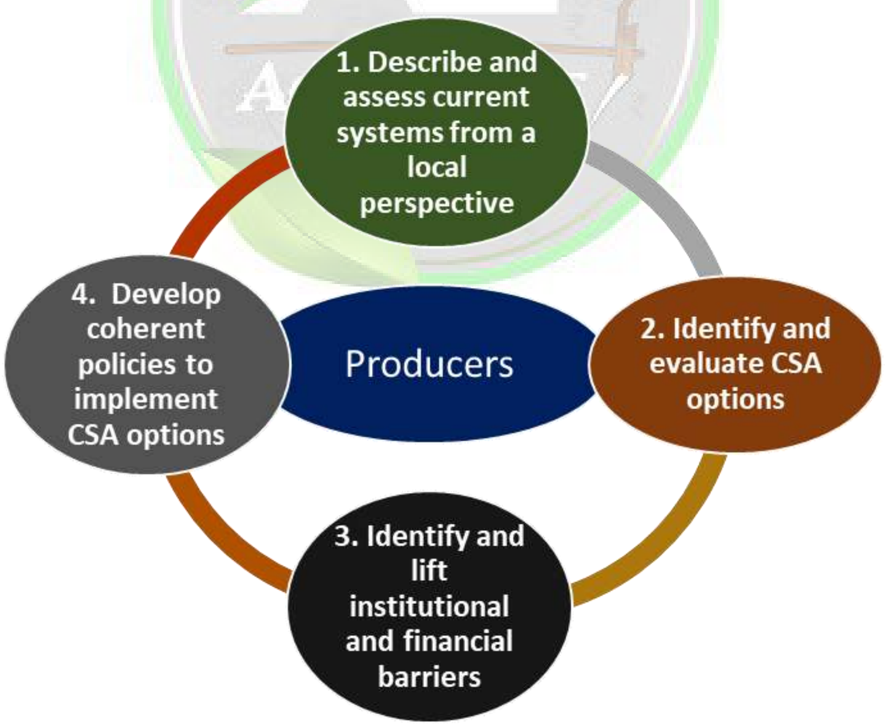
OBJECTIVES OF CSA

i. Sustainably increasing agricultural productivity

ii. Adapting and building resilience agricultural systems to climate change

iii. Reducing and/or removing greenhouse gas emissions

STEPS IN CSA FRAMEWORK



CSA interventions are highly location-specific and knowledge-intensive and it will require considerable effort to develop the knowledge and capacities needed to make CSA a reality and to develop local specific CSA measures that are socially and environmentally acceptable and sustainable (FAO, 2013).

Different elements of climate-smart agricultural systems may include

I. Management of farms, crops, livestock, aquaculture and capture fisheries
II. Landscape or ecosystem management
III. Services for farmers and land managers
IV. Changes in the wider food system

Making agriculture more climate smart is possible through crop management practices likeminimum tillage, agroforestry, terracing, mulching, drought-tolerant crops, changing cropping calendars, water harvesting and soil management practices like improved methods of fertilizer application, crop residues, organic manures, control soil loss due to erosion and soil carbon sequestration.

NEW INITIATIVES IN CSA

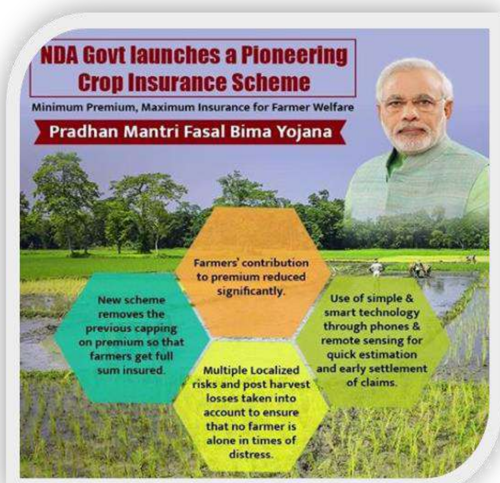
Information for CSA is delivered through technologies such as radio, weather stations, mobile phones and video programs.

SMS Advisory

Community Radio

Weather Information

Newly launched CSA related schemes in India



As well as the ways in which new knowledge and skills are shared with farmers, such as model farmers, farmer field schools, village information centers or question-and-answer services.

Conclusion

Climate-Smart agriculture provides management options to farmers, to adapt and mitigate climate change and maintain income and look for opportunity to increase it. Crop production must adapt - crop varietal selection, plant breeding, cropping patterns, water conservation technologies and soil management practices and become resilient to changes (frequency and intensity). Crop production can contribute to mitigating climate change by reducing green house gas (GHG) emissions - for example by reducing the use of inorganic fertilizers, use of biofertilizers and avoiding flooding to reduce methane emissions (e.g. in paddy rice systems) and sequestering carbon (e.g. planting perennial crops and grass species).

Volume: 03 Issue No: 11

USES AND MANAGEMENT PRACTICES OF NONI

Article ID: AG-V03-I11-36

***Sravanthi, D., Neelima, P, Shireesha, K, Amuktamalyada, G, Naganjali, K, Sravan Kumar, T, Gopalakrishna Murthy, K and Hemantha Kumar. J**

Agricultural College, Aswaraopet

Professor Jayashankar Telangana State Agricultural University (PJTSAU)

*Corresponding Author Email ID: danamsravanthi@gmail.com

Introduction

Noni (*Morinda citrifolia* L.) is a unique horticultural plant belongs to Rubiaceae family. It has tremendous demand because of its high medicinal value. It is naïve to South East Asia (Indosia) and Australia. Over the years of its popularity diminished due to unpleasant smell from the ripened fruit. It is a tropical fruit commonly known as Indian Mulberry.

Soil and climate:

Noni is a plant that grows in all types of well drained soils, and it can withstand to adverse climatic conditions. It can withstand seasonal waterlogging. Noni may thrive in wide range of acidity conditions. It comes up well between 20-38^{0}C and mean annual rainfall of 250-4000 mm.

Season:

It is a woody crop that grows well in any adverse conditions. Noni fruit production varies, with more fruit being produced in summer than in winter. However, noni produces new leaves and fruits throughout the year long wherever it is grown.

Propagation:

Morinda citrifolia is mainly propagated through seeds, in addition it may be planted through stem/ root cuttings and air layering. The preferred methods of propagating are by seed and by cuttings made from stem. Disadvantages of producing plants from cuttings are that they may not be as strong as seedlings.

Seed processing

Let the fruit ripen after picking until it becomes transparent and tender. Should you only gather semi-ripe fruits, this could take three to five days. After the fruits are entirely soft, push them up against a screen to remove the clinging meat and gradually extract the soft, fibrous pulp. Periodically rinsing in water facilitates the pulp's floating off. Healthy noni seeds float in water because they contain an air bubble trapped inside, which sets them apart from most other seeds. Soft fruits can be suspended in water and very sparingly pulsed in a blender for brief periods to remove most of the flesh and mildly scarify the seeds if the seeds are to be utilized right away. The flesh should be entirely removed from the seeds if they are going to be kept.

Rooted cuttings & Seedlings

Pre-planting seed treatment:

In the absence of pretreatment, noni seeds take six to twelve months to germinate. Scarification of the hard seed coat can accelerate seed germination and raise the percentage of germination overall. Any physical technique that destroys, pierces, abrades, or splits open the seed coat can accomplish scarification. One easy way to separate the noni seeds from the pulp is to put ripe fruits in a blender and pulse the blending mechanism several times to break apart the noni seeds. To increase the germination percentage, a more labor-intensive technique involves trimming the tip of noni seeds close to the embryo to allow water to permeate the seed coat. Scarified noni seeds take 20 to 120 days to germinate, depending on the habitat and temperature.

Potting media:

Natural or local forest soil devoid of weeds and nematodes, combined with sand and composted organic matter, is ideal for growing seedlings. Avoid utilizing nematode-infested soils or media, or treat them with heat (at least 50^0C for 15 minutes) before using. For the development of noni, the majority of nurseries favor natural potting media over commercial media. For weed control and moisture retention, you can cover the seeds with mulch (such as sawdust, leaf litter, or sand).

From complete shade to direct sunlight, noni seeds can sprout. The majority of consistent germination occurs in light partial shade (20–30%). The individual seedlings in pots are grown out in partial shade (20–30%) following the germination and early establishing stages.

Transplanting:

Noni seedlings may be transplanted in about 2-12 months after germination. After germination, noni seedlings can be moved in a period of two to twelve months. Due to transplant shock and the creation of a root system, seedling development is sluggish during the first year following transplantation. Subsequently, as the crown grows in size and photosynthetic mass, seedling growth accelerates significantly.

Propagation from stem cuttings:

Varying sizes of stem cuttings can be used, but 20-40 cm (8-16 in) cutting are manageable and effective. In three weeks, stem cuttings may begin to root, and in 6–9 weeks, they will be prepared for transplanting. Rooted stem cuttings can be grown in pots for up to 24 weeks or more, much like plants grown from seeds, and they will perform admirably when transplanted.

Plant Protection:

Aphids, scales, weevils, leaf miners, whiteflies, thrips, and an unidentified species of eriophyid mite are just a few of the insects that can attack and harm noni. When fertilizer is applied excessively, it can draw sap-feeding insects like aphids, white flies, and scales, which can lead to the accumulation of sooty mold on noni leaves. Contact pesticides can be used to manage caterpillars, while systemic pesticides can be sprayed twice a year to control sucking insects.

Certain plant diseases produced by fungi or fungus-like organisms, such as leaf spots (Colletotrichum sp. and others) and stem, leaf, and fruit blights (Phytophthora sp. and Sclerotium rolfsii), are more common in moist, high-rainfall, or flooded locations. Although comparatively insignificant, fungal leaf spot can be an annoyance in some areas. They can be reduced by applying approved fungicides on a regular basis (fungicides based on copper) or by maintaining sanitation by removing or picking up badly damaged leaves. Certain fungal infections of the leaves (fungal leaf spots brought on by the fungus-like Phytophthora) can seriously impede the growth of leaves and the development of fruits. Root knot infections, which are brought on by root-knot nematodes, are the most prevalent and serious pest issue for noni. Meloidogyne species. Using compost, fertilizer, and irrigation efficiently can help reduce

Production of medicinal plants must use little or no chemical pesticides. Neem-based formulations are utilized in organic methods for pest control; fish oil resin soap is an effective tool for managing these sucking pests. Botanicals, such as garlic, *Vitex negundo*, *Lantana camera*, *Clerodendron inerme,* and *Calotropis gigantea* extracts, are frequently mixed and sprayed on a regular basis to combat pests. It is possible to control diseases such as damping off and root rot by applying *Trichoderma viridi* (2 kg/ha) and *Psuedomonas flurescens* (2 kg/ha).

Harvest and Yield:

Fruits are harvested as they begin to turn white or even before they reach full ripeness, which is when they become soft, translucent, and have developed their distinct aroma. The tree begins to give when it is three years old, and from the fifth year onwards, it will yield consistently. Fruit yield fluctuates annually among genotypes or cultivars and is dependent on the cultivation system, habitat, and/or environment (soil). Large-fruited varieties cultivated in monoculture in full sun and extensive fertilization may provide annual yields of up to 80,000 kg/ha or more. Numerous variables, like as planting density, genotype, environment, and soil fertility, affect yields.

Uses:

Noni treats heart disease and stroke and lowers blood pressure. This is as a result of scopoletin's presence, which has been shown by science to widen blood vessels and reduce blood pressure. Additionally, it increases the body's synthesis of nitric oxide, a substance that makes blood vessels more elastic and able to dilate more readily. The circulatory system's healthy structure is supported by the xeronine system. Scopoletin is a great tool for promoting smooth joint movement because of its anti-inflammatory and histamine-inhibiting properties.

Finally Lastly, Noni's ability to enhance cells may help to lessen the harm done to the joints and other affected tissues. It also supports improved immune system and pancreatic function. Noni accomplishes this by functioning as an adaptogen that helps them heal themselves. This may be related to diabetes by the pancreatic beta cells not functioning properly or by supporting the cells that are unable to utilize the blood's glucose. Increased magnesium in the heart cells from noni aids in maintaining a healthy cardiac rhythm. Through the improvement of bronchioles' cellular structures, it eradicates bronchitis infection. Asthma is caused by inflammation and allergies, both of which can be treated with noni. By balancing hormones through its effects on the liver and hormone receptors, it also helps with menstrual migraine headaches. It relieves numbness brought on by damaged nerves.

Noni tea is a general febrifuge, analgesic, and aids in the treatment of malaria. Jaundice is treated with a decoction made from the stem bark of Noni. Scalp pesticide is prepared using the seed oil. Poultices made from leaves or fruits can be used to treat rheumatism, sprains, deep bruises, and tuberculosis. It is thought that the fruits are utilized as a stimulant of the brain and hunger. One pigment used to make colors is found in the bark, while another pigment found in the roots is utilized to make yellow dye. Noni dyes have historically and currently being used to color textiles and apparel. Noni seed oil is used as an insect repellent and scalp insecticide.

In North East India,

Noni is not grown for commercial purposes. Due to their easy availability and lower cost, people in North East India rely heavily on natural items (folk medicine) and traditional methods of healing. The tropical humidity of this area makes it ideal for the growing of noni. With the help of the National Medicinal Plant Board, New Delhi, the Rain Forest Research Institute (RFRI), Jorhat, has recently introduced noni to Assam, Mizoram, and Tripura on an experimental basis. The results have been encouraging. The Noni cultivation package currently in use in Northeastern India has been enhanced by RFRI, which has also developed procedures for the processing, product preparation, and preservation of Noni fruits. In Northeast India, noni farming has the potential to greatly enhance local communities' standard of living while simultaneously providing reasonably priced health benefits. Since the ripe fruits are also a good source of nutrition for pigs and poultry, noni cultivation will also aid in the promotion of animal husbandry. Noni is a health tonic that promotes human health and longevity; it is not a medication.

Volume: 03 Issue No: 11

DIVERSITY ARRAY TECHNOLOGY (DArT)

Article ID: AG-V03-I11-37

[1*]J.R. Jerish, [2]S. Saravanan and [3]M. Arumugam Pillai

[1]Doctoral scholar, Department of Genetics and Plant Breeding, AC & RI, Killikulam, India

[2]Associate Professor (PBG) and Head, Rice Research Station, Ambasamudram

[3]Professor and Head, Department of Genetics and Plant Breeding, AC & RI, Killikulam, India

*Corresponding Author Email ID:jrjerish@gmail.com

Introduction

Numerous DNA based genetic markers like RFLP, RAPD, AFLP etc., have been developed, but all these marker systems are dependent on gel electrophoresis. To overcome this, hybridization based methods have been developed. DArT was developed by Jaccoud *et al*. 2001. It is a hybridization-based and cost-effective fingerprinting method. It is a high throughput and low-cost genotyping system. This technology does not require knowledge of either the sequence or the function of the DNA segments

Diversity array technology (DArT) is a high throughput, low-cost genotyping system. It is essentially similar to amplified fragment length polymorphism procedure, except for the use of microarray-based nucleic acid hybridization in the place of gel electrophoresis for the detection of polymorphism. DArT was initially developed for the assessment of genetic diversity present in a species, but it has found several other applications. DArT analysis consists of the following two steps: (1) construction of a microarray, called diversity array or genotyping array, and (2) genotyping of the test individuals/lines based on hybridization of their genomic fragments with the concerned genotyping array (contains such genomic DNA segments of a given species, which are found to be polymorphic across a range of germplasm of interest)

Steps in DArT

- ✓ Isolation and purification of the genomic DNAs from several individuals/lines

- ✓ Pooling of ~5 ng DNA from each of these individuals/lines and digesting the pooled DNA with the selected restriction enzymes
- ✓ Ligation of appropriate adapters to the restriction fragments
- ✓ Reducing the complexity of fragments by 10–1,000-fold and PCR amplification of the selected fragments
- ✓ Cloning of the amplified fragments
- ✓ DNA insert from each of the clones is amplified individually using vector-specific primers
- ✓ Amplification products are purified and spotted onto a solid support like a microscopic slide to prepare the microarray

Complexity reduction:

Complexity of a genome or DNA preparation represents the total number of different sequences present in it. Thus, a DNA preparation of low complexity will have a smaller number of different sequences than that of high complexity.

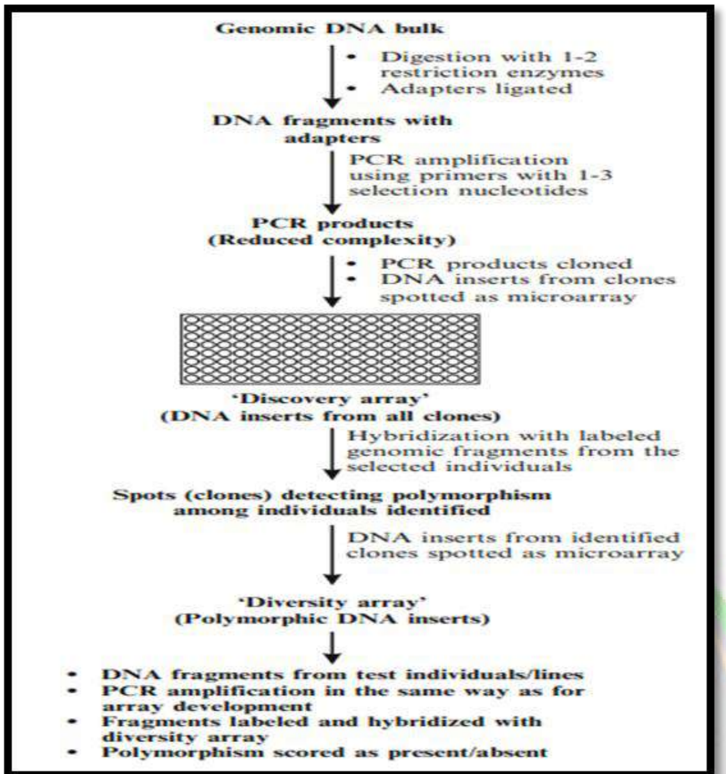
One approach for reducing the complexity of DNA fragments is to use primers having one to three selection nucleotides at their 3′ ends for PCR amplification. A selection nucleotide is an arbitrary nucleotide added to the 3′ end of the primer so that only such fragments that have the nucleotide complementary to this nucleotide at the corresponding position will be amplified. This will reduce the number of fragments amplified to one-fourth of the total number of different fragments for every selection nucleotide used in a primer.

Another approach for complexity reduction is to digest the genomic DNA with a combination of two (one rare cutter enzyme like P*st*I and one frequent cutter enzyme, such as (T*aq*I or B*st*NI) restriction enzymes. In this case, the enzyme combination has considerable effect on the level of polymorphism revealed.

Discovery array:

All the fragments amplified following the complexity reduction procedure are cloned. DNA inserts from all the clones are amplified again using vector-specific primers, and the amplified fragments from each insert are spotted individually on a suitable solid support to generate a microarray. This is called discovery array. But it may only contain a small proportion (usually, around 4–10 %) of the fragments present in a discovery array would be polymorphic.

Detailed Procedure:



Diversity array:

The polymorphic fragments are identified by using fluorescence-labeled genomic DNA fragments from the same individuals/lines, whose genomic DNA was pooled to construct the discovery array, for hybridization with the fragments spotted onto the discovery array. The labeled fragments are prepared following the same protocol of restriction digestion and PCR amplification that was used for construction of the discovery array.

If genomic DNA fragments from two individuals/lines were labeled with two different fluorescent dyes and were used together for hybridization with the discovery array, most of the spots would hybridize with fragments from both the individuals/lines. These spots would produce a fluorescence color distinct from those generated individually by the two fluorescent dyes used for labeling.

Some spots, however, will hybridize with the fragments from only one of the two lines/individuals. These spots would produce fluorescence color characteristic for the dye used for labeling of the concerned fragments, and they would contain fragments that differ between the two lines/ individuals, i.e., are polymorphic. The spots containing polymorphic fragments are identified, and the DNA inserts are amplified from the corresponding clones and are finally spotted onto a solid support to develop the genotyping array.

Genotyping using DArT:

- ✓ For genotyping a line/an individual, the genomic DNA (50–100 ng) from the individual/line is isolated and fragments suitable for analysis are prepared using the same protocol that was used for microarray preparation.
- ✓ The genomic DNA is digested with the same restriction enzyme(s) and amplified using the same primer that was used to construct the genotyping array.
- ✓ The fragments are labeled with a fluorescent dye and used for hybridization with the genotyping array.
- ✓ The genotyping array is simultaneously hybridized with the fragments of the cloning vector used for genotyping array construction; these fragments are labeled with a different fluorescent dye. This is done in view of the presence of the sequences from this vector in all the spots on the microarray.
- ✓ Hybridization signals are detected and analyzed using specialized software, e.g., DArTsoft, which converts them into scores of 1 or 0, i.e., “present” or “absent.”
- ✓ These scores provide the fingerprint of the individual/line, and they are also used for statistical analyses in the same way as the scores for RAPDs, SSRs, etc.
- ✓ The software like DArTdb, Client Interaction, DArTsoft, and DArTools required for DArT analyses have been built on the open-source software LAMP.

Polymorphism due to DArT:

DArT generally detects polymorphism produced by SNPs in the restriction sites and at the sites corresponding to the selection nucleotides of the PCR primers. It also detects relatively large InDels (insertions and deletions), structural rearrangements, and copy number variations in the region between the two neighboring restriction sites. The DArT markers are distributed throughout the genome, but a majority of them tend to be located in the genetically active regions of the genome. DArT is as effective in detecting polymorphism in a polyploid species like wheat as it is in diploid species like barley.

Applications:

- ✓ Comprehensive characterization of germplasm

- ✓ Diversity studies (Yang *et al* 2006)
- ✓ Selection of parents for hybridization
- ✓ Genetic, physical (in genome sequencing) and QTL mapping

Advantages:

- ✓ DArT automated platform could genotype thousands of loci in a single assay (Xie *et al* 2006)
- ✓ Allows automated data acquisition and storage
- ✓ Low costs of development
- ✓ Minimal DNA requirement
- ✓ Comprehensive genome coverage
- ✓ Effective in detecting polymorphism in a polyploid species eg., wheat species

Disadvantages:

- ✓ Use of restriction enzymes makes the technology more expensive
- ✓ Requires DNA preparations of high purity
- ✓ Requires specialized equipment as well as software programs

Reference

Jaccoud, D., Peng, K., Feinstein, D., & Kilian, A. (2001). Diversity arrays: a solid state technology for sequence information independent genotyping. *Nucleic acids research*, *29*(4), e25-e25.

Xie, Y., McNally, K., Li, C. Y., Leung, H., & Zhu, Y. Y. (2006). A High-throughput Genomic Tool: Diversity Array Technology Complementary for Rice Genotyping. *Journal of Integrative Plant Biology*, *48*(9), 1069-1076.

Yang, S., Pang, W., Ash, G., Harper, J., Carling, J., Wenzl, P., & Kilian, A. (2006). Low level of genetic diversity in cultivated pigeonpea compared to its wild relatives is revealed by diversity arrays technology. *Theoretical and applied genetics*, *113*, 585-595.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

A REVIEW ON DEEP LEARNING TECHNOLOGIES FOR SMART AGRICULTURE APPLICATIONS

Article ID: AG-V03-I11-38

***Dr.P.Prema**

Associate Professor (Computer Science), Agricultural College and Research Institute, TNAU, Madurai, Tamil Nadu

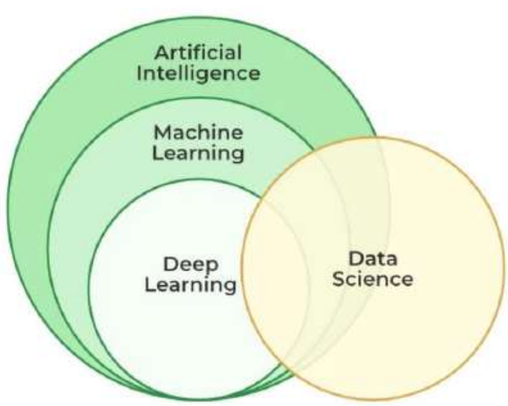
*Corresponding Author Email ID: pp76@tnau.ac.in

Introduction

Smart agriculture refers to the usage of technologies like Internet of Things, sensors, location systems, robots and artificial intelligence. Smart agriculture is the broad application of artificial intelligence (AI), which involves big data, the internet of things (IoT), deep learning, and many other digital technologies [1]. As the world population grows, a significant increase in food production must be realized. Ensuring the constant and consistent availability and quality of food globally without affecting natural ecosystems is challenging for modern technologies. Deep learning is a new cutting-edge technology for image processing and data analysis. It has yielded promising results, possesses enormous potential, and has been successfully employed in various fields, including agriculture. In recent years, deep learning-based agricultural applications (smart agriculture) have achieved tremendous success. Various intelligent systems based on AI differ in their ability to record and interpret data and assist the farmers in making the right decisions at the right time. Data can be recorded using installed IoT nodes (sensors), processed by any deep learning method, and imposed decisions on operational areas through actuators. Furthermore, AI-based smart agriculture can be utilized to schedule optimum resources such as fertilizer, pesticides, and water, thereby minimizing pollution and operational/ production costs and maximizing production. As AI can assist in the early detection and prevention of plant diseases, halting their spread would require the application of fewer medications; this reduces environmental contamination significantly [2]. The continuous provision of agronomic inputs, such as water, nutrients, and fertilizers, is critical for plant health, growth, and yield [3]. The absence of any of these inputs may cause biotic and abiotic stress. The decision to apply the right amount of a particular resource at the right time by considering the current situation and future predictions is possible only through AI. This research studied the utilization of AI and deep learning in agriculture and its future potential and the agricultural parameters retrieved by IoTs and used them to feed the deep learning algorithms for further processing. This article presents a survey of how the smart agriculture use the deep learning techniques and its application in agriculture.

Deep Learning

Deep learning is a subset of machine learning and AI, and is essentially a neural network with three or more layers. These neural networks aim to mimic the activity of the human brain; however, they fall far short of the human brain’s ability to learn from large amounts of data. While a single-layer neural network can provide approximate predictions, additional hidden layers can aid in optimizing and refining the accuracy. Machine learning is a subfield of AI that allows the system to learn from concepts and knowledge without being explicitly programmed. It begins with observations, such as faceto-face interactions, to prepare for data features and trends and improve future results and judgments. Deep learning is built on a combination of machine learning algorithms that use multiple nonlinear transformations to model high-level abstractions in data [4]. Feature learning, or the automatic extraction of features from raw data, is a significant advantage of deep learning. Features from higher hierarchy levels are produced by the composition of lower-level components [5]. Recurrent neural network (RNN) and convolutional neural network (CNN) are two standard deep learning networks used in agriculture.



Today Deep learning has become one of the most popular and visible areas of machine learning, due to its success in a variety of applications, such as computer vision, natural language processing, and Reinforcement learning. Deep learning can be used for supervised, unsupervised as well as reinforcement machine learning. it uses a variety of ways to process these.

Supervised Machine Learning:

Supervised machine learning is the machine learning technique in which the neural network learns to make predictions or classify data based on the labeled datasets. Here we input both input features along with the target variables. the neural network learns to make predictions based on the cost or error that comes from the difference between the predicted and the actual target, this process is known as backpropagation. Deep learning algorithms like Convolutional neural networks, Recurrent neural networks are used for many supervised tasks like image classifications and recognization, sentiment analysis, language translations, etc.

Unsupervised Machine Learning:

Unsupervised machine learning is the machine learning technique in which the neural network learns to discover the patterns or to cluster the dataset based on unlabeled datasets. Here there are no target variables. while the machine has to self-determined the hidden patterns or relationships within the datasets. Deep learning algorithms like autoencoders and generative models are used for unsupervised tasks like clustering, dimensionality reduction, and anomaly detection.

Reinforcement Machine Learning:

Reinforcement Machine Learning is the machine learning technique in which an agent learns to make decisions in an environment to maximize a reward signal. The agent interacts with the environment by taking action and observing the resulting rewards. Deep learning can be used to learn policies, or a set of actions, that maximizes the cumulative reward over time. Deep reinforcement learning algorithms like Deep Q networks and Deep Deterministic Policy Gradient (DDPG) are used to reinforce tasks like robotics and game playing etc.

Deep Learning models are able to automatically learn features from the data, which makes them well-suited for tasks such as image recognition, speech recognition, and natural language processing. The most widely used architectures in deep learning are feedforward neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).

Convolutional Neural Network (CNN)

A CNN is a deep learning algorithm composed of multiple convolutional layers, pooling layers, and fully connected layers [6]. It is a multi-layer neural network based. CNNs are mainly used for image processing and handwritten character recognition. In several computer vision studies, CNNs have been used for image classification, object detection, fragmentation of images, voice recognition, text and video processing, and medical image analysis, among other functions. A CNN architecture typically consists of convolutional, pooling, and fully connected layers [7]. Figure 1 illustrates the architecture of CNNs.

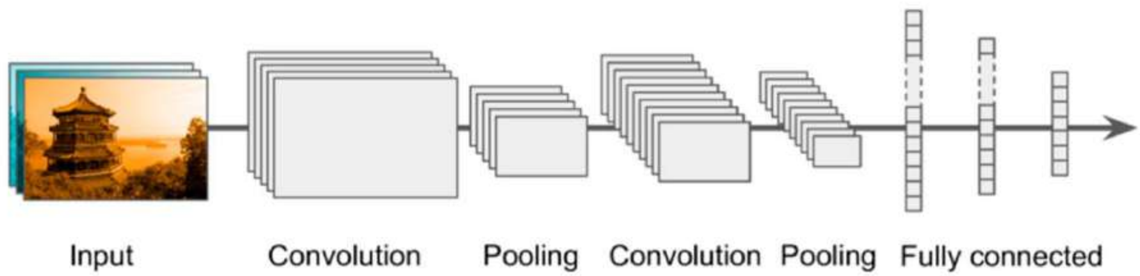


Fig 1 : CNN architecture

Convolutional Layer

The convolutional layer is the most basic and the most significant in a CNN. The resulting pixel matrix for the supplied picture or object is twisted or multiplied to build an activation map for the given image. The activation map's main advantage is that it stores all of the distinguishing qualities of a given image while limiting the amount of data that must be processed simultaneously. The data is combined in a features detector matrix, and various image variants are created by employing different feature detector levels. The convoluted model is also trained with backpropagation to achieve the lowest possible error in each layer. The depth and padding are determined by the error set with the fewest errors. The convolutional layer is responsible for extracting visual features.

Pooling Layer

It is a crucial phase that attempts to minimize the dimensions of the activation map further while simultaneously maintaining only the essential features and minimizing the remarkable invariance. It, in turn, reduces the number of learnable features in the model . CNN to aggregate all the various dimensions of an image to recognize the supplied object even if the form is warped or at a different angle. Pooling can be carried out in multiple ways, including max pooling, average pooling, stochastic pooling, and spatial pyramid. The most frequent method used is max pooling.

Fully Connected Layer

This is the final layer where the neural network is fed. In general, the matrix is flattened before being handed over to the neurons. Data are difficult to follow after this point due to numerous hidden layers with changing weights for each neuron's output. All data reasoning and computing occur here .

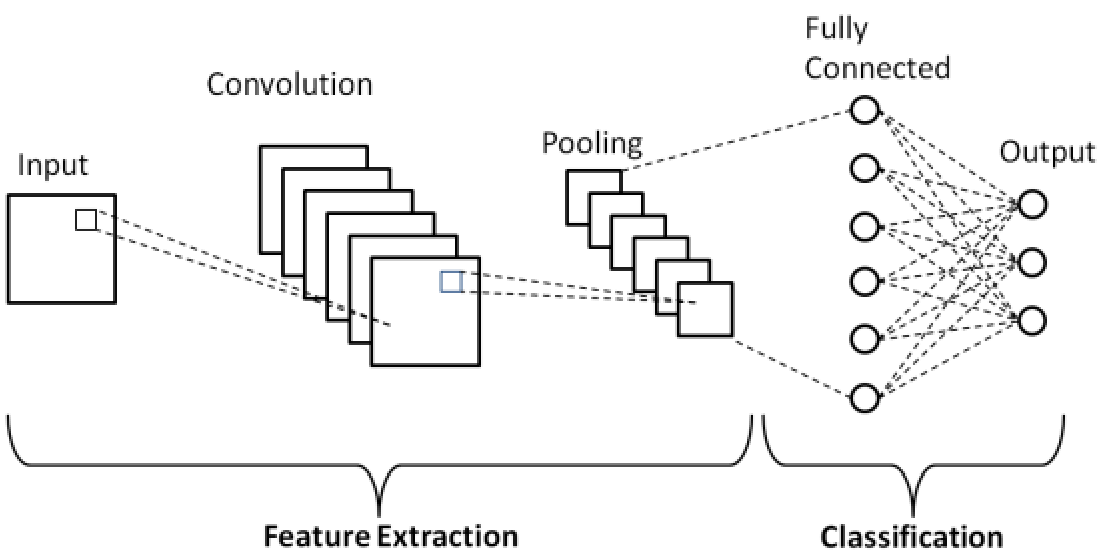


Fig 2 : Convolutional Neural Network

Recurrent Neural Network (RNN)

An RNN is a neural sequence model that performs exceptionally well on crucial tasks such as language modeling, speech recognition, and machine translation. RNNs,as opposed to traditional neural networks, take advantage of the network's sequential information; this attribute is critical in many applications where the structure inherent in the data sequence contains valuable information. For instance, to understand a word in a sentence, you must first understand the context. Hence, an RNN can be considered a short-term memory unit that consists of the input layer x, the hidden (state) layer s, and the output layer [8]. Figure 2 depicts the generic structure of an RNN. Long short-term memory (LSTM) is an RNN architecture built to simulate temporal sequences and their long-term relationships with more precision than ordinary RNNs. Figure 3 depicts the LSTM Long Short Term Memory architecture.

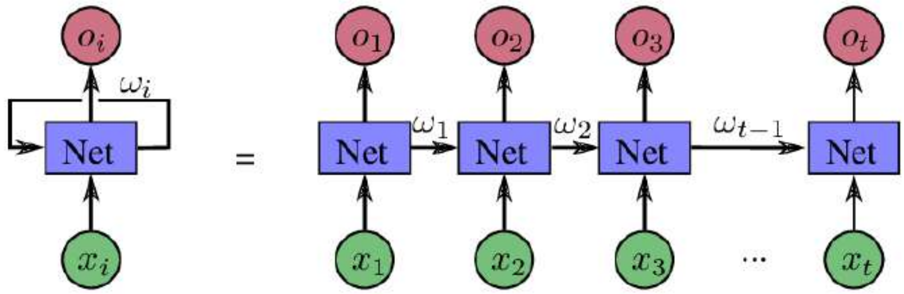


Fig 3 : Structure of RNN

LSTM networks are an extension of recurrent neural networks (RNNs) mainly introduced to handle situations where RNNs fail. It fails to store information for a longer period of time. At times, a reference to certain information stored quite a long time ago is required to predict the current output. But RNNs are absolutely incapable of handling such "long-term dependencies".There is no finer control over which part of the context needs to be carried forward and how much of the past needs to be 'forgotten.Other issues with RNNs are exploding and vanishing gradients which occur during the training process of a network through backtracking.

Applications of Deep Learning in Agriculture

Deep learning algorithms are being used in smart agriculture to monitor various related parameters and observe them from anywhere in the world. CNN algorithm can be used in plant disease detection and classification applications, and it has given tremendous results. Weather forecasting applications also use the CNN algorithm very frequently because it is based on time series and offers effective results.

Identification/Classification of Plant Disease

Disease fungus, microbes, and bacteria obtain energy from the plants on which they dwell, affecting crop productivity. If not diagnosed in time, this can cause significant economic losses for farmers. Pesticides used to remove pathogens and restore crop functionality impose substantial financial pressures on farmers. Excessive pesticide usage also results in nvironmental degradation and affects agricultural areas' water and soil cycle [8]. Moreover, plant diseases impact the growth of particular species; hence, early detection of such stress is critical. Many deep learning models (DL) have been deployed to identify and classify plant diseases. Deep learning appears to possess considerable potential in terms of its increasing accuracy over time.

Many new DL architectures and improvements/modifications to existing ones are proposed. Various modern visualization techniques are being used to identify and classify the symptoms of plant illnesses [9]. In [10], the author provided a method for identifying and classifying banana diseases based on the CNN model. It can assist the farmers in detecting the attacking illness in a timely, affordable, and swift manner. This system could detect two banana diseases,Sigatoka and speckle, by capturing a photo of an affected leaf and using a deep neural networks model. The authors of [11] used another deep learning model (AlexNet) to classify the type of disease in plants through the leaves pictures with high accuracy of results. A deep learning hybrid model is presented in [12] to classify the sunflower illnesses, including Alternaria leaf rot, Downy mildew, phoma rot, and verticillium wilt.

Crop Identification/Classification

Once a crop is properly cured of all kid of illness and stress, the next critical step for the former is to harvest it at the proper time and market demand. Deep learning can also play an essential role in making a harvesting plan by considering different parameters such as soil type/quality/pH, weather forecast (including temperature, precipitation, humidity,and hours of sunlight), and fertilizers schedule. A research paper [13] is one of this kind. A multi-layer DL architecture was proposed in [14]. It can classify different crop species in a land-covered area by taking satellite imagery from numerous sources. An ensemble of 1-D and 2-D CNNs beat the RF classifier and a chorus of MLPs, facilitating a more accurate classification of summer crops, mainly maize and soybeans. CNN models offer more than 85% classification accuracy for main crops (wheat, corn, sunflower, soybeans, and sugar beets).

Identification of Water Stress

Agricultural production is heavily dependent on water and is also increasingly exposed to water risks. Furthermore, it is the most water-consuming sector, and a significant water polluter as spraying pesticides and applying fertilizers can pollute both underground and surface water resources. In this regard, article [15] proposed a convolutional neural networks model to identify the water-stressed and typical areas in the maize crop field. The performance of the proposed framework has been compared with ResNet50, VGG-19, and Inception-v3, and the results show that the proposed model gave better output with an accuracy of 93%. Identification of the water-stressed areas in the crop (maize) field the dataset with 1340 RGB images using DJI Inspire-1 Pro UAV with CNN. In preprocessing ,the Segmented images were resized to 1792 x 1792 and divided into an 8x 8 grid to obtain 224 x 224 image patches of the canopy (leaves). The image has added with Gaussian noise, contrast, saturation, brightness, and random flips. The Accuracy of train dataset 93%, Precision on test dataset 0.9370, F1-score on test dataset is 0.9403. the author [16] developed and tested a novel deep learning-based pipeline model for detecting phenotyping plant water stress areas using pictures of chickpea plant shoots. This paper mainly focused on Monitoring of stress induced by water deficiency in plants. The authors created a new dataset of two chickpea varieties, JG-62 and Pusa-372, containing 7680 images, The Deep learning model CNN-LSTM algorithm are executed with TensorFlow and Keras.

Weather Forecasting

Weather information is becoming increasingly crucial in the emerging agriculture sector, emphasizing accuracy and control while cultivating crops. The use of information technology, which includes weather forecasts and other features such as satellite and aerial imaging, GPS guidance, sensors, drones, variable fertilizer application, and plant health indicators, is a crucial component of this technique. Authors [17,18] developed LSTM deep learning models to predict frost in plants by measuring low temperatures. Despite the high computational cost of LSTM models, they provided excellent time-series prediction results to find/expect ice in the plants.

Conclusions

In this work, we analyzed recent research efforts related to the use of deep learning techniques in agriculture over the past years. Our findings indicate that deep learning performs better than other typical image processing techniques but can improve considerably if specific other parameters are considered. Moreover, deep learning offers a high level of accuracy and outperforms existing, commonly used image processing techniques. This work is helpful for researchers trying to experiment with deep learning and apply it for solving various agricultural problems involving classification or prediction and those related to computer vision and image analysis and data analysis in general. Furthermore, this technique has yielded promising results in its application in agriculture, leading to smart and more effective solutions for making agriculture more efficient and sustainable.

References

1. Liu, Q.; Yan, Q.; Tian, J.; Yuan, K. Key technologies and applications in intelligent agriculture. J. Phys. Conf. Ser. 2021, 1757, 012059.

2. Ren, C.; Dae-Kyoo, K.; Jeong, D. A survey of deep learning in agriculture: Techniques and their applications. J. Inf. Processing Syst.2020, 16, 1015–1033.
3. Kumar, A.; Shreeshan, S.; Tejasri, N.; Rajalakshmi, P.; Guo,W.; Naik, B.; Marathi, B.; Desai, U. Identification of water-stressed area in maize crop using UAV based remote sensing. In Proceedings of the 2020 IEEE India Geoscience and Remote Sensing Symposium (InGARSS), Ahmedabad, India, 1–4 December 2020.
4. Dargan, S.; Kumar, M.; Ayyagari, M.R.; Kumar, G. A survey of deep learning and its applications: A new paradigm to machine learning. Arch. Comput. Methods Eng. 2020, 27, 1071–1092.
5. LeCun, Y.; Bengio, Y.; Hinton, G. Deep learning. Nature 2015, 521, 436–444.
6. Pouyanfar, S.; Sadiq, S.; Yan, Y.; Tian, H.; Tao, Y.; Reyes, M.P.; Shyu, M.-L.; Chen, S.C.; Iyengar, S.S. A survey on deep learning:Algorithms, techniques, and applications. ACM Comput. Surv. (CSUR) 2018, 51, 1–36.
7. Ajit, A.; Acharya, K.; Samanta, A. A review of convolutional neural networks. In Proceedings of the 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), Vellore, India, 24–25 February 2020.
8. Sharma, A.; Jain, A.; Gupta, P.; Chowdary, V. Machine learning applications for precision agriculture: A comprehensive review. IEEE Access 2020, 9, 4843–4873.
9. Saleem, M.H.; Potgieter, J.; Arif, K.M. Plant disease detection and classification by deep learning. Plants 2019, 8, 468.
10. Jihen, A.; Bouaziz, B.; Algergawy, A. A Deep Learning-Based Approach for Banana Leaf Diseases Classification. In Datenbanksysteme für Business, Technologie und Web (BTW 2017)-Workshopband; Gesellschaft für Informatik e.V.: Bonn, Germany, 2017.
11. Dipali, M.; Deepa, D. Automation and integration of growth monitoring in plants (with disease prediction) and crop prediction. Mater. Today Proc. 2021, 43, 3922–3927.
12. Akash, S.; Malik, A. A c for the classification of sunflower diseases using deep learning. In Proceedings of the 2021 2nd International Conference on Intelligent Engineering and Management (ICIEM), London, UK, 28–30 April 2021

13. Bhanumathi, S.; Vineeth, M.; Rohit, N. Crop yield prediction and efficient use of fertilizers. In Proceedings of the 2019 International Conference on Communication and Signal Processing (ICCSP), Chennai, India, 4–6 April 2019.
14. Kussul, N.; Lavreniuk, M.; Skakun, S.; Shelestov, A. Deep learning classification of land cover and crop types using remote sensing data. IEEE Geosci. Remote Sens. Lett. 2017, 14, 778–782
15. Kumar, A.; Shreeshan, S.; Tejasri, N.; Rajalakshmi, P.; Guo,W.; Naik, B.; Marathi, B.; Desai, U. Identification of water-stressed area in maize crop using UAV based remote sensing. In Proceedings of the 2020 IEEE India Geoscience and Remote Sensing Symposium (InGARSS), Ahmedabad, India, 1–4 December 2020.
16. Azimi, S.; Wadhawan, R.; Gandhi, T.K. Intelligent monitoring of stress induced by water deficiency in plants using deep learning. IEEE Trans. Instrum. Meas. 2021, 70, 5017113.
17. Guillén, M.A.; Llanes, A.; Imbernón, B.; Martínez-España, R.; Bueno-Crespo, A.; Cano, J.C.; Cecilia, J.M. Performance evaluation of edge-computing platforms for the prediction of low temperatures in agriculture using deep learning. J. Supercomput. 2021, 77,818–840.
18. Guillén-Navarro, M.A.; Martínez-España, R.; Llanes, A.; Bueno-Crespo, A.; Cecilia, J.M. A deep learning model to predict lower temperatures in agriculture. J. Ambient. Intell. Smart Environ. 2020, 12, 21–34.

Volume: 03 Issue No: 11

STANDARDIZATION OF VALUE ENRICHED RTE EXPANDED PRODUCTS FROM GERMINATED RAGI FLOUR

Article ID: AG-VO3-I11-39

Meenakshi.V*, Saranaya, U and M.Ilamaran*

* Associate Professor (FSN) and Student

Department of Food Science and Nutrition

Community Science College and Research Institute, TNAU, Madurai -625 104.

*Corresponding Author Email ID: meenakshi.v@tnau.ac.in

Abstract

Finger millet (*Eleusine coracana*), also known as ragi is a good source of carbohydrate, protein, dietary fibre and minerals, and an important staple food for people under low socio- economic group and those suffering from metabolic disorders like diabetes and obesity. Novel process for ready to eat (RTE) foods based on minor millet like barnyard millet, finger millet, proso millet can be developed as a healthier alternative snacks /breakfast cereal. Ragi was germinated using different soaking time and germination time. Ragi ragi soaked for 12 hours and germinated for 18 hours had higher vitamin C content (8.23 mg %) .Higher protein (3.10 g %) and crude fibre content (0.3 g %) was observed in ragi soaked for 12 hours and germinated for 18 hours was and an decreasing trend in crude fibre and protein content was observed during germination of ragi. The value enriched RTE expanded product was prepared using germinated ragi flour in the ratio of 50 % 60%,70 %, 80%, 100% and maize in the ratio of 50 %, 40 %,30 % , 20%,0% level and processed at different inlet and outlet temperatures in twin screw extruder. RTE from 100 % maize flour was used as control. Different variations in taste was made using sugar (10%), Spiced masala (10%) ,dark chocolate(10%), pepper(10%).Using 9-1 hedonic scale organoleptic evaluation was made. From the sensory score it was found that value enriched expanded product from germinated ragi flour (80%) +Maize flour (20%) had the highest sensory score.

Key words: Germinated Ragi Flour, Twin Screw Extruder, Nutritional composition, RTE expanded products, Organoleptic characteristics and Hedonic Scale sensory score.

Introduction

Expanded (Ready to Eat) RTE cereals are manufactured from mixtures of cereal flours and starches combined with small amounts of malt, fat, sugars, emulsifiers, and salt. The raw materials in the extrusion cooking processes cover various combinations of ingredients including: cereals, grains and starches, tubers, legumes, oil seeds, cereals as well as animal fat and proteins (Ilo *et al.*, 2000). Ready to eat breakfast was successfully developed using the low amylose rice flour incorporated with seeded banana powder in a single-screw extruder (Borah *et al.*, 2015). Dhumal *et al.* (2014) developed cold extrudate, microwave puffed and oven toasted low fat ready to eat fasting foods successfully using potato and barnyard millet. Corn flour is widely used to elaborate expanded extrudates. It is well known that the addition of legumes to cereals produces an increase in both the amount and the quality of the protein mix. Extruded snacks from starch mixtures of different sources such as corn, cassava (Rampersad *et al* 2003), wheat starch (Onwulata and Konstance 2002). Nutritional features of food are becoming increasingly relevant determinants of consumption patterns for Indian households. Over the last decades, income growth and consequent decrease of food expenditure compared with total consumption, have progressively diverted consumers' attention toward qualitative aspects in the choice of foods. Snacks generally made from corn, wheat, rice and oats, while other cereals such as pearl millet, finger millet, barley, rye, sorghum and triticale have not been used extensively so far. Snack foods now comprise an important part of the daily nutrient and calorie intake of many consumers. They can be sweet or savory, light or substantial, and many even are endowed with attributes such as ‘Healthy’ or ‘just for fun’ Expanded products like snacks and breakfast cereals are very popular today because of their crunchy texture, which arises from the honeycomb structure imparted to the material during extrusion. Ready-To-Eat snacks/Breakfast cereals have dramatically transformed the cereal industry, the key being quality-extruded products offered to consumers at competitive prices (Lin *et al*.2002). Pearl millet and finger millet could seek great potential as an ingredient in extruded snacks or breakfast cereals because of its lower cost.

Germination of Ragi :

Ragi ragi soaked for 12 hours and germinated for 18 hours had higher vitamin C content (8.23 mg %).Higher protein (3.10 g %) and crude fibre content (0.3 g %) was observed in ragi soaked for 12 hours and germinated for 18 hours was and an decreasing trend in crude fibre and protein content was observed during germination of ragi. The soaked for 12 hours and germinated for 18 hours was used for making of RTE products

Standardization of value enriched expanded products from germinated ragi flour

The value enriched expanded product was prepared using germinated ragi flour in the ratio of 50 %, 60%, 70 % 80%, 100% and maize in the ratio of 50 % 40 %,20%,0% level. The ingredients used in the preparation of control (T_o) value enriched expanded products were germinated ragi flour (2kg), chocho powder (10g). Treatments carried out were T1 (50% ragi + 50% maize), T2 (60% ragi + 40% maize), T3 (70% ragi + 30% maize), T4 (80% ragi + 20% maize), T0 (100% ragi). The other ingredients used in different treatments were oil (0.5%), water (12%). RTE from 100 % maize flour was used as control.

The ingredients used in the preparation of control (T_o) value enriched expanded products were germinated ragi flour (2kg), chocho powder (10g). Treatments carried out were T1 (50% ragi + 50% maize), T2 (60% ragi + 40% maize), T3 (70% ragi + 30% maize),T4 (80% ragi + 20% maize),T0 (100% ragi). The other ingredients used in different treatments were oil (0.5%), water (12%).

Different inlet temperature 80˚c, 90˚c, 100˚c and outlet temperature at 120˚c, 130˚c, 140˚c was experimented in the twin screw extruder. The results were compared with control by the use of 9-1 hedonic scale.

The germinated ragi flour (80%) + maize flour (20%) level in developed expanded product was found to be highly acceptable compared to control. The value enriched expanded product was developed using sugar (10%), chaat masala(10%), dark chocolate(10%), pepper(10%) .The results were compared with control by use of 9-1 hedonic scale. Sugar based developed product was found to be highly acceptable.

Results and Discussion

Ragi flour soaked for 12 hours and germinated for 18 hours was used for the RTE product development. For the development of germinated ragi flour based expanded products mixing process of Ragi flour +Maize flour + oil +water was carried out in customized mixer for 20 mins. Different Inlet temperature of 80 ºC, 90ºC, 100 º C and Outlet temperature of 120 º C , 130 º C , 140 º C and Screw speed -32Hz, Feeder speed-14Hz ,Cutter speed -10Hz was carried out for the optimization of the process. Germinated expanded ragi product was developed incorporating maize flour @ 20 %,30 %,40 %,50 % and 100 % level.

Table 1 Development of Germinated Ragi flour RTE products

S. No	Ingredients	Control	(T0)	T1 (50 %)	T2 (60 %)	T3 (70 %)	T4 (80 %)
1.	Germinated ragi flour	-	100	50	60	70	80
2	Maize flour(g)	100	-	50	40	30	20
3	Chocho powder(g)	-	-	1	1	1	1
4	Water (ml)	12	12	12	12	12	12
5	Oil(ml)	-	-	0.5	0.5	0.5	0.5
6	Salt(g)	-	-	0.1	0.1	0.1	0.1

Germinated Ragi **Expanded Ragi Millet RTE product**

The germinated ragi flour processed at inlet temperature 80˚c and outlet temperature 120˚c was found to be highly acceptable. Overall, it is evident that among the different treatments of germinated ragi flour developed value enriched product from sugar based germinated ragi flour(80%)+Maize flour(20%) at inlet temperature 80˚c and outlet temperature 120˚c had the highest sensory score and it had been recorded as maximum score in overall acceptability.

Table 2 : Sensory characteristics of expanded product from germinated ragi flour

Sensory characteristics	**Control (T0)**	**T1 (50 %)**	**T2 (60 %)**	**T3 (70 %)**	**T4 (80 %)**
Colour and appearance	7.0	8.0	8.0	8.0	8.0
Flavour	7.0	7.0	7.0	7.0	7.0
Texture	6.0	6.0	6.0	6.0	7.0
Taste	7.0	6.0	6.0	7.0	8.0
Over all acceptability	7.0	6.0	6.0	7.0	8.0

Table 3: Nutritive value of the expanded products from germinated Ragi flour (%)

Nutrients	**Control (RTE from maize flour)**	**RTE (Germinated Ragi flour)**
Energy	360 k.cal	387.1 k.cal
Fat	2 g	1.0 g
Fibre	1.05	3.2 g
Protein (g)	8.90	7.8 g
Vitamin C (mg)	5.05	4.8 mg
Iron (mg)	1.43	5.2 mg
Calcium (mg)	20	295 mg

The developed germinated millet RTE product had a energy value of 387.1 k.cal, carbohydrates 84.9 g %, fibre 3.2 g % and protein content (7.8 g %). Germinated ragi flour had higher amount of iron (5.2 mg%) and calcium (295 mg %).

Conclusion:

The Low cost value enriched product can serve as a Healthy snacks as an alternative for unhealthy choices. When we compared with cereals like rice based snacks, germinated ragi flour based expanded snacks contain more calcium, iron and protein. Nutritious germinated ragi expanded products can be used for all age groups.

References

Ilo, S.2000. Role of lipids in the extrusion cooking processes. Grasas y Aceites Vol. 51 No. 1-2 (2000).

Anjan Borah , Charu Lata Mahanta , Dipankar Kalita 2015. Optimization of process parameters for extrusion cooking of low amylose rice flour blended with seeded banana and carambola pomace for development of minerals and fiber rich breakfast cereal. J Food Sci Technol . 2016 Jan;53(1):221-32.doi: 10.1007/s13197-015-1772-9. Epub 2015 Sep 11.

Dhumal, C.V., Pardeshi, I.L., Sutar, P.P., & Jayabhaye, R. (2014). Development of potato and barnyard millet based ready to eat (RTE) fasting food. Journal of Ready to Eat Foods, 1(1), 11-17.

Rampersad, R.; Badrie, N.; Comissiong, E.2003. Physico-chemical and sensory characteristics of flavored snacks from extruded cassava/pigeonpea flour. Journal of Food Science 68(1): 363-367.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

EFFECTS AND CONTROL MEASURES OF MARINE POLLUTION

Article ID: AG-VO3-I11-40

***Dr. R. Ramesh, Smt. D. Sravanthi, Dr. M. Ramprasad, Dr. P. Neelima, Dr. T. Pavani, G. Amuktamalyada, Dr. P. Reddy Priya and Dr. B. Deepak Reddy**

Agricultural College, Aswaraopet, PJTSAU, Telangana State

*Corresponding Author Email ID: rameshppphy@gmail.com

Introduction

Marine pollution is defined as the introduction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as hazardous to human health, obstruction of marine activities and lowering the quality of sea water.

- Over 80% of the pollution in the ocean is runoff from the Land
- Almost 90% of all floating materials in the ocean are plastic
- Marine debris, especially plastic, kills more than one million seabirds and 100,000 mammals and sea turtles every year
- Dead Zones which are areas of oxygen deficient water were life ceases to exist, have increased drastically over the past decade.

Sources

Municipal waste & sewage from residences and hotels in coastal towns are directly discharged into sea. Pesticides and fertilizers from agriculture which are washed off by rain enter water courses & finally to sea. India is estimated to use 55,000 tons of pesticides annually and about 25 percent of it is carried to ocean. Petroleum & oil washed off from roads normally enter sewage system & finally into seas. Ship accidents & accidental spillage at sea can therefore be very damaging to the marine environment. Off shore oil exploration also pollute the sea water to a large extent.

Dry docking: All ships periodic dry docking servicing; cleaning the hulls etc. during this period when cargo compartments are emptied, residual oil goes into sea. Pollution due to organic wastes: When O_2 concentration falls 1.5 mg/l, the rate of aerobic oxidants reduced and replaced by the anaerobic bacteria that can oxidize the organic molecules without the use of oxygen.

Pollution due to oil: Crude oil is transported by sea after a tanker has unloaded its cargo of oil; it has to take on sea water ballast for return journey. This ballast water is stored in cargo compartments that previously contained oil. During unloading of cargo certain amount of oil remains clinging to the walls of container & this may amount to 800t in a 200,000t tankers. The ballast water thus contaminated with oil. When fresh crag of oil is to be loaded these compartments are clean with water which discharges the dirty ballast along with oil into sea.

Tanker accidents: In the natural process, a large no of oil tanker accidents happen every year. Sometimes this can results in major disasters. Volcanic eruptions in the sea also causing marine pollution.

Deep sea mining is a relatively new mineral retrieval process that takes place on the ocean floor. Ocean mining sites are usually done at about 1,400 - 3,700 meters below the ocean's surface. The vents create sulfide deposits, which contain precious metals such as silver, gold, copper, manganese, cobalt, and zinc. These raise questions about environment damage to surrounding areas. Removal of parts of the sea floor will result in disturbances to the benthic layer, and habitat of benthic organisms. Beside from direct impact of mining the area, leakage, spills and corrosion would alter the mining area's chemical makeup.

Causes of Marine pollution

Oil Spills: Oil spills have huge and immediate economic, social, and environmental impacts. Local people lose their livelihoods as fisheries and tourism areas are temporarily closed. The cleanup costs are enormous and tens of thousands of marine animals and plants are killed or harmed. And the damage goes on. The chemicals used to break up the oil can be toxic and it's impossible to remove all the spilled oil. Even after an area has been cleaned up, it can take a decade or more to fully recover. When oil is spilled on the sea, it spreads over the surface of the water to form a thin film called as *oil slick*. There's also the problem of the oil that goes down with the ship, which can contaminate the seabed and marine organisms.

Fertilizers: Fertilizers that runoff from farms and lawns is a huge problem for coastal areas. The extra nutrients cause Eutrophication. The run off kills the Algae which depletes the water's dissolved oxygen and suffocate other marine life. Eutrophication is the addition of artificial or natural substances, such as nitrates and phosphates, through fertilizers or sewage, to an aquatic system. Eutrophication has created enormous dead zones in several parts of the world, including the Gulf of Mexico and the Baltic Sea.

Sewage Pipes: In many parts of the world, sewage flows untreated, or under-treated, into the ocean. For example, 80% of urban sewage discharged into the Mediterranean Sea is untreated. This sewage can also lead to eutrophication. In addition, it can cause human disease and lead to beach closures.

Chemicals: Chemicals accumulate in organisms, becoming concentrated in their bodies and in the surrounding water or soil. These animals are in turn eaten by larger animals, which can travel large distances with an increased chemical load. People become contaminated either directly from household products or by eating contaminated seafood and animal fats. Evidence is mounting that a number of man-made chemicals can cause serious health problems including cancer, damage to the immune system, behavioral problems, and reduced fertility.

Garbage Dump: There are several garbage oceans across the world but the biggest as large as the size of Texas is the Great Pacific Garbage Dump. This Dumps Can be dangerous to out animal wildlife and eventually effect our fish that we would eat in that area.

Plastic: Unlike most other trash, plastic isn't biodegradable. Sunlight does eventually break down the plastic, reducing it to smaller and smaller pieces, but that just makes matters worse. The plastic still never goes away; it just becomes microscopic and may be eaten by tiny marine organisms, entering the food chain. The world produced 300 billion pounds of plastic each year, about 10% ends up in the ocean, 70% of which eventually sinks.

Effects of marine pollution:

Apart from causing Eutrophication, a large amount of organic wastes can also result in the development of 'red tides'. These are phytoplankton blooms because of which the whole area is discolored. Commercially important marine species are also killed due to clogging of gills and other structures. When oil is spilled on the sea, it spreads over the surface of the water to form a thin film called as oil slick. This damages marine life to a large extent. Commercial damage to fish by tainting which gives unpleasant flavor to fish and sea food reduces market values of sea food and causes death of birds through its effect on feathers. Birds often clean their plumage by pruning and in the process consume oil which can lead to intestinal, renal and liver failure.

For salt marshy plants oil slick can affect the flowering, fruiting and germination. Organic waste addition results in end products such as hydrogen sulphide, ammonia and methane which are toxic to many organisms. This process results in the formation of an anoxic zone which is low in its oxygen content; from which most life disappears except for anaerobic microorganisms and renders the water fowl smelling.

The coral reefs are the productive ecosystems offer many benefits to people.

These coral reefs are threatened by

a) The sediments from deforestation carried by the runoffs.

b) The agricultural and industrial chemicals reaching through river discharges.

To mention an example, River Ganga is estimated to carry 1.5 billion tons of sediments due to deforestation and intensive farming in India, Bangladesh and Nepal through which it flows to Bay of Bengal. Drill cuttings dumped on the seabed result in the production of toxic sulphides in the bottom sediment thus eliminating the benthic fauna.

General Impacts

Impacts on living resources

Hazards to human health

Hindrance to marine activities

Impairment quality of sea water

Reduction of amenities

Loss of aesthetic beauty

Impacts on the sensitive habitats

Control measures of marine pollution

- Introduction of sewage treatment plants to reduce BOD of final product before discharging into sea.
- Cleaning oil with high pressure jets of water
- Crude oil washing: The clingage is removed by jets of crude oil while the cargo is being unloaded.
- Proper care is to be taken while loading and unloading of oil tankers to seek minimum leaks
- Cleaning oil from surface waters and contaminated beaches can be accelerated through the use of chemical dispersants which can be sprayed on the oil.

Volume: 03 Issue No: 11

MANAGEMENT OF BACTERIAL DISEASES BY BIOTECHNOLOGICAL METHODS

Article ID: AG-VO3-I11-41

M.Deivamani[1*], V.K.Satya[2], P.Senthilkumar[3], S.Malathi[4] and K.Sivakumar[5]

[1]Assistant Professor (Plant Pathology), Krishi Vigyan Kendra, TNAU, Dharmapuri

[2] Assistant Professor (Plant Pathology), Horticultural College and Research Institute for Women HC&RI (W), Tamil Nadu Agricultural University, Kumulur

[3] Associate Professor (Nematology), Agricultural College & Research Institute, Tamil Nadu Agricultural University, Vazhavachanur

[4]Assistant Professor (Plant Pathology), Information and Training Centre, TNAU, Chennai

[5]Assistant Professor (Plant Pathology), Krishi Vigyan Kendra, TNAU, Dharmapuri

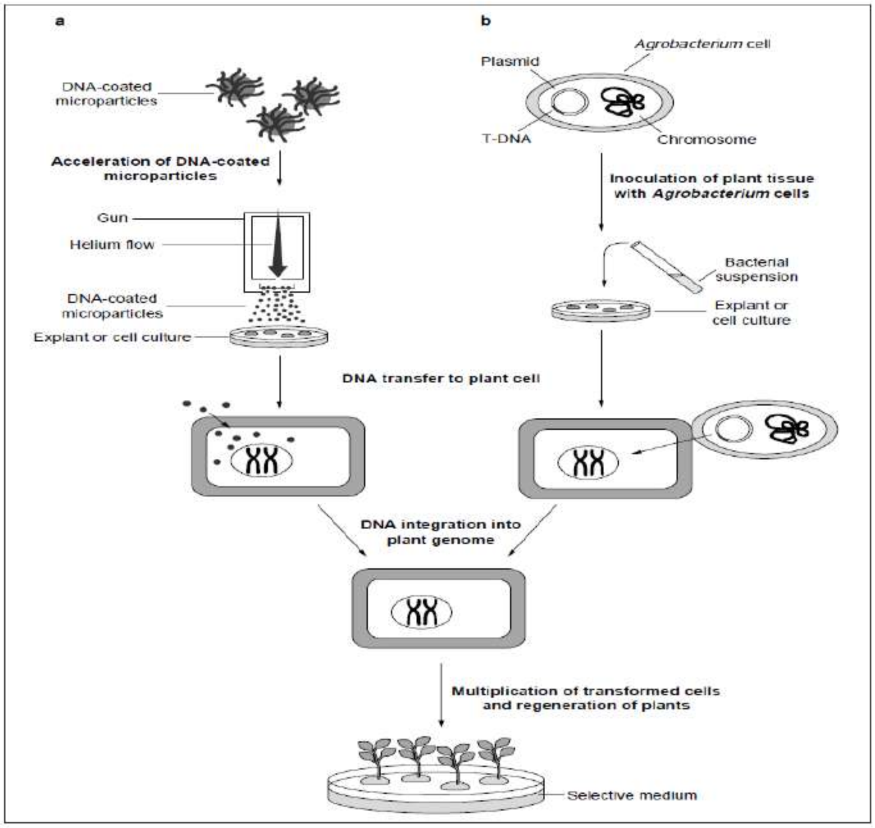
*Corresponding Author Email ID: deivamani.m@tnau.ac.in

Introduction

Bacterial diseases are of great economic significance for many crop plants, with the highest losses occurring in cereals, vegetables and fruits. In most cases, applications of protective agrochemicals, when feasible, are not sufficient to control bacterial diseases. Now days, many different genetic strategies have been proposed to engineer plant resistance to bacterial diseases, including producing antibacterial proteins of non-plant origin, inhibiting bacterial pathogenicity or virulence factors, enhancing natural plant defenses and artificially inducing programmed cell death at the site of infection.

Plant transformation techniques

Gene insertion in plants can be achieved by direct gene transfer through particle bombardment or through biological vectors like a disarmed tumor inducing (Ti)-plasmid of *Agrobacterium tumefaciens*. Particle bombardment uses accelerated metal (gold or tungsten) micro-projectiles coated with DNA to penetrate and deliver foreign genes into plant cells, which are then selected and regenerated into plants. On the other hand, *Agrobacterium*



tumefaciens, a soil bacterium, transforms its hosts by integrating a segment (called T-DNA) of its tumor-inducing plasmid into the nuclear genome. The transfer of this T-DNA is regulated by a complex process with the involvement of numerous bacterial genes (majorities are called virulence genes) that are located outside the T-DNA. This interesting feature allows for the use of T-DNA as a vehicle to introduce virtually any gene into plant cells. Whichever technique is used, the precise transformation conditions for a specific cell type require optimization for each species, and possibly even, each cultivar.

Agrobacterium-mediated transformation offers several advantages over direct gene transfer methodologies (particle bombardment, electroporation, etc.), such as the possibility to transfer only one or a few copies of DNA fragments carrying the genes of interest at higher efficiencies with lower cost and the transfer of very large DNA fragments with minimal rearrangement (Shibata and Liu, 2000). Transformation of plants by *Agrobacterium* mediated DNA transfer is currently the most commonly used phenomenon in accomplishing plant gene transfer.

Strategies for developing bacterial disease resistant plants

- One approach to control bacterial disease is to improve a plants defense against a particular pathogen.
- This has been made possible by genetic engineering by using genes found in fungi, insects, animals and other plants.

- Antimicrobial proteins, peptides, and lysozymes that naturally occur in insects, plants, animals, and humans are now a potential source of plant resistance.

Expression of antimicrobial proteins: Antimicrobial peptides (AMPs) with -helical structures are ubiquitous and found in many organisms. AMPs have been isolated from frogs, insects, and mammalian phagocytic vacuoles. AMPs are selective for prokaryotic membranes over eukaryotic membrane due to the predominantly negatively charged phospholipids in the outer leaflet of the prokaryotic membrane. Such preference is considered a regulatory function in target selectivity.

Magainins: Magainin is a defense peptide secreted from the skin of the African clawed frog (*Xenopus laevis*), first discovered by Zasloff (1987). Magainins and their analogs have been studied as a broad-spectrum topical agent, a systemic antibiotic, a wound-healing stimulant, and an anticancer agent (Jacob and Zasloff, 1994). However, only magainin analogs (MSI-99 and Myp30) have recently been transferred into plants for used against bacteria.

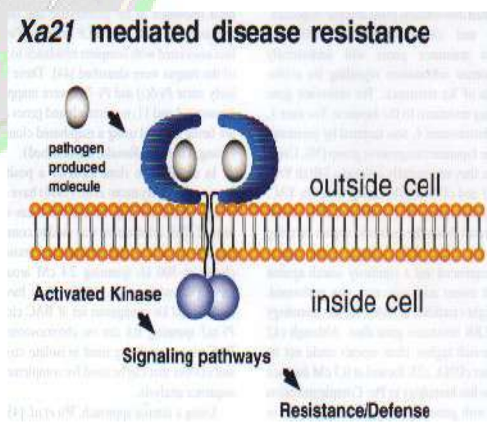
Cecropins: Cecropins are antibacterial lytic peptides native to the hemolymph of *Hyalophora cecropia*, the giant silk moth. These peptides interact with the outer phospholopid membranes of both Gram-negative and Gram-positive bacteria and modify them by forming a large number of transient ion channels. Native (Cecropin B), mutant (SB37, MB39) and synthetic (Shiva-1, D4E1) cecropins are active *in vitro* against a wide range of plant pathogenic bacteria including *Erwinia carotovora*, *E. amylovora*, *Pseudomonas syringae*, *Ralstonia solanacearum* and *Xanthomonas campestris* whereas they exert no toxicity at bactericidal concentration to cultured cells or protoplasts of several plant species.

Attacins: Attacins are another group of antibacterial proteins produced by *Hyalophora cecropia* pupae (Hultmark et al., 1983). The mechanisms of antibacterial activity of this protein is to inhibit the synthesis of the outer membrane protein in gram negative bacteria. Attacin expressed in transgenic potato enhanced its resistance to bacterial infection by *Erwinia carotovora* subsp. *atrospetica*. Transgenic pear and apple expressing attacin genes have significantly enhanced resistance to *Erwinia. amylovora* in *in vitro* and greenhouse. In field tests, reduction of fire blight disease has been observed in transgenic apples expressing attacin genes.

Lysozymes: Lysozymes are a ubiquitous family of enzymes that occur in many tissues and secretions of humans, animals, as well as in plants, bacteria and phage. The lysozyme attacks the murein layer of bacterial peptidoglycan resulting in cell wall weakening and eventually leading to lysis of both gram negative and gram-positive bacteria. T4L, from the T4-bacteriophage, also has been reported to enhance resistance of transgenic potato against *E. carotovora*, which causes bacterial soft rot. Transgenic apple plants with the T4L gene showed significant resistance to fire blight infection. There is evidence of efficacy of bovine lysozyme isozyme c2 (BVLZ) transgene against a variety of *Xanthomonas campestris* strains in both monocotyledon and dicotyledon crops including tomato, tobacco, rice and potato.

Thionins: Thionins are plant antimicrobial proteins which are able to inhibit a broad range of pathogenic bacteria *in vitro*. The expression of alpha-thionin gene from barley in transgenic tobacco confers enhanced resistance to two pathovars of *P.syringae*. Unfortunately, most thionins can be toxic to animal and plant cells and thus may not be ideal for developing transgenic plants (Reimann-Philipp et al., 1989).

Plant resistance (R) genes: Pathosystem-specific plant resistance (*R) genes* have been cloned from several plant species. These include *R* genes that mediate resistance to bacterial, fungal, viral, and nematode pathogens. Many of these *R* gene products share structural motifs, which indicate that disease resistance to diverse pathogens may operate through similar pathways. Transgenic tomato plants expressing the pepper *Bs2* gene suppress the growth of *Xanthomonas campestris* pv. *vesicatoria.* The *Bs2* gene is a member of the nucleotide binding site leucine-rich repeat (NBS-LRR) class of R genes. The *Pto* gene is another class of R genes, encoding a serine/threonine protein kinase that confers resistance in tomato to *Pseudomonas syringae* pv *tomato* strains that express the type III effector protein *AvrPto. Pto*-over expressing plants show resistance not only to *P. syringae* pv *tomato* but also to *X. campestris* pv *vesicatoria* and to the fungal pathogen *Cladosporium fulvum* (Mysore *et al.*, 2003). Therefore, *Pto* genes are considered as potential candidates to protect plants against pathogens.

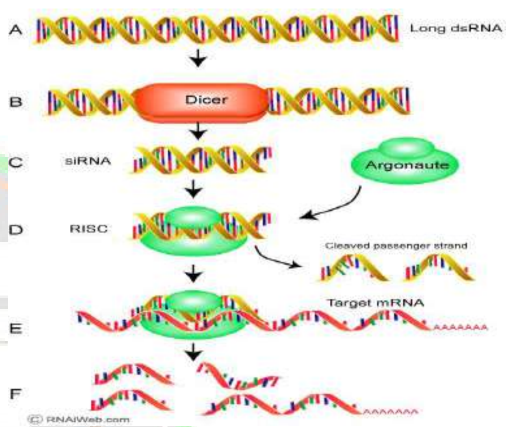


Bacterial blight disease and the Xa21 disease resistance gene

The *Xa1* gene in rice confers resistance to Japanese race 1 of *X. oryzae* pv. *oryzae*, the causal pathogen of bacterial blight *Xa1* is a member of the NBS-LRR class of plant disease resistance genes. The sequence of the predicted protein carries both a leucine-rich repeat motif and a serinethreonine kinase-like domain. Proposed model for the action of the *Xa21* resistance gene product. Upon ligand binding (possibly a pathogen produced peptide) to the LRR (putative receptor domain), a signal is transduced across the transmembrane domain activating the intracellular kinase domain. Upon activation, a phosphorylation cascade transduces the signal to 'defense' molecules which restrict pathogen growth (Figure).

RNAi in Plant Disease Management

- RNAi technology has emerged as one of the most potential and promising strategies for enhancing the building of resistance in plants to combat various fungal, bacterial, viral and nematode diseases causing huge losses in important agricultural crops.
- The nature of this biological phenomenon has been evaluated in a number of host-pathogen systems and effectively used to silence the action of pathogen.



Mechanism of RNAi

A. exogenously introduced long dsRNA acts as a trigger of the RNAi process.

B. RNase III enzyme Dicer in an ATP-dependent reaction.

C. Dicer processes long dsRNA into 21-23 nt siRNA with 2-nt 3' overhangs. siRNA can also be synthesized outside a cell - introduced into a cell through the process of transfection or electroporation.

D. The siRNA are incorporated into the RISC RNAi effector complex which consists of an Argonaute (Ago) protein as one of its main components. The passenger (sense) strand of the siRNA duplex leading to an active RISC.

E and F. The remaining (antisense) strand of the siRNA duplex serves as the guide strand and guides the RISC to its homologous mRNA, resulting in the endonucleolytic cleavage of the target mRNA.

Management of Plant Pathogenic Bacteria

- They developed a crown gall disease management strategy that targets the process of tumourogensis (gall formation) by initiating RNAi of the *iaaM and ipt oncogenes.*

Expression of these genes is a prerequisite for wild type tumor formation. Transgenic *Arabidopsis thaliana* and *Lycopersicon esculentum* transformed with RNAi constructs, targeting *iaaM* and *ipt* gene(s) showed resistance to crown gall disease.

- The natsiRNA (nat-siRNAATGB2) was strongly induced in *Arabidopsis* upon infection by *Pseudomonas syringae pv tomato* and down-regulates a *PPRL gene* that encodes a negative regulator of the RPS2 disease resistance pathway. The induction of *nat-siRNAATGB2* increases the RPS2-mediated race-specific resistance against *P. syringae pv tomato* in *Arabidopsis*

Successful improvement of resistance to bacterial diseases through genetic engineering

Protein	Origin	Transgenic species	Resistance to	Level of resistance
Production of antibacterial proteins of non-plant origin				
Shiva-1	Giant silk moth	Tobacco	*Ralstonia solanacearum*	Partial
MB39	Giant silk moth	Tobacco	*Pseudomonas syringae pv. tabaci*	Partial
Attacin E	Giant silk moth	Apple	*Erwinia amylovora*	Partial
Lysozyme	T4 bacteriophage	Potato	*Erwinia amylovora*	Partial
Lysozyme	Human	Tobacco	*Pseudomonas syringae pv. tabaci*	Partial
Lactoferrin	Human	Tobacco	*Ralstonia solanacearum*	Partial
Tachyplesin	Horseshoe crab	Potato	*Erwinia carotovora*	Partial
Shiva-1	Giant silk moth	Tobacco	*Ralstonia solanacearum*	Partial
Inhibition of bacterial pathogenicity or virulence factors				
Tabtoxin-resistance protein	P.syringae pv. tabaci	Tobacco	P.syringae	Total
Phaseolotoxin-insensitive OCTase[a]	*P.syringae pv. phaseolicola*	Bean	*P. s. pv. phaseolicola*	Total
Enhancement of natural plant defenses				
Pectate lyase	*E.carotovora*	Potato	*E. carotovora*	Partial

Resistance protein *Xa21*	Resistant rice cultivars	Rice	*Xanthomonas oryzae pv. oryzae*	Total
Glucose oxidase	*A.niger*	Potato	*E. carotovora*	Partial
Thionin	Barley	Tobacco	*P. syringae* pv. *tabaci*	Partial
Artificially induced programmed cell death at the site of infection				
Bacterio-opsin	Halobacterium halobium	Tobacco	*P. syringae* pv. *tabaci*	Total

Present limits to commercial applications of bioengineering for plant resistance to bacterial diseases

This review shows that there are a wide range of approaches to creating bacterial resistance in plants through genetic engineering, but that this is currently limited to few plant–bacterial models. Extending these studies to other plant–bacterial interactions, and achieving this on a commercial scale, will require the fulfilment of several criteria, such as efficacy, durability, absence of toxicity and low environmental impact. Antibacterial strategies are difficult to evaluate for efficacy prior to plant transformation. In addition to transgene integration, efficacy depends upon the expression level, which can, in some cases, be affected by homology-dependent gene silencing. This is a serious threat for strategies using homologous sequences (e.g. *R* genes, thionins, phytoalexins). Plant engineering also raises the questions of potential toxicity or allergenic risks to humans and animals when transgenic plants are consumed, and of their environmental impact. However, the consequences on the evolution of the pathogen (appearance of new races) and the spread of the disease have not yet been evaluated in the case of engineered resistance to bacterial diseases.

Volume: 03 Issue No: 11

DIRECT SEEDED RICE - SUSTAINABLE APPROACH TO RICE CULTIVATION

Article ID: AG-VO3-I11-42

***D. Sravanthi[1], B. Deepak Reddy[1], P. Laxman Rao[2], G. Amuktamalyada[1], M.M. Kadasiddappa[3], R. Shiva Kumar[4] , Pavani, T [1]and J. Hemantha Kumar[1]**

[1]Agricultural College, Aswaraopet,

[2]College of Agricultural Engineering, Kandi, Sangareddy,

[3]Agricultural College, Palem,

Professor Jayashankar Telangana State Agricultural University (PJTSAU), Telangana

[4] School of Agricultural Sciences and Technology (SAST), Shirpur, NMIMS, Mumbai

*Corresponding Author Email ID: danamsravanthi@gmail.com

Introduction

Rice is one of the most important food crops in the world, and staple for more than half of the global population. 40% of the world's irrigation water is used for rice production in cultivation of traditional transplanting of rice (TPR), but as urbanization and climate change make water scarcer, as well as labour shortages and shrinking arable land, new ideas and innovations in rice cultivation are urgently needed to meet growing demand and ensure food security. Direct seeded rice (DSR) is one potential alternative management strategy to these problems (Farooq et al, 2007). Instead of the conventional way of raising seedlings in a nursery before transplanting them into flooded fields, direct seeding is a crop establishment approach in which rice seeds are placed straight into the field.

Direct seeding of rice refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. There are three principal methods of direct seeding of rice in DSR, pre-germinated seeds can be sown in a puddled soil (wet seeding) or prepared seedbed (dry seeding) through broadcasting (scattering seeds) or through drum seeders. Dry seeding has been the principal method of rice establishment since the

1950s in developing countries (Pandey and Velasco, 2005). In TPR method seedlings from a nursery planted in puddled fields and it is labour and water intensive.

	
1. Drect seeded rice	**2. Traditional transplantation of rice**
	
3. Broadcasting of rice	**4. Drum seeder technique**

Why DSR needed?

- ✓ Increasing water scarcity
- ✓ Increasing demand and competition of water from non- agricultural sector
- ✓ The rising cost ans scarcity of labour at peak periods
- ✓ Increasing labour wages
- ✓ Adverse effect of puddling
- ✓ Rising interest in conservation agriculture
- ✓ Best fit in cropping systems
- ✓ Crop intensification
- ✓ Development in DSR techniques

In DSR a farmer can save Rs.8000 to Rs.10000 per acre and seeds required will be 8 to 12 kg while in case of TPR method needs 25 to 30 kg seeds (Hemanth Kumar, 2023). The method of transplanting and establishment is one of the important agronomic practices, which influences the cropgrowth and development (Gopi et al. 2006). It also helps the crop to maintain proper spacing, optimum population and supports in vigorous growth put forth more production. A specially labour drudgery in different operations (Sravanthi et al., 2022) One of the most significant hurdles is weed control. In flooded paddy fields, water serves as a natural barrier to weed growth. However, in DSR systems, weeds can grow side by side with rice, reducing yield. Thus, effective weed management strategies are critical for the successful application of DSR.

Advantages of direct seeding

- No significant reduction of yield under optimal conditions
- Savings on irrigation water by 12-35% under efficient water management practices
- Reduces labor and drudgery by eliminating seedling uprooting and transplanting
- Reduces cultivation time, energy, and cost
- No plant stress from transplanting
- Faster maturation of crops
- Lower GHG emissions
- Mechanized DSR provides employment opportunities for youth through service provision business model
- Increases total income by reducing cost of cultivation

Comparative yields in DSR can be obtained various cultural practices *viz.*,

- Selection of suitable cultivars
- Improved short duration
- High yielding varieties
- Proper sowing time
- Optimum seed rate
- Proper water management
- Nutrient and water management techniques to encouraged the farmer to shift from TPR to DSR culture.

Compared to transplanted crops, direct seeded crops take less effort and grow more quickly. With this technique, plants are not stressed out by having their roots plucked out of the ground and regrown as tiny rootlets. However, they have more competition from weeds. Direct seeding can be carried out in one of two ways depending on the technique chosen for land preparation.

A) **Dry Direct Seeding:** This method is usually practiced for rainfed and deep water ecosystems. Farmers then dry soil surface, then incorporates the seed either by ploughing or harrowing.

B) **Wet Direct Seeding:** Direct seeding in wet fields can be accomplished by either distributing pre-germinated seeds or using a drum seeder to drill seeds into the puddled soil.

All the field operations are carried out in dry field for dry rice cultivation, whereas, wet rice cultivation practiced in puddled field situations it is the usual practice to sow ungerminated seeds in dry soil and sprouted seeds in puddled soil.

In dry direct seeding there are 3 methods, which are generally used

Broadcasting

1) Broadcasting of 60-80 kg of seeds uniformly by hand or in furrows
2) Make shallow furrows along the prepared field
3) After broadcasting cover the seeds with harrow.

Drilling

1) Drilling seeds may be done using precise machinery like the **Turbo Happy Seeder**.
2) Drill the seed of 80–100 kg per hectare
3) The machine scatters seeds over both dry and wet soil before irrigating them. To make sure that seeds are not sown at depths larger than 10 to 15 mm, a smooth, flat seedbed is required.
4) This method allows for the simultaneous application of seeds and fertilisers.
5) With contrast to broadcasting, manual weeding is also simpler with machine-drilled crops.

Dibbling

Dibbling or hill planting is typically done on mountain slopes or in areas where harrowing and ploughing are challenging. To dig holes, use a long pole made of wood, bamboo, or with a metal scoop fastened to the end. Fill the holes with dirt after placing the seeds there. On mountain slopes or in difficult-to-plough terrain, dibbling or hill planting is frequently done. After planting the seeds there, fill the holes with soil.

How to use herbicides to effectively control weeds

The kind of weeds will determine which herbicide to use. All weeds in the rice crop cannot be controlled by a single herbicide. Apply a pre-emergence herbicide at 1-3 DAS and post-emergence at 15 and 25 DAS for effective weed control..

How to do stale seedbed technique

If the field has a significant weed seed bank, this strategy works well. Due to the two-month fallow time between harvest and sowing, which let weeds to sprout before they are destroyed, they may be controlled either with herbicides or by intercultivation operations. It can significantly reduce the weeds in DSR.

Manual and mechanical weeding

Weeds are practically impossible to control by **manual weeding by hand**. However, one or two hand weeding can be done to remove weeds that escape herbicide application, prevent weed seed production and the accumulation of weed seeds in the soil. Motorised cono weeders and other hand weeders can be used for mechanical weeding.

Current constraints

- Higher seed rates
- Seeds exposed to birds and pests
- Weed management
- Higher risk of lodging
- Risk of poor or non-uniform crop establishment

Conclusion

On the face of global water scarcity and escalating labour rates, when the future of rice production is under threat, DSR offers an attractive alternative. A successful transition of rice cultivation from transplanting system TPR to DSR culture demands breeding of special rice varieties and developing appropriate management strategies. If the extent and nature of weeds properly managed, comparable yield may be obtained from DSR compared with TPR. Another concern is the need for precision in seed placement. Unlike transplanting, where seedlings are carefully placed in fields, direct seeding requires accurate equipment to ensure optimal plant density and uniform growth. Technological advancements, such as laser-assisted land leveling and drill seeders, are paving the way for overcoming these challenges, making DSR an increasingly feasible option for farmers.

Because of the water, labor, and energy intensive nature of this system, and rising interest in conservation agriculture, dry-seeded rice (Dry-DSR) with zero tillage (ZT) or reduced tillage (RT) has emerged as a viable recent development in DSR. Projections and trends seem to suggest that Dry-DSR will likely be a major rice culture in many countries in the future.

References

D. Sravanthi, A.V. Ramanjaneyulu, P. Raghu Rami Reddy and P. Jagan Mohan Rao. 2022. Mechanized transplanting and harvesting in rice: An on-farm study. The Pharma Innovations Journal. 11(12): 3815-3820.

M. Farooq, S.M.A. Basra and N. Ahmad. 2007. Improving the performance of transplanted rice by seed priming. Plant Growth Regulators. 51, 129–137.

R. Gopi, S.Ramesh, B.J. Pandian, B. Chandrasekaran and T. Sampathkumar. Evaluation of Crop establishments and Split application of N and K on Growth, Yield attributes, Yield and Economics of Hybrid Rice Co RH2. Asian Journal of Plant Science. 2006;5(6):1022-1026.

J. Hemanth Kumar., 2023. https://telanganatoday.com/dsr-cultivation-gaining-traction-in-khammam

S. Pandey and L.Velasco. 2005. Trends in crop establishment methods in Asia and research issues. In “Rice Is Life: Scientific Perspectives for the 21st Century” (K. Toriyama, K. L. Heong, and B. Hardy, Eds.), pp. 178–181. International Rice Research Institute, Los Ban˜os, Philippines and Japan International Research Center for Agricultural Sciences, Tsukuba, Japan.

Volume: 03 Issue No: 11

FIELD FUNGI AND STORAGE FUNGI – THEIR SIGNIFICANCE IN HORTICULTURAL PRODUCES

Article ID: AG-VO3-I11-43

M.Deivamani[1*], V.K.Satya[2], S.Malathi [3], M.A. Vennila[4] and S.Srividhya[5]

[1]Assistant Professor (Plant Pathology), Krishi Vigyan Kendra, TNAU, Dharmapuri

[2] Assistant Professor (Plant Pathology), Horticultural College and Research Institute for Women HC&RI (W), Tamil Nadu Agricultural University, Trichy

[3]Assistant Professor (Plant Pathology), Information and Training Centre, TNAU, Chennai

[4]Associate Professor (Agrl. Extension), Krishi Vigyan Kendra, TNAU, Dharmapuri

[5]Associate Professor (Horticulture), Horticultural College & Research Institute, Tamil Nadu Agricultural University, Jeenur

*Corresponding Author Email ID: deivamani.m@tnau.ac.in

Introduction

Worldwide post harvest fruit and vegetables losses are as high as 30 – 40% and even much higher in some developing countries. The post harvest diseases affect a wide variety of crops particularly in developing countries which lack sophisticated post harvest storage facilities. The infection by fungi and bacteria may occur during the growing season, at harvest time, during handling, storage, transport and marketing, or even after purchase by the consumer. There are two groups of fungi differing in one or more physiological characteristics: they are field and storage fungi.

Field fungi: The fungi attacked the plants in the field condition and then it will develop further during storage.

Storage fungi: The fungi attack in the storage condition and disease development.

Significance:

Diseases are often the most important constraint to the production of fruit and vegetables. They indirectly reduce yields by debilitating the plant, and directly reduce the yield or quality of fruit before and after they are harvested. They range from esthetic problems that lower the marketability of the harvested product to lethal problems that devastate local or regional production. Virtually every important fruit and vegetables is affected by one or more serious diseases. Diseases determine how and where a crop is produced, what post-harvest treatments are utilized, in what markets the crops are sold, and whether production is sustainable and profitable. Post harvest pathogens employ mechanical energy and chemical substances (enzymes and toxins) to cause diseases in perishables. Mechanical energy and enzymes are required to penetrate, to form appressorium and to colonize while enzymes and toxins are required to degrade host tissues and consume the substances degraded from the host.

Yield loss: Direct yield loss due to disease. In case of mango, powdery mildew cause flower dropping, it leads to yield reduction.

Disease development: Some of the field fungi express the symptoms during storage condition. Eg: Onion neck rot and Mango anthracnose

Weight loss: Some of the fruits and vegetables can occur shriveling and mummified symptoms to develop due to pathogen expression. Eg: Grapes downey mildew.

Lower market value: Field fungi are causing some spots like canker symptoms on fruit and vegetables. So, consumer does not prepare to buy those products. It leads to low market value.

Enzymes:

Postharvest rots, by nature, suggest maceration due to loss of tissue coherence and separation through pectolytic activity. The postharvest pathogens produce endopolygalacturonases (endo - PGs) endopectin lyases and endopectate lyases. The endo – PGs randomly hydrolyse the α-1, 4 galacturonide linkages of pectic acid producing a series of oligogalacturonides. the endo-PGs are commonly produced by the pathogenic and non-pathogenic fungi and bacteria. Production of endo-PG by several post harvest pathogens belonging to *Penicillium*, *Rhizopus*, *Geotrichum*, *Sclerotinia*, *Erwinia* has been correlated with tissue maceration. Similarly, maceration of citrus peel by *Geotrichum*, of sweet potato by *Rhizopus*, and of persimon by Gloeosporium can be accounted entirely by extra cellular endo-PG activity. The endo pectic acid transeliminase acting on pectic acid and oligogalacturonides are the major enzymes involved in bacterial soft rot of potatoes but involvement of endo-PG may not be ruled. Leakage of electrolytes due to enhanced permeability has been noticed in red chilli infected with *Colletotrichum gloeosporiodes. S*uch as increased permeability is perhaps due to the action of endo-PG obtained from the infected fruits.

Changes in carbohydrates:

The fruits are rich in simple sugars while most perishables are also rich in carbohydrates. Maturity and ripening the amount of carbohydrates and subsequently soluble carbohydrates including sugar rise. During pathogenesis usually there is an increase in the loss of complex carbohydrates and initial increase in simple sugars followed by decrease too. Sugars such as glucose and fructose also decrease but perhaps never as much as in pine apples infected by *Botryodiplodia theobromae*. In case of *Alternaria alternata* (apple) – during the pathogen infection it changes in sucrose, glucose and fructose content in fruits. And also decrease sugar content *Botrytis cinerea* in grape. *C. gloeosporioides* in mango reduced in glucose, fructose, sucrose, monosaccharides, oligosaccharides content.

Changes in proteins and aminoacids:

The amount of both, free and protein bound fractions increase during pathogenesis on per cent dry weight basis. This may be due to the proteolysis of the host which may be more than compensated by consumption by the pathogen in the initial phase and metabolisation by the invading fungal mycelium on the host. The consumption and metabolisation by the fungi, in their turn, are surpassed by the proteolysis by the host at late stages. There are evidence to show reduction or disappearance of some amino acids, glutamic acid in particular and appearance of new amino acids like valine in infected tissues. Eg. *Ceratocystis fimbriata, Rhizopus stolonifer and Mucor piriformis, Alternaria citri, A.solani, A.flavus, Colletotrichum* spp.

Reduction in ascorbic content:

Fruits particularly the tropical ones are important sources of vitamin C (ascorbic acid). Ascorbic acid content normally diminishes during storage, which is enhanced by perhaps an injury or infection. Even partially infected fruits are rendered worthless as a source of vitamin C. fungi differ in the rate and reduction of ascorbic acid. Eg. *A.alternata* (Banana), *A.flavus* (guava, pear), *C.falcatum* (mango), *Botryodiplodia theobromae* (guava), *Ceratocystis parodoxa* (pine apple).

Reduction in alkaloid content:

The reduction in content of capsaicin responsible for the pungency or flavour in chillies due to *C. piperatum.*

Changes in total soluble solids:

The change of total soluble solids (TSS) are very meagre in post harvest pathology. Decrease in TSS has been noted in lemon, Balady orange and sweet orange. Eg. *C. gloeosporioides, Alternaria citri* and *Botrydiplodia theobromae.* In mandarin orange infected by *A. citri* TSS is reduced by about 50 per cent.

Changes in miscellaneous substances:

Reduction of oil content but enhanced level of fatty acid in coconut infected with fungi. Lipid content of sweet potato is reduced due to infection of *Botrydiplodia theobromae.* Fresh produce would loss moisture due to transpiration but respiration helps to retain the same but at the cost of weight loss. The reduction is moisture and crude fibre coconut due to infection with fungi.

Changes in ripening process:

Ethylene production: Ethylene, a natural hormone produced by some fruits as they ripen, promotes additional ripening of produce exposed to it. The old adage that one bad apple spoiled the whole bushel is true. Damaged or diseased apples produce high levels of ethylene and stimulate the other apples to ripen too quickly. As the fruits ripen, they become more susceptible to diseases. The loss of quality had reduced shelf life, and specific symptoms of injury. Ethylene evolution due to infection is noticed in mandarin orange infected with *Botrydiplodia theobromae.* In avocado – *Fusarium solani* infected fruits are an increase in rate of respiration and ethylene evolution. And also softening due to disease infection. Eg. *Penicillium digitatum, C.gloeosporioides*

Mycotoxins:

The salvage of edible flesh portions from partly decayed or damaged fruit for processing introduces another risk, mycotoxin contamination. The Mycotoxin production by some genera of fungi that also cause fruit rots has been documented (e.g. *Penicillium. Alternaria, Aspergillus. Fusarium. Phomopsis),* and the toxins have been associated with processed fruit products such as apple juice. Patulin, a mycotoxin and carcinogenic lactone, affecting the equilibrium among the blood constitutes, is produced by *Penicillium* and *Aspergillus* spp. In the apples rotted by *penicillium expansum*. Fifteen of 75 isolates of *A.flavus* from fruits and vegetables have been to produce aflatoxin. A level of 0.08 to 2.2 ppm of aflatoxin has been recorded in different fruits infected with *A. flavus* and *A.parasiticus.*

Storage fungi:

- *Aspergillus* - Aflatoxin - Centrilobular necrosis and proliferation of bile ducts and fibrosis in liver. Impairment of blood clotting system, hemorrhage, weakening of gastric motor function (birds and animals)
- *Aspergillus nidulans* – Sterigmatocystin - Necrosis and peritonitis (rats).
- *Penicillium islandicum* – Luteoskyrin - Centrilobular necrosis and cirrhosis of liver in many experimental animals.

Field fungi:

- *Rhizopus stolonifer* – toxin unnamed, Glomerulonephrosis. Fatty infiltration of liver (humans).
- *Alternaria tenuis* - Alternarin, tenuazonic acid- Haemorrhage, multiple lesions (birds).
- *Fuarium moniliforme*- T2 toxin (diacetoscirpenol)

Physiological changes:

- That many fungi remain quiescent or latent on the fruits being carried from the field but develop rotting much later storage condition this may be due to
- i). Nutritional requirements of the parasites are not met by the composition of the green fruit,
- ii). Enzyme potential necessary for invading the green fruit is greater than for the ripe and ones and is temporarily beyond the capability of the fungus.
- iii). Some toxins are present in the green fruit which disappears or is inactivated in the ripe ones, and
- iv). The energy requirements of the fungus can only be met when the metabolism of the host has passed from the green to the ripening phase.
- Eg: *Phomopsis viticola and Collectotrichum gloeosporiodes.*

Mechanical injury:

- Mechanical damage is the major cause of postharvest losses and among the perishable crops tomato is susceptible to mechanical injury considrably.
- Excessive impact occurs during harvesting, grading, handling and transportation
- Tomato - 40% of the crop sustained mechanical damage.
- The bruise susceptibility of fruits and vegetables depend on many factors such as severity of loading, variety, texture, maturity, temperature, size, shape, etc.,

Marketing:

- A serious reduction in quality can occur in produce displayed for lengthy periods in retail outlets because of poor marketing organization.
- Major causes of quality reduction during marketing include water loss leading to wilting, undesirable ripening (e.g. soft rot of apples) and senescence (e.g. yellowing of leafy vegetables) under condition of poor temperature and RH management; mechanical damage associated with rough handling by staff and customers; associated disease development.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

DEVELOPMENT OF COCONUT DEHUSKER

Article ID: AG-VO3-I11-44

D. Ravindra Babu[1*], K. Durga Bhavani[2], A. Vishnu Prasad[3], D. Mohana Priya[4], D. Swaroop Sanjay[5], G Vijaya Kumar[6], G Lalitha Devi[7] and K.V.S Naga Madhavi[8]

[1*]Assistant Professor,[2,3,4,5,6,7 and 8] Students, Department of Agricultural Engineering, Pydah College of Engineering, Patavala, Kakinada, Andhra Pradesh.-533461

Corresponding Author Email ID:* dravindrababu@pydah.edu.in

Introduction

Coconut palm (*Cocos Nucifera*) is one of the major cash crops belonging to the tropical and sub-tropical areas (Nair, 2010). Coconut palm is a versatile plant popularly known as "kalpavriksha" tree of life, tree of heaven because it gives people diversified products from basic needs to luxury. Coconut palm belongs to *Aracacea* family and the only accepted species in the genus cocos. Based on the usage of the coconuts, they are harvested into two stages, immature and mature stage. In the immature stage, coconuts are harvested for coconut water and coconut kernel and in mature stage, coconuts are harvested for copra for oil production and used in coir industry (Gunn *et al.*, 2011).

India is the third largest producer of coconut in the world next to Indonesia and Philippines having area of about 2.09 million hectares with annual production of 23904 million nuts. It consists of a hard shell covering the edible portion. A fibrous outer layer known as the husk, covers the shell. Hence the coconut has to be dehusked before it can be used for any purpose. Different products obtained from husk. The size of coconut with husk is 145 to 200 mm in diameter and it can be 200 to 300 mm long (Sabale, 2016; Piyathissa and Kahandage, 2015).

Dehusking is a process of the removal of husk which occupies 35% of the total weight of the nut. The traditional method of dehusking is done by using traditional tools such as

"Parang", hoe, blade, or spear. The manual dehusking process requires an operator to use his or her strength and skill to pierce the coconut sharply and twist the coconut to one side, loosen the husk and detach the fiber from the shell. The manual dehusking process is time consuming and it also involves the risk of the labour injury. Labour fatigue also contributes to the low productivity (Alonge, 2010).

The dehusking machines available in the market are costly and that restricts the adoption of the technique among small scale farmer. Hence the machine should be made available at an affordable price to increase their usage (Kumar *et al.*, (2017); Roopashree, (2017). The present work involves designing, fabrication and analyzing a coconut de-husking machine available at low cost. This process is much faster than the manual process also easy to handle. The spiked rollers are installed parallel to each other on a platform and rotate in opposite direction to remove husk.

Machine description

This coconut dehusking machine peels off the coconut husk from coconut fruit to obtain dehusked coconut fruit via mechanical controlled dehusking devices. The coconut is placed on the rollers, these rollers are connected to each other using spur gears and are free to rotate in bearings and these rollers are connected by a pulley and coupled by chain to worm gear box which is connected to the motor.

Benefits

This machine is useful to the coconut estates and co-operatives, coconut growers and coconut processing factory. The machine can provide faster work rate and less human interaction. This machine is expected to increase the coconut production, hence an additional income to coconut growers. It is useful to the coconut growers by many ways. It does not require direct human force as in normal methods because in this hydraulic pump and cylinder is used to enhance the force at the head of the coconut to put pressure on poker assembly. Also the coconut of any size and shape can be dehusked easily. It is easy to operate, does not need skilled labour, rapid, safe operation and simple maintenance. It can be easily assembled and disassembled and it can be carried from one place to another.

The cost of this machine is lesser as compared to the present available machines. Also these available machines require external electrical power supply and the worker should be skilled with the machine. Also these machines are not safe because they work with a very high speed and a large tools and equipment.

Motor capacities used by different researchers

Kumar *et al.*, (1998) designed and fabricated coconut dehusking machine. The motor used in the machine of a single phase, 1hp, AC geared motor with 70 rpm. The motor shaft is coupled to the roller by chain and sprocket mechanism which drives the system.

Wadile and Kohle, (2015) designed and develop coconut dehusking machine with 3 phase (740 W) induction motor to drive the mechanism. The drive from the motor is transmitted to the gearbox for speed reduction. The speed of rotation of the output shaft of the motor is 1440 rpm. Kwangwaropas (1992) evaluated the performance of hydraulically operated coconut dehusking machine consisted of a 1.5 kW (220V) electric motor to drive hydraulic pump. Two person could operate this machine and average dehusking time was 10-12 seconds/coconut.

Relation between motor used for husk yield

Sharma and Aggarwal (2006) given that Performance test analysis conducted shows that the machine dehusk coconut fruits without nut breakage and distortion of the extracted fiber length and also that its average dehusking efficiency and capacity are 93.45% and 79 coconuts per hour husk yield.

Products developed from husk

Coir or coconut fiber, is a natural fiber extracted from the husk of coconut and used in products such as floor mats, doormats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets. It has the advantage of not sinking, so it can be used in long ropes in deep.

Forces required for de-husking process

Dinanath (1987), Conducted a research on force analysis for dehusking. Manually applied load and self-weight of the coconut will be acting at the point of contact on the two rollers. Shearing force will act between the husk and the coconut. The resultant of these two forces will act on the rotating roller while dehusking.

Different dehusking machineries with capacities, weight and operation

Pandiselvam *et al.*, (2018), conducted a research on engineering properties of five varieties of coconuts for efficient husk separation. Dehusking capacity of Large (50-55 cm), medium (45-50 cm) and small (40-45cm) weight of the randomly selected 30 green and dry coconuts samples were observed. The average weight of the green coconuts was observed as 1 kg and the average weight of the dry coconuts were observed as 0.71 kg. The average weight of 5 varieties of coconuts from the state of Kerala in which the Malayan Orange Dwarf and Chowghat Orange Dwarf varieties of green and dry coconuts found to have similar mean values. Coconut is directly placed by the operator in between the roller this may lead to harmful to the operator. So to overcome this problem one lever is provided on the top.

References

Sabale. R. M., and K. P. Kohle. (2016). Design and Development of a Coconut Dehusker for Small Scale Coir Industry and Marginal Farmers. *International Journal of Science, Engineering and Technology Research*, 5(2).

Dinanath C, and Chaguanas, Trinidad and Tobago. (1946). "Coconut dehusking machine", US patent no 4,708,056, November 24.

Wadile P. A., and Kolhe K. P. (2017). Design and Development of Coconut Dehusking Machine. *International Journal of Advance Engineering and Research Development*. Volume 4.

Piyathissa. S. D. S., and Kahandage. P. D. (2015). Introducing an appropriate mechanical way for Coconut dehusking. *Procedia Food Science*, 6, pg. 225 – 229.

Roopashree, C. R., (2017). Design and Development of Coconut Dehusking Machine, International Journal of Engineering Development and Research, volume 5

Kumar G. S., Shashidhar B., Asantapur., Vishwas, C., Prashanth Kumar, Dhanush D. (2017). Design and Fabrication of Coconut Dehusker. *Journal of Mechanical Engineering and Automation.*

Kwangwaropas, M. (1998). Research and development of a general purpose coconut dehusking machine. Research abstracts conducted by University's Lecturers in Thailand during 1995 –1997, Office of the Permanent Secretary, Bangkok (Thailand).Bureau of Higher Education Standards

Sharma, P. C., & Aggarwal, D. K. (2006). Machine Design. 3rd ed. Nai Sarak Dechi: S. K. Kataria & Sons, . p. 657.

Gunn, B. F., Baudouin, L., & Olse. (2011). Independent origins of cultivated coconut in the world tropics, PLoS ONE. 6(6): e21143

Alonge, A. F., (2010). Properties of coconut relevant to its dehusking. *In*: Adetunji W. D (Ed.). Proceeding of XVIIth world congress of the International Commission of Agricultural and Bio system engineering (CIGR) June: 13-17

Pandiselvam, R., Manikandan, M., Kothakota, A., Rajesh, G., Beegum, S., Ramesh, S., & Hebbar, K. J., 2018. Engineering properties of five varieties of coconuts for efficient husk seperation, *Journal of Natural Fiber*. 1-9.

Nair, K. P. 2010. The agronomy and economy of important tree crops of the developing world. Elsevier, *New Delhi*, **1:** 67-98.

Volume: 03 Issue No: 11

EBB & FLOW HYDROPONIC SYSTEM

Article ID: AG-V03-I11-45

***M.Kavitha, P.S.Swetha, N.A.Tamilselvi, C.Indu Rani and C.Thangamani**

Department of Vegetable Science, Horticultural College and Research Institute,

Tamil Nadu Agricultural University, Coimbatore

*Corresponding Author Email ID: kavitha.m@tnau.ac.in

Abstract

Ebb and flood hydroponic technologies have been nourishing for crops like tomato, bedding plants, potted plants, cut flowers *etc.*, in climate-controlled greenhouse environments for more than 40 years. These crop production systems have been done under controlled condition. Benefits of this production system included a simple method for evenly supplying water, dissolved oxygen, and plant nutrients to the crop's root zone without the need for a permanent plumbing connection, either for intake during a flood or for drainage during an ebb.The end result was efficient uptake of water, nutrients, and oxygen from the root zone's bottom, and with the root zone's bottom saturated, there was little need for flushing out nutrients and other dissolved substances. A recirculating hydroponic system that conserved water and nutrients and immediately benefited the environment by preventing discharge was created by collecting all unused irrigation water and returning it to storage for later use.

Key words: Ebb and flow, Hydroponics, Nutrients, Environment

Introduction

The Ebb and Flow system, also referred as Flood and Drain system, is a widely-recognized hydroponic system. The development of the ebb and flood hydroponic system began in 1981 as a potential solution which concerns about irrigation efficiency, crop transport, handling and hygiene in overhead irrigated container plant production. The integrated system provided several specific advantages, including eliminating manual watering, flexibility in design of internal transport of potted plants, heating the root zone with low temperature water, and reducing bacterial and fungal diseases because of cultivation surfaces that were easy to clean and disinfect between cultivation cycles (Benton-Jones, 2007). This system is relatively low expensive to install and requires a moderate level of expertise to maintain 'Ebb' indicates water that is leaving the roots, whereas 'flow' denotes water that is coming in. The word itself implies that there are two fundamental phases of activity. As they go back and forth, the two phases support plant growth.

Ebb and flow system

Ebb and flow system works on the basis of the flood-and-drain principle. In this technique, the growing medium is flooded with nutrient solution for a brief period of time after which the nutrient solution allows itself to drain out of the rooting medium and returned into the reservoir. Air is drawn into the rooted bed by the outflow of nutrient solution from the medium that supports growth, providing a source of oxygen. Plants are able to absorb water and nutrients from the properly moist rooting medium.The system relies on gravity to pump the water back into the tank for reuse.

Figure 1 : Structure of Ebb and flow system

Components and Working

In order to accomplish this, every ebb and flow system needs requires the basic components. plant tray, the reservoir, the subsurface pump, and the timer are the fundamental parts of Ebb & flow system.

Plant Tray

A plant tray, sometimes known as a flood tray is a large, shallow depth container on a raised stand . Perforated pots with a growing medium, such as Perlite, are used to hold the plants in the tray. The flood tray should be nearly twice as deep as the seedling pots you choose. Water that is rich in nutrients is drawn from the reservoir underneath into the flood tray. The water enters the plant roots at the bottom of the pots and rises. The water continues to drain out once more, allowing the roots to properly dry out and get enough oxygen before flooding happens once more.

The reservoir is positioned directly beneath the flood tray of the stand. The reservoir is connected directly to the flood tray using the fill tube and the drain tube. The fill tube connects to the flood tray by connecting it to one of the submersible pumps with a timer. The pump allows the water to be pumped up to the flood tray and then the drain tube pulls the water back down to the reservoir after the flood so that it can be reused. This action is normally done with a submerged pump that is connected to a timer. The timer is set to come on several times a day, depending on the size and type of plants, temperature, humidity, and the type of growing medium used.

Growth media

The proper growing medium must be selected, as it is very important for any type of Hydroponics. One must avoid selecting a medium that is relatively lighter in weight since the ebb and flow hydroponics method demands that plants to be submerged directly in the solution that provides nutrients. The containers may float and possibly topple over if a light-weight material, such as perlite, is used.It is best to use a heavier non-soil growing media, such as rockwool, coco coir or clay pebbles.

Choices of Plants to grow

The adjustable ebb and flow technique can produce outstanding results for many different kinds of plants..

Figure 2 : Ebb and flow system showing the growth of pots with red Amaranthus

Herbs, fruits, and vegetables all function flawlessly with the flood and drain system. Some of the greatest options for growing are as follows: strawberries, peppers, tomatoes, cucumbers, lettuce, Palak, Coriander, radish, mint,Amaranthus and oregano. Numerous more plants can be grown using the approach. The majority of plants prefer an intelligent water supply and root aeration

Advantages

- The cost of establishing the structure, procuring materials, and taking care of the fabric is comparatively low, resulting in substantial cost savings.
- Plants have a plenty of nutrients available to them.
- Flood and drain hydroponics are a bit cheaper and more complex than other varieties of hydroponics that necessitate specialised knowledge.
- It is very simple to use.
- There is little requirement for technical assistance when working with the system.

Disadvantages

- Instances of pH fluctuation.
- Excess nutrients create an unfavourable PH environment, causing farm products to degrade.
- Any small mistake during the establishment process has the ability to cause the system as a whole to fail and stop working.

Conclusion

A nutrient management technique called Ebb and Flow, also referred to as Flood and Drain, includes periodically flooding and draining fertiliser solutions. Its operation is split into the two stages listed below: The Flood happens when nutrients and water overflow into the growing area and spill over the plant roots. The ebb and flow mechanism makes sure that your plants are provided with ample amount of nutrients to use as long as they receive just the right amount of nutrients. The overflow tube prevents flooding of the containers. Your plants will therefore grow in a wholesome and supportive atmosphere.

References

Daud, M., Handika, V., & Bintoro, A. (2018). Design and realization of fuzzy logic control for Ebb and flow hydroponic system. *International Journal of Scientific and Technology Research*, *7*(9), 138-144.

Giacomelli, G. A., van Weel, P. A., & Blok, C. (2019, June). Ebb and flood nutrient delivery system for sustainable automated crop production. In *International Symposium on Advanced Technologies and Management for Innovative Greenhouses: GreenSys2019 1296* (pp. 1129-1136).

Halveland, J. (2020). Design of a Shallow-Aero Ebb and Flow Hydroponics System and Associated Educational Module for Tri Cycle Farms.

Baiyin, B., Tagawa, K., Yamada, M., Wang, X., Yamada, S., Shao, Y., ... & Ibaraki, Y. (2021). Effect of nutrient solution flow rate on hydroponic plant growth and root morphology. *Plants*, *10*(9), 1840.

Chhetri, S., Dulal, S., Subba, S., & Gurung, K. (2022). Effect of different growing media on growth and yield of leafy vegetables in nutrient film technique hydroponics system. *Archives of Agriculture and Environmental Science*, *7*(1), 12-19.

Gaikwad, D. J., Priyadarsini, S., & Mallick, B. (2020). Effects of different hydroponics systems and growing media on physiological parameters of spinach. *International Journal of Current Microbiology and Applied Sciences*, *9*(5), 1409-1414.

James, E., & van Iersel, M. (2001). Ebb and flow production of petunias and begonias as affected by fertilizers with different phosphorus content. *HortScience*, *36*(2), 282-285.

Nicola, S., Hoeberechts, J., & Fontana, E. (2006, February). Ebb-and-flow and floating systems to grow leafy vegetables: a review for rocket, corn salad, garden cress and purslane. In *VIII International Symposium on Protected Cultivation in Mild Winter Climates: Advances in Soil and Soilless Cultivation under 747* (pp. 585-593).

Wortman, S. E. (2015). Crop physiological response to nutrient solution electrical conductivity and pH in an ebb-and-flow hydroponic system. *Scientia Horticulturae*, *194*, 34-42.

Zambon, F. T., Meadows, T. D., Eckman, M. A., Rodriguez, K. M. R., & Ferrarezi, R. S. (2022). Automated ebb-and-flow subirrigation accelerates citrus liner production in treepots. *Agricultural Water Management*, *262*, 107387.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

EMBRYO RESCUE TECHNIQUE FOR WIDE HYBRIDIZATION

Article ID: AG-VO3-I11-46

[1]Aarathi, J., [2*]V. Krishnan, [1] R. Praveen, [1]J. Arathi, [1]Lakshmipriya, [1]K. Preetha, [1]FS. Aparna and [2]A. Premkumar

[1]PG Scholar & [2]Faculty, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal 609603, U. T. of Puducherry

*Corresponding Author Email ID: anurathakrishnan66@gmail.com

Introduction

Embryo rescue is one of the earliest and successful forms of in-vitro culture techniques that is used to assist in the development of plant embryos that might not survive to become viable plants. Embryo culture is a tissue culture technique that has proven to be of greatest value to breeders. This technique nurtures the immature or weak embryo, thus allowing it the chance to survive. Plant embryos are multicellular structures that have the potential to develop into a new plant. The most widely used embryo rescue procedure is referred to as embryo culture, and involves excising plant embryos and placing them onto media culture. Embryo rescue is most often used to create interspecific and intergeneric crosses that would normally produce seeds which are aborted. Interspecific incompatibility in plants can occur for many reasons, but most often embryo abortion occur. In plant breeding, wide hybridization crosses can result in small shrunken seeds which indicate that fertilization has occurred, however the seed fails to develop.

HISTORICAL OVERVIEW OF EMBRYO RESCUE

The first attempt to grow the embryos of angiosperms was made by **Hannig in 1904** who obtained viable plants from in vitro isolated embryos of two crucifers *Cochleria* and *Raphanus* (Hannig, 1904).In 1924, Dietrich grew embryos of different plant species and established that mature embryos grew normally but those excised from immature seeds failed to achieve the organization of a mature embryo **(Dietrich,1924).**

They grew directly into seedlings, skipping the stages of normal embryogenesis and without the completion of dormancy period.

Laibach (1925) demonstrated the practical application of this technique by isolating and growing the embryos of interspecific cross *Linum perenne* and *L. austriacum* that aborted in vivo. This led Laibach to suggest that in all crosses where viable seeds are not formed, it may be appropriate to excise their embryos and grow them in an artificial nutrient medium. Embryo culture is now a well-established branch of plant tissue culture.

EMBRYO CULTURE

Embryo culture is the sterile isolation and growth of an immature or mature embryo in vitro, with the goal of obtaining a viable plant.

EMBRYO CULTURE

Mature embryo culture

It is the culture of mature embryos derived from ripe seeds. This type of culture is done when embryos do not survive in vivo or become dormant for long periods of time or is done to eliminate the inhibition of seed germination

Immature embryo culture

It involves the culture of immature embryos to rescue them from unripe or hybrid seeds which fail to germinate. This approach is very useful to avoid embryo abortion and produce a viable plant

THE EMBRYO RESCUE TECHNIQUES

There are several barriers, which operate at pre-fertilization and post-fertilization levels to prevent the successful gene transfer from wild into cultivated species (Fig.1)

PRE-FERTILIZATION BARRIER

1. Failure of pollen germination
2. Slow pollen tube growth
3. Pollen tube unable to reach the style
4. Arresting of pollen tube in the style, ovary and ovule
5. Failure to obtain sexual hybrids

POST-FERTILIZATION BARRIER

1. Hybrid inviability and weakness Embryo abortion Embryo abortion at very young stages Lethality of F1 hybrids Chromosome elimination
2. Hybrid sterility
3. Hybrid breakdown

TECHNIQUES FOR OVERCOMING BARRIERS TO WIDE HYBRIDIZATION

S.NO.	PRE-FERTILIZATION BARRIER	TECHNIQUES FOR OVERCOMING BARRIERS
1.	Failure of pollen germination	a) Mechanical removal of pistil followed by pollination of the exposed end of the style b) Use of recognition pollen
2.	Slow pollen tube growth	a) Use of recognition pollen b) In vitro fertilization c) Use of growth hormones and immune-suppressants
3.	Pollen tube unable to reach the style	a) Shortening the style
4.	Arresting of pollen tube in the style, ovary and ovule	a) In vitro fertilization
5.	Failure to obtain sexual hybrids	a) Protoplast fusion
6.	Differences in ploidy level.	a) Protoplast fusion Chromosome doubling of species or species hybrid before hybridization with the recipient species b) Bridging species technique c) Reducing the chromosome number of cultivated polyploid species before hybridization

S.NO.	POST-FERTILIZATION BARRIER	TECHNIQUES FOR OVERCOMING BARRIERS
1.	Hybrid inviability and weakness	
	Embryo abortion	a) Embryo rescue b) In vivo/vitro embryo rescue/embryo implantation
	Embryo abortion at very young stages	a) Ovary culture b) Ovule culture

		c) In vitro fertilization
	Lethality of F 1 hybrids	a) Reciprocal crosses b) Grafting of hybrids Regenerating plants from callus
	Chromosome elimination	a) Altering genomic ratios of two species b) Inducing chromosomal exchanges before onset of elimination
2.	Hybrid sterility	c) Chromosome doubling (amphiploid production) d) Backcrossing
3.	Hybrid breakdown	a) Growing larger F 2 populations

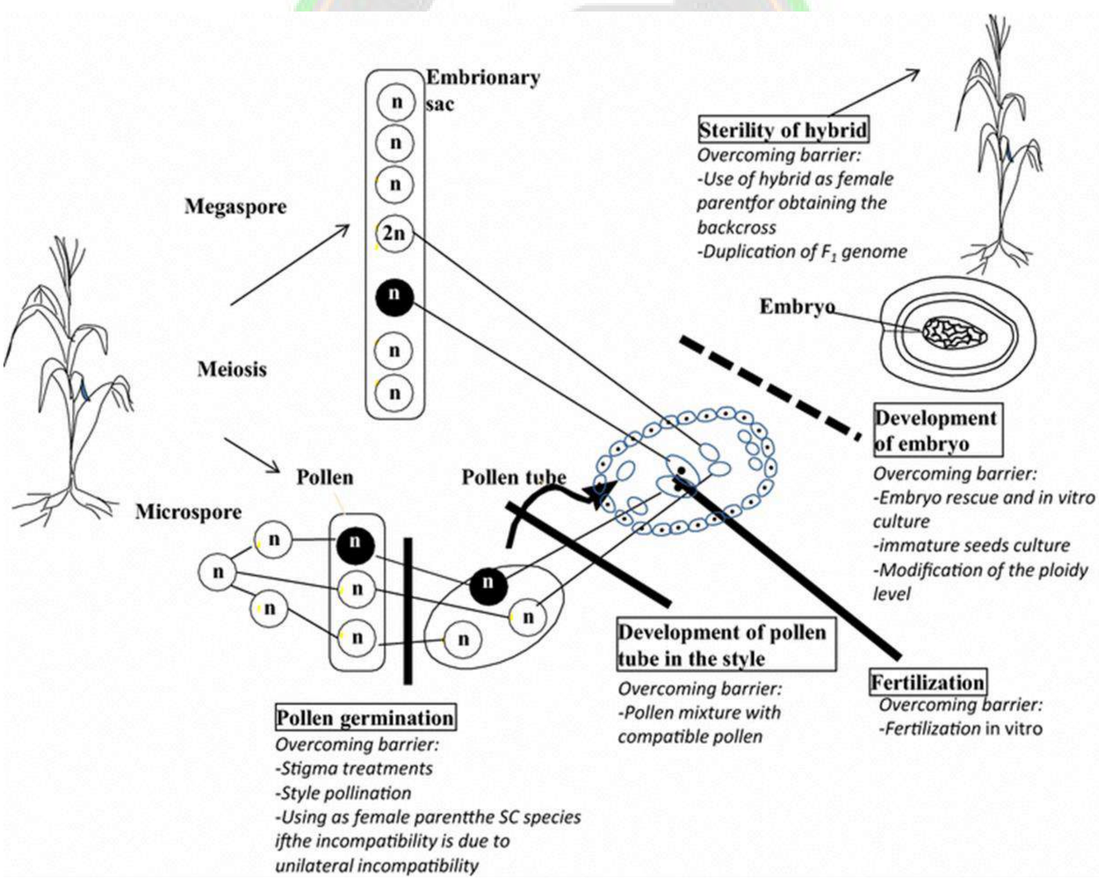


Fig. 1 Applications of Embryo Rescue techniques at different stages of Embryo development

PRINCIPLE OF EMBRYO CULTURE

The underlying principle of embryo rescue technique (Fig.2) are

i. To aseptic excision of the embryo and its trans-fer to a suitable nutrient medium for develop-ment under optimum culture conditions.

ii. To obtain pathogen-free embryos, since the embryo is lodged in the sterile environment of the ovule or seed or capsule or fruit.

iii. Entire seeds or fruits containing the ovule are surface sterilized and the embryos are then aseptically separated from the surrounding tissues.

iv. The most important aspect of embryo cul-ture work is the crucial selection of the medium necessary to sustain continued growth of the embryos.

v. The formulation of nutrient media may vary depending upon the species used for study and many of them have not been rigorously de-termined.

vi. After the embryos have grown into plantlets in vitro, they are generally transferred to sterile soil or vermiculite and grown to matu-rity in the green house.

PROTOCOL FOR EMBRYO CULTURE

A. Protocol for embryo culture (Cereals— wheat, maize, barley, rice, etc.)

There are numerous examples in which hybrid embryo rescue operations have been carried out.

1. Harvest ears of maize/panicle of rice/spikes of wheat or barley after 12–14 days of crossing or pollination. Developing seeds should be in the milky stage. At this stage embryos are less than 1.5 mm in diameter. Check the size of embryo under binocular microscope. With the help of forceps and/or needle take out the seeds from the ear/ panicle/ spike and remove the lemna and palea wherever it is present.

2. Place few such seeds in a beaker and sterilize them with 20% commercial sodium hypochlorite solution for 10 min. These operations are to be carried out in the laminar airflow hood. Rinse 3–5× with sterile distilled water.

3. Place a sterilized grain on a sterile slide/petri dish and make cuts with needles above the embryo in the endosperm while holding embryo stationary with the second needle.

4. Dissect out immature embryos (1–1.5 mm diameter) from the seeds under a dissection microscope in the hood of laminar flow. Place the embryos on MS or B5 medium without growth regulators for direct plant formation.

6. Incubate the cultures in light at 25°C.

7. Transfer the plantlets after 2 weeks to half strength MS or B5 media with reduced sucrose (1%) concentration.

8. Transfer the plants to plastic pots

Place the pots in humid conditions or mist chambers under diffused light at 25°C. Open the tents or remove the inverted container to allow air exchange briefly everyday. After 1 week, let some air in the tent for 1 h each day. After another week, increase gradually to several hours per day. After 2–3 weeks remove the wrap or inverted container from the plants to adjust to natural environmental conditions.

B. Protocol for Embryo Culture (Legumes—Green Gram, Black Gram, French Bean, Soybean, etc.)

1. Collect developing pods in which the embryos are at the heart stage and the beginning of cotyledon stage. Depending upon the species this stage will approximately be after 9–12 days of pollination.

2. Dip the pods in 70% alcohol for 1 min and then sterilize with 20% commercial sodium hypochlorite solution for 10 min. These operations are to be carried out in the laminar flow hood. Rinse 3–5x with sterile distilled water.

3. Place the pods on a sterile slide/petri dish and slit open the pods and place the developing seeds on a slide or petri dish.

4. Remove the seed coat pieces directly above the embryo and carefully dissect out the embryos with forceps and needle.

5. Inoculate the embryos on the following medium: MS + casein hydrolysate (200 mg/l) + L-glutamine (100–200 mg/l) + NAA (0.01µM) + BAP (1.0 µM) + sucrose (3–8%).

6. Incubate the cultures in light at 25°C.

7. Transfer the plantlets after 3–4 weeks to half strength MS medium without growth regulators but with reduced sucrose (1%) concentration.

8. Transfer the plants to plastic pots.

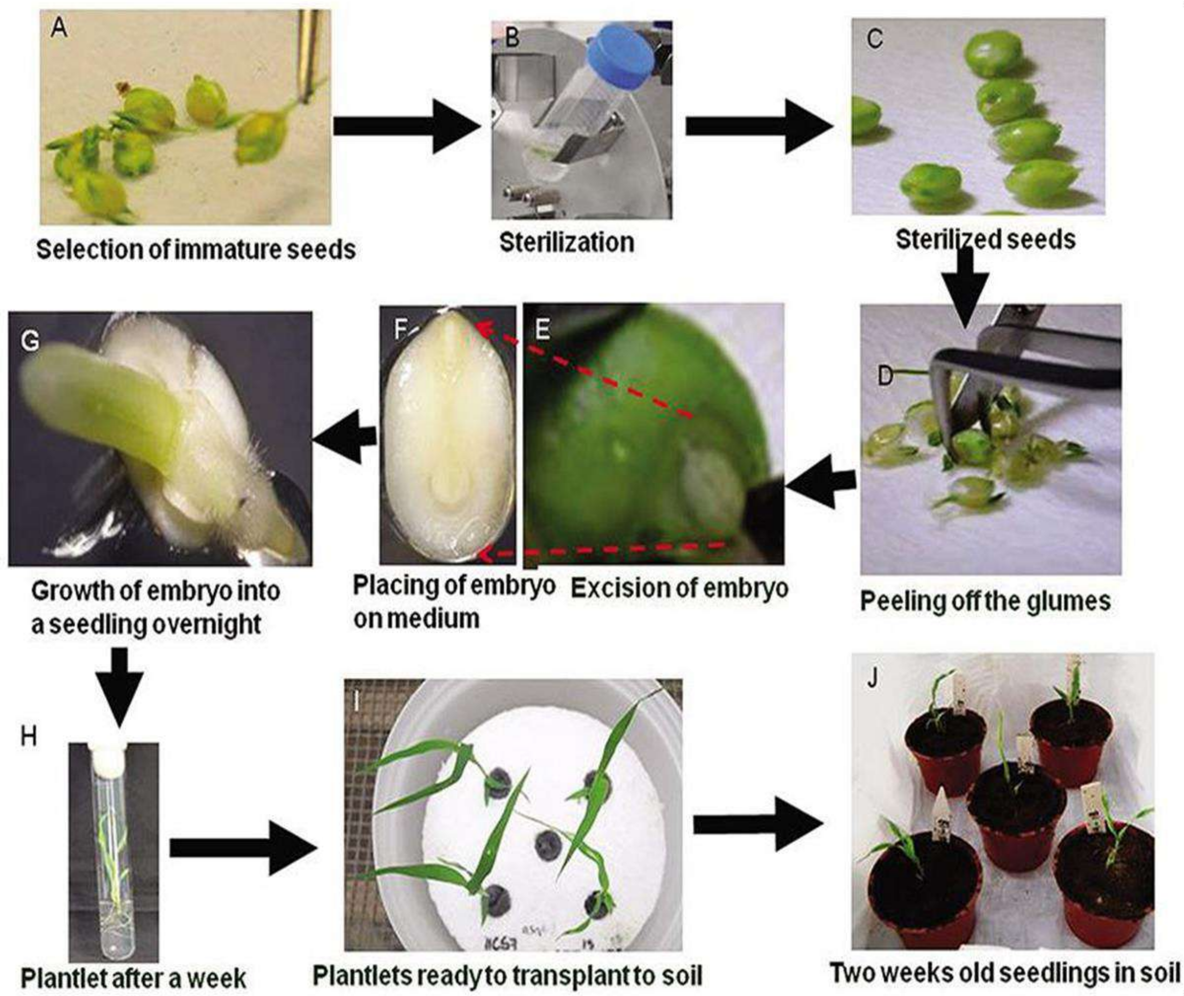


Fig. 2 Sequential steps in Embryo Culture

APPLICATION OF EMBRYO CULTURE

1. The most useful and popular application of embryo cultures is to raise rare hybrids by rescuing embryos of incompatible crosses.

2. Overcoming Dormancy and Shortening Breeding Cycle: Long, periods of dormancy in seeds delay breeding works, especially in horticultural and crop plants.

3. Prevention of embryo abortion in wide crosses.

4. Production of haploids.

5. Prevention of embryo abortion with early ripening stone fruits.

6. Embryos are excellent materials for in vitro clonal propagation. This is especially true for conifers and members of Gramineae family.

7. Germination of seeds of obligatory parasites without the host is impossible in vivo, but is achievable with embryo culture.

LIMITATION OF EMBRYO CULTURE

1. Embryo culture is not possible due to difficulty of its excision at very early stage.

2. Difficulty of arriving at the right kind of complex nutrient medium for culturing hybrid Embryos.

Conclusion

Thus Embryo culture is a valuable in vitro tool for breeding. It is most often used to rescue embryos from interspecific and intergeneric crosses and from embryos that do not fully develop naturally. As research continues with this technique, new and valuable uses will be developed to assist the biotechnological breeding of plants.

References

G. Kalloo et al. (eds.), Distant Hybridization of Crop Plants © Springer-Verlag Berlin Heidelberg 1992

H.S. Chawla: 2009: Introduction to Plant biotechnology, Third edition, 69-72.

Int.J.Curr.Microbiol.App.Sci (2018) 7(6): 3350-3358

Poonam Kumari, Thaneshwari and Rahul, Embryo Rescue in Horticultural Crops

Volume: 03 Issue No: 11

ENTOMOVECTOR- AN ALTERNATIVE WAY OF CONTROLLING PLANT DISEASE

Article ID: AG-V03-I11-47

***Denisha Rajkhowa, Minggap Yirang, Ajaykumara K.M. and Rajiv Das**
College of Agriculture, CAU,Pasighat and College of Horticulture and Forestry, CAU, Pasighat
*Corresponding Author Email ID: denisha.rajkhowa@gmail.com

Introduction

Insects and plants have co-evolved to benefit one other since the beginning of time, but plant pathogens have also co-adapted for optimal dispersal. Abiotic factors mediate disease dispersal across short and long distances, but insect vectors such as pollinators can also play a role. Indeed, they are well-known for their ability to transfer viruses, fungal and bacterial spores, as well as pollen (Card *et al.*, 2007). On the basis of this, the idea of using pollinators as vectors in a new, environmentally friendly management technique to disperse control agents against plant illnesses and insect pests into crop blooms emerged (Peng *et al.*, 1992). Pollinators are not only necessary for pollination in this setting, but they also play an important dual role. Hokkanen and Menzler-Hokkanen (2007) coined the term "entomovector technology," and describe it as the use of managed pollinators as disseminators of biological control agents against crop pests. The technique integrates many ecological components such as pollinators, biocontrol agents, and plant pathogens/insect pests (Kevan *et al.*, 2008).

Principles of entomovector

Entomovector includes the interaction of numerous components. It includes a specific pollinator, known as the vector, transfer microbiological BCA product to the protected crop in a manner that is safe for humans, the vector, and the environment. The vector is loaded with a dispenser which content a suitable number of colony-forming units of the microbial BCA, for this purpose, the vector walks through a device filled with the BCA formulation. The dispenser must provide a way to load the vector safely and sufficiently without significantly altering the physiological behaviour of the vector or compromising its health and safety. Risk analyses pertaining to safety must be finished and product registration must be in place in order to guarantee that the BCA has no negative impacts on people, vectors, or the environment.

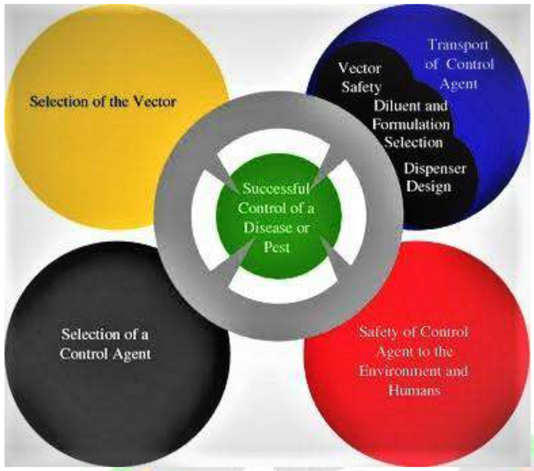


Fig: Diagramatic illustration of the components necessary for efficient entomovectoring and how they interact (Pic. by Mommaerts *et al.*, 2011)

Selection of vector

It is evident that success in dissemination and deposition of the microbial control agents (MCA) is crucial in an entomovector strategy. As a result, selecting the most efficient vector is critical, the selection for the most suitable vector is dependent on several factors, including the crop species, the crop-visitation rate of the vector, the flying conditions for the vector and the vector's intrinsic capacity to disseminate MCAs. The number of insect species that have been used in the entomovectoring system is limited. The bottleneck is in linking the commercial availability of the pollinator with the blooming period of the plant under protection as the pollinator life cycle is not always related to its blooming period (Mommaert *et al.*, 2011). This is also why honeybees and bumblebees, both commercially available throughout the year, are very much in demand for use in the entomovectoring system and have been the vector in many scientific reports investigating entomovectoring (Keevan *et al.*, 2020). For instance, Apis and Bombus workers differ in pollen deposition and removal because of different foraging behaviour. Examples of crop–pollinator links were found for numerous species of the Asteraceae family that proved to be particularly attractive to honeybees and wild bees. Members of the Brassicaceae family were mostly disliked by solitary bees and bumblebees but were visited frequently by honeybees. Bumblebees were notably present on plants of the Leguminosae family (Maccagnani, 2020) Apart from honeybees and bumblebees, solitary bees such as Megachile rotundata, Osmia bicornis, Osmia cornuta and Osmia lignaria have been used as vectors as well (Maccagnani and Sgolastra, 2020) .

Selection of the biocontrol agent

Criteria for suitable biocontrol agents Potential biocontrol agents for use in the entomovector technology need to fulfill the criteria as defined for agents against postharvest diseases by (Droby *et al*., 2009) and (Sharma *et al*.,2009): (1) genetically stable, (2) effective at low concentrations, (3) not fastidious in its nutrient requirements, (4) able to survive adverse environmental conditions, (5) resistant to pesticides, (6) non pathogenic to the host, (7) not detrimental to human health, and (8) preparable in a form that can effectively be stored and disseminated. In addition to these criteria three extra characteristics should be included for a suitable MCA, namely (9) effective against aerial and/or foliar plant pathogens/insect pests, (10) safe for the vector and the crop, and (11) able to survive and grow under conditions present in the flower.

Contribution of pollinators to the control of plant Pathogens and insect pests in plants

In the past, honey bees have been used with success for the dissemination of MCAs against economically important plant pathogens of orchard fruits (apple and pear), strawberry, raspberry, blueberry and sunflowers. Multiple studies have reported on the success of both honey bees and bumble bees to vector different entomopathogenic control agents into flowers to control pest insects which feed on, or inhabit, the flowers. An overview is given in Table 1.

Dispenser

An optimal dispenser system needs to fulfill three criteria: (a) loads the vector with a sufficient amount of the powdery MCA product, (b) does not interfere with the foraging behavior of the vector, and (c) has long refilling intervals (1 day). Overall, the dispensers so far developed can be classified into two groups, namely the one-way type dispensers, where the chamber through which the bees enter or leave the dispenser is the same (or is not completely separated), and the two-way type dispensers where the chamber (with control agent) through which bees leave the dispenser is separated from the chamber (without control agent) via which they enter the dispenser.

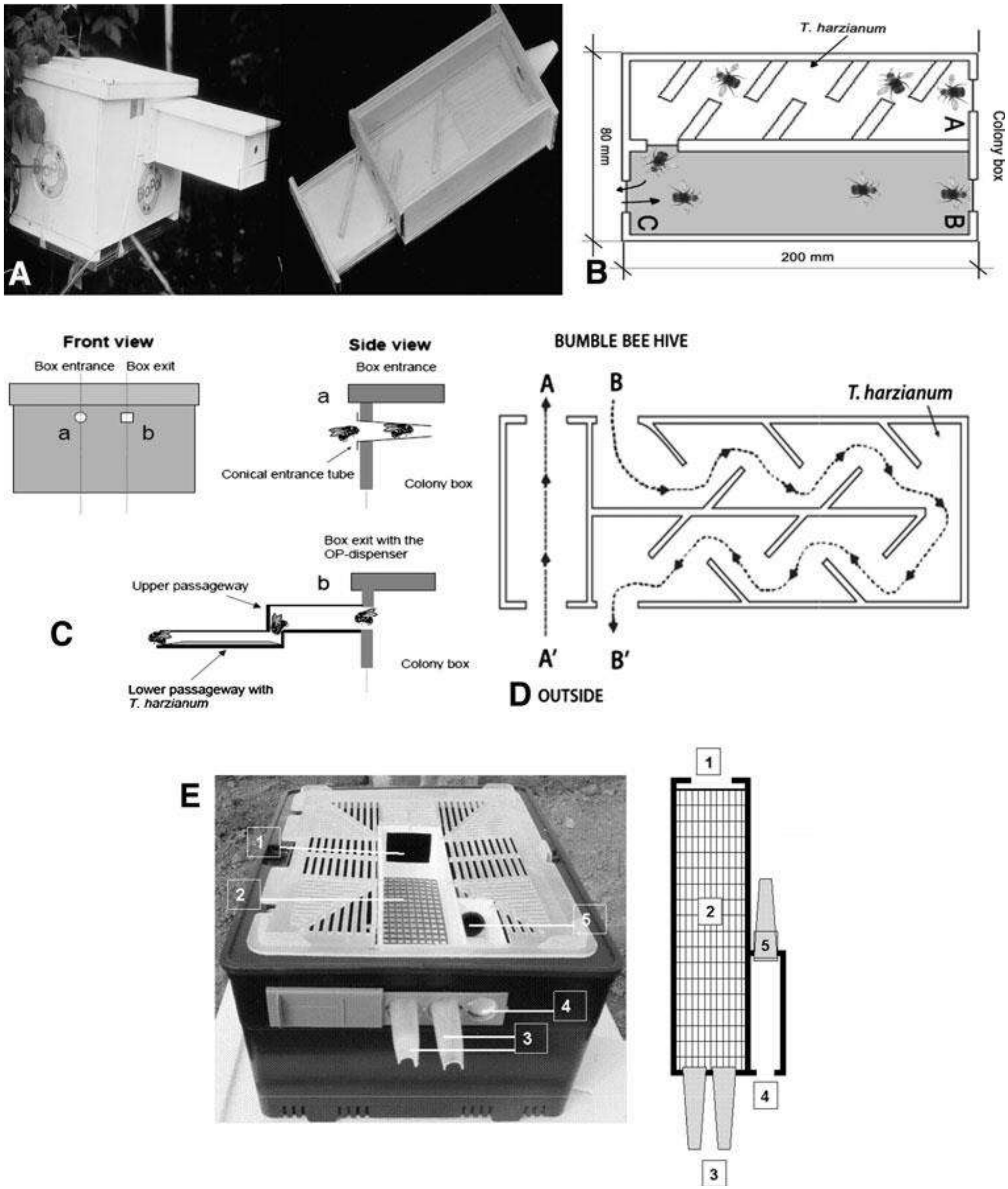


Fig. 1 Overview of dispensers developed for the bumblebee *B. impatiens* and *B. terrestris*. One way type dispensers: (a) (Yu and Sutton, 1997), and (b) SSP and two-way type dispensers: (c) OP; (d) Houle and (e) the dispenser as developed by (Mommaerts *et al.*, 2010).

Adapted from (Yu and Sutton, 1997), (Maccagnani *et al*., 2005), (Albano *et al*., 2009), and (Mommaerts *et al*., 2010)

Two main pollinators in entomovectoring: honeybees and bumblebees

Commercially, honeybees (Apis mellifera) have been used in North America, Europe, South America and Asia. Bumblebees have been successfully deployed in North America (Bombus impatiens), Europe (Bombus terrestris) and the Republic of Korea (Bombus terrestris) (Keevan *et al.,* 2020). The conditions under which the vectors must fly are decisive in determining which vector will generate the best result for pollination. This also applies to the choice between bumblebees and honeybees. For example, it is known that honeybee workers do not fly, or fly poorly, under rainy conditions and that rain affects their ability to disseminate BCAs. Bumblebees, which are described as bad-weather foragers, perform better under rainy conditions (Goulson, 2010). In addition, honeybees have been described as less suitable for entomovectoring in greenhouse crops (Guerra- Sanz, 2008). However, bumblebees can better tolerate higher temperature extremes and are also more resistant to temperature fluctuations. This is why bumblebees are the most used pollinators inside greenhouses (Mand *et al*., 2020). Nevertheless, bumblebees are also suitable for entomovectoring in open field conditions (Mommaert *et al.*, 2011).

Another important advantage that bumblebees have over the honeybee is the fact that they perform buzz pollination (Goulson, 2010). This is a highly efficient pollination technique in which the flower stamens are shaken intensively by the vibrating wings of the insect, resulting in the formation of a cloud of pollen grains [23]. Using this technique, bumblebees can pollinate flowers more efficiently than honeybees (Mand *et al*., 2020). Other potential pollinators in entomovectoring: solitary bees Osmia species.

Case studies with the honeybee, *Apis mellifera*

The first study on entomovectoring was conducted by (Peng *et al.,* 1992) for the protection of strawberry plants against *Botrytis cinerea* with *Apis mellifera* and the microbial BCA *Gliocladium roseum*. This system was able to suppress *Botrytis cinerea* on the flowers in the greenhouse and in the open field, except when the weather conditions were bad due to the resulting reduced foraging activity. Honeybees and bumblebees were used for entomovectoring the fungus *Trichoderma harzianum* on strawberry plants in open fields for the control of *Botrytis cinerea* (Kovach *et al.*, 2000). This entomovectoring system resulted in better control of *Botrytis* *cinerea* than conventional spraying. The more targeted and continuous application of the BCA at flower opening – in comparison to spraying, which occurred before most flowers had opened – resulted in flowers being immediately protected at opening: the unprotected time is significantly less compared to spraying. Furthermore, entomovectoring resulted in on average 22% more seeds, with a 26% to 40% (by weight) higher yield as a result. Entomovectoring with *Trichoderma harzianum* resulted in a level of control and a yield that were as good as or better than those achieved with commercial fungicides plus pollination (Kovach *et al*., 2000).

In another study (Smagghe *et al*., 2012), experiments were carried out on open field strawberry plants in Finland. During these experiments, honeybees loaded with Prestop-Mix, with the active component *Gliocladium catenulatum*, increased the yield by 58%, due owing to enhanced pollination and avoidance of fungicides with potential negative effects on the seed set.

Case studies with the bumblebees *Bombus terrestris* and *Bombus impatiens*

(Kapongo *et al*. 2008) demonstrated how *Clonostachys rosea* transported by *Bombus impatiens* suppressed *Botrytis cinerea* by 57% and 46% in the flowers and leaves of the tomato plant, respectively, and by 58.9% and 46.8%, respectively, in the flowers and leaves of the sweet pepper. (Mommaerts, Put and Smagghe, 2011) investigated entomovectoring with Prestop-Mix and the vector *Bombus terrestris* to combat *Botrytis cinerea* on the strawberry plant under greenhouse conditions. They observed that the use of this BCA and vector could provide a significantly higher yield (2 to 2.5 times higher) compared to the control group without BCAs, even under conditions that were considered ideal for the fungus. Several companies have developed business models based on entomovectoring technology. Examples are Biobest (Belgium), Bee Vectoring Technology (BVT, Canada) and Assatek (Finland). An example of a commercially available product is the Flying Doctors hive. This is a patented nest sold by Biobest and used especially for vectoring with *Bombus terrestris*. The dispenser is based on the Mommaerts dispenser (Mommaert *et al*., 2010)

Environmental and human safety of the entomovector technology

MCAs have been examined for their negative effects on nontarget organisms because they are registered plant protection chemicals used in agriculture and horticulture. But in the entomovector technology, the MCAs are dispersed continuously and possibly also on non-target sites (Brimmer and Boland, 2003), where they can, as in the case of Trichoderma spp., compete with the naturally occurring microflora for nutrients (Vinale *et al*., 2008). Authorization has only been given for spray applications or for mixing in the soil with fixed doses. In addition to ensuring MCA passage into the flowers, the condition of the vector must be determined. Three types of side effects evaluation are required: short-term (acute) and long-term (chronic) survival loss (toxicity), sublethal effects on worker and nest (population) reproduction, and effects on pollinator foraging behavior.

So far, Bt, *B. bassiana* GHA, *M. anisopliae*, and HNPV have all been employed as MCAs to control insect pests. Although the side-effects differ depending on the pollinator species and stage (adult vs. larval instar), it was determined that entomopathogenic MCAs negatively influence vector lifespan (Mommaerts *et al*. 2010). Although Bt has been found to be safe for adult honey bees (Vandenberg and Shimanuki 1986) but there have been reports of worker *B. terrestris* deaths that are dependent on the Bt strain (Mommaerts *et al*., 2010). Bumble bees were shown to be more vulnerable to mycosis caused by *B. bassiana* GHA than honey bees. Indeed, the pathogen was able to grow on the insect body after dermal contact with a suspension of the commercial compound Botanigard, resulting in the insect's death (Mommaerts *et al*. 2008), but the risks are low as an acceptable level of vector mortality of 14% and a satisfactory efficacy level of pest control, 40% mortality of the pest by adjusting the initial concentration to 6 x 9 10^{10} conidia/g product was obtained (Kapongo *et al*. 2008)

Potential sublethal consequences should be examined in addition to the decreased chance of survival. The physiology and behavior of insect pollinators can undergo considerable alterations when exposed to a variety of pesticides at sublethal concentrations (Desneux et al., 2007). Behavioural changes affecting the nest performance of *B. terrestris* have been reported after ad libitum uptake of sugar water dosed with sublethal concentrations of *B. bassiana* GHA (Mommaerts *et al*., 2009). Also other effects such as on orientation performance and learning/olfactory/memory can be assessed. For example in the laboratory, sublethal effects on honeybees have been assessed by a complex maze and the proboscis extension response (PER) (El Hassani *et al*. ,2005), whereas in the field various authors have used automatic tracking with a harmonic radar and radio frequency identification devices to follow honey bee behaviour (Reynolds and Riley, 2002). The foraging behavior test was recently established in a lab and used to bumble bees as well to evaluate potential effects of sublethal concentrations on the foraging behavior of free-flying bees (Mommaerts *et al*., 2010). In research on associative learning, PER for bumble bees has only ever been employed thus far; it has not been used to evaluate the effects of pesticide exposure on olfaction or memory (Toda *et al*., 2009). In addition, the entomovector technology requires the exposure assessment of MCAs as a dry formulation. Behavioural changes have been observed in previous studies upon exposure to dust (Pettis *et al*. 2004). However, the present experimental designs do not allow such assessment and thus the development of an appropriate methodology is needed. For humans no additional risks are connected with this technology, as the active substances of commercial MCAs are already registered according to the EU Directive 91/414/EEC.

General conclusions and research perspectives

Since the initial studies on entomovector technology in the early 1990s, recent advances have resulted in (i) the development of suitable dispensers for the three vectors; (ii) The efficiency of several pollinators has been evaluated; (iii) Potential carriers have been identified; and (iv) Several MCAs are now commercially available.

At present the entomovector technology is already recommended for practice and is used with success in some countries such as BeeTreat in Finland (Hokkanen *et al.*, 2011), but the system will benefit from further improvements. First, the reliability of the system needs to be improved under diverse environmental conditions, and combinations of different MCA strains and/or mixtures of MCAs with low risk chemical pesticides and naturally occurring antimicrobial substances can be investigated in combination with other cultural strategies. Second, commercial goods need to be improved in order to increase MCA deposition in the flowers for a better ability to manage under strong disease or insect load. Several potential carriers have already been found, but it will be important to assess how well they work with the vectors and how they affect the bee body after flight. Investigating the potential of combinations in this situation might also be interesting. Last but not least, we anticipate that additional research on understanding pollinator foraging behavior, vector-plant interactions, and fresh understandings of antagonists' modes of action in various environmental contexts and when interacting with various plant pathogens will contribute to the growing success of this control strategy in the future. However, it should be noted, nevertheless, that whichever system is created and advocated, its practical acceptance will be directly influenced by its simplicity and usability, while still offering effective control at a reasonable price.

Table 1: Over view of pollinator and vector (Table by Mommaerts *et al.* 2011)

Vector	Active ingredient (CFU/g)	Crop	Dispenser	Bee load direct (CFU/bee)	Flower load (CFU/flower)	Target	Control	Reference
A. mellifera	*Gliocladium roseum* (5 x 10^8)	Strawberry	Peng	6.3 x 10^4	1.6-27 x 10^3	*Botrytis cinerea*	Supressed	Peng *et al.* 1992
A. mellifera	Trichoderma harzianum T39 (1.0 x 10^9)	Strawberry	Triwaks	1.5 x 10^5	2.2 ± 0.5 x 10^4	*Botrytis cinerea*	Supressed	Shafir *et al.* 2006
A. mellifera	*Bacillus subtilis* QRD132	Blue berry	Gross	5.1- 6.4 x 10^3	5.1 x 10^3	*Sclerotinia sclerotiorum*	Supressed	Escande *et al.* 2002
Bacillus impatiens	*Clonostachys rosea* + *Beauveria bassiana* (1.4 x 10^7 + 6.3 x 10^{10})	Tomato	No Information	2.6 x 10^4	4.3 ± 0.3 x 10^3	*Botrytis cinerea*	Supressed	Kapongo *et al.* 2008
B. impatiens	*Beauveria bassiana* GHA (1 x 10^9)	Sweet pepper	No information	4.5 ± 0.5 x 10^5	1.8 ± 0.5 x 10^4	*Lygus lineolaris*	Significant mortality of the pest	Al- mazra'awi *et al.* 2007

References

Smagghe G., Mommaerts V., Hokkanen H. & Menzler-Hokkanen I. (2012). Multitrophic interactions: the entomovector technology. *In* Arthropod–plant interactions: novel insights and approaches for IPM (G. Smagghe & I. Diaz, eds). Springer, Dordrecht, the Netherlands, 127–157. https://doi.org/10.1007/978-94-007-3873-7_5

Albano S., Chagon M., de Oliveira D., Houle E., Thibodeau P.O., & Mexia A. (2009). Effectiveness of *Apis mellifera* and *Bombus impatiens* as dispensers of the Rootshield_ biofungicide (*Trichoderma harzianum*, strain T-22) in a strawberry crop. *Hell Plant Prot J.*, **2**:57–66

Card S.D., Pearson M.N. & Clover G.R.G. (2007). Plant pathogens transmitted by pollen. *Austr Plant Pathol.*, **36**:455–461

Desneux N., Decourtye A. & Delpuech J.M. (2007).The sublethal effects of pesticides on beneficial arthropods. *Annu Rev Entomol* ., **52**:81–106

Droby S., Wisniewski M., Macarisin D. & Wilson C. (2009). Twenty years of postharvest biocontrol research: is it time for a new paradigm? Postharv Biol Technol., **52**:137–145

El Hassani A.K., Dacher M., Gauthier M. & Armengaud C. (2005). Effects of sublethal doses of fipronil on the behavior of the honeybee (*Apis mellifera*). *Pharmacol Biochem Behav*., **82**:30–39

Goulson D. (2010). Bumblebees: behaviour, ecology, and conservation, 2nd Ed. Oxford University Press, New York, United States of America, 336 pp.

Guerra-Sanz J.M. (2008). Crop pollination in greenhouses. *In* Bee pollination in agricultural ecosystems (R.R. James & T.L. Pitts-Singer, eds). Oxford University Press, Oxford, United Kingdom, 27–47. https://doi.org/10.1093/ acprof:oso/9780195316957.003.0003

Hokkanen H.M.T. & Menzler-Hokkanen I. (2007). Use of honeybees in the biological control of plant diseases. *Entomol Res*., **37**:A62–A63

Kapongo J.P., Shipp L. & Kevan P. (2008). Optimal concentration of *Beauveria bassiana* vectored by bumble bees in relation to pest and bee mortality in greenhouse tomato and sweet pepper. *Biocontrol*. **53**:797–812

Kevan P.G., Kapongo J.P., Al-mazra'awi M. & Shipp L. (2008). Honey bees, bumble bees and biocontrol. **In**: James RR, Pitts-Singer T (eds) Bee pollination in agriculture ecosystems. Oxford University Press, New York

Kevan P.G., Shipp L. & Smagghe G. (2020). Ecological intensification: managing biocomplexity and biodiversity in agriculture through pollinators, pollination and deploying biocontrol agents against crop and pollinator diseases, pests and parasites. *In* Entomovectoring for precision biocontrol and enhanced pollination of crops (G. Smagghe, O. Boecking, B. Maccagnani, M. Mänd & P.G. Kevan, eds). Springer Nature, Cham, Switzerland, 19–51. https:// doi.org/10.1007/978-3-030-18917-4_2

Kovach J., Petzoldt R. & Harman G.E. (2000). Use of honey bees and bumble bees to disseminate *Trichoderma harzianum* 1295-22 to strawberries for *Botrytis* control. *Biol. Control*, **18** (3), 235–242. https://doi.org/10.1006/bcon.2000.0839

Laloi D., Sandoz J.C., Picard-Nizou A.L., Marchesi A., Pouvreau A., Tasei J.N., Poppy G. & Pham-Delegue M.H. (1999). Olfactory conditioning of the proboscis extension in bumble bees. *Entomol Exp Appl* .,**90**:123–129

Maccagnani B. & Sgolastra F. (2020). Solitary bees as pollinators. *In* Entomovectoring for precision biocontrol and enhanced pollination of crops (G. Smagghe, O. Boecking, B.

Maccagnani, M. Mänd & P.G. Kevan, eds). Springer Nature, Cham, Switzerland, 63–79. https:// doi.org/10.1007/978-3-030-18917-4_4

Maccagnani B., Mocioni M., Ladurner E., Gullino M.L. & Maini S. (2005). Investigation of hive-mounted devices for the dissemination of microbiological preparations by *Bombus terrestris*. *Bull Insectol*., **58**:3–8

Maccagnani B., Veromann E., Ferrari R., Boriani L. & Boecking O. (2020). Agroecosystem design supports the activity of pollinator networks. *In* Entomovectoring for precision biocontrol and enhanced pollination of crops (G. Smagghe, O. Boecking, B. Maccagnani, M. Mänd & P.G. Kevan, eds). Springer Nature, Cham, Switzerland, 1–17. https://doi.org/10.1007/978-3-030-18917-4_1

Mand M., Karise R. & Smagghe G. (2020). Bumble bees and entomovectoring in open field conditions. *In* Entomovectoring for precision biocontrol and enhanced pollination of crops (G. Smagghe, O. Boecking, B. Maccagnani, M. Mänd & P.G. Kevan, eds). Springer Nature, Cham, Switzerland, 81–93. https://doi.org/10.1007/978-3-030-18917-4_5

Pettis J.S., Kochansky J. & Feldlaufer M.F. (2004). Larval *Apis mellifera* L. (Hymenoptera: Apidae) mortality after topical application of antibiotics and dusts. *J Econ Entomol* ., **97**:171–17

Reynolds D.R. & Riley J.R. (2002). Remote-sensing, telemetric and computer-based-technologies for investigating insect movement: a survey of existing and potential techniques. *Comput Electron Agric*., **35**:271–307

Sharma R. R., Singh D. & Singh R. (2009). Biological control of postharvest of fruits and vegetables by microbial antagonists: a review. *Biol Contro,l* **50**:205–221

Toda N.R.T., Song J. & Nieh J.C. (2009). Bumblebees exhibit the memory spacing effect. *Naturwissensch*. **96**:1185–1191

Vandenberg J.D. & Shimanuki H. (1986). Two commercial preparations of the beta exotoxin of *Bacillus thuringiensis* influence the mortality of caged adult honeybees *Apis mellifera* (Hymenoptera: Apidae). *Environ Entomol.*, **15**:166–169

Yu H. & Sutton J.C. (1997). Effectiveness of bumblebees and honeybees for delivering inoculum of *Gliocladium roseum* to raspberry flowers to control *Botrytis cinerea*. *Biol Control* , **10**:113–122

Volume: 03 Issue No: 11

TRIBOELECTRIC NANOGENERATOR

Article ID: AG-V03-I11-48

[1]K. Madheswaran and [2] K. Sureshkumar*

[1] UG Scholar, J.K.K. Munirajah College of Agricultural Science, T. N. Palayam, Gobi, Erode 638 506, Tamil Nadu

[2] Assistant Professor, J.K.K. Munirajah College of Agricultural Science, T. N. Palayam, Gobi, Erode 638 506, Tamil Nadu

*Corresponding Author Email ID: suresharavind1406@gmail.com

Introduction

A Triboelectric nanogenerator is an energy harvesting device. It works on the basis on triboelectric effect and electrostatic induction. It's a new technology which was discovered by (Professor. Zhong Lin Wang's group at Georgia institute of technology in 2012).

Principle: It converts **mechanical energy into electrical energy**.

TRIBOELECTRIC EFFECT

- It is a contact induced electrification process.
- Material becomes electrically charged after it is contacted with a different material through *friction.*
- When two different materials of different charges coming into contact , charges move from one material to the other .
- This is to equalize their *electrochemical potential*.
- Transferred charges can be electrons or maybe ions/molecules.
- When separated, some of the bonded atoms have a tendency to keep extra electrons, and some have a tendency to give them away. It produces triboelectric charges on surfaces.
- Materials having strong triboelectrification effect are likely less conductive or insulators.

EXAMPLE: Rubbing of hands is an example of triboelectric effect.

Electrostatic induction is a method to generate static electricity in a material by bringing an electrically charged object near it.

Since the first report of TENG [Triboelectric Nanogenerator] in January 2012, the output power density of TENG has improved reaching 313 W/m^2 , the volume density reaches 490 kW/m^2,and conversion efficiencies of 60-72% have been demonstrated.

STEPS INVOLVED IN ENERGY CONVERSION OF TENG :

Charge generation

↓

Charge separation

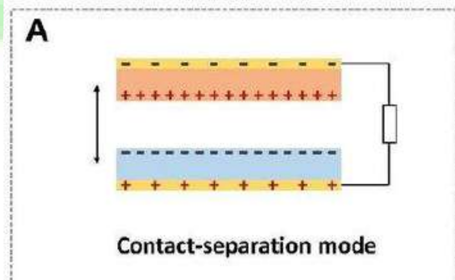
↓

Charge flow

Changing environmental conditions and changing the contact area of materials are some of the methods used to increase the charge using the triboelectric nanogenerators.

Modes and Mechanisms used for energy harvesting in TENG

1. Vertical contact separation mode
2. Lateral sliding mode
3. Single-electron mode
4. Freestanding triboelectric layer mode



1. **Vertical contact separation mode:**

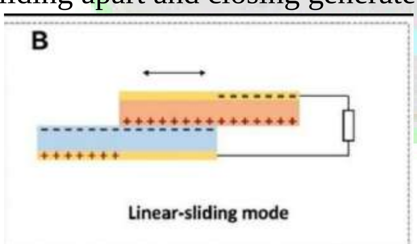
- When two dissimilar dielectric films face with each other, the electrodes gets deposited on the top and bottom of the stacked structure.
- For example the top surface is covered with Kapton [-ve charge] and bottom surface is covered with PMMA [polymethyl methacrylate] .[+ve charge]
- A physical contact between the two dielectric films creates oppositely charged surfaces.
- When it is separated by a small gap by lifting a potential drop is created .
- Once the charge disappears the triboelectric charge created

potential disappears, the electrons flow back.

- When this periodic mechanical deformation lasts, the alternating current signals will be continuously generated.
- When the pair of materials get into contact to generate triboelectric charge, one needs to be insulator so the charge cannot be conducted away but will remain on the inner surface of the sheet.
- Few structures of vertical contact separation mode are Spacer structure , Arch-shaped structure, Spring assisted separation structure, Multi-layered integration structure.

2. Lateral sliding mode:

- When two dielectric films are in contact, a relative sliding in parallel to the surface also creates triboelectric charges on the two surfaces.
- With triboelectrification from sliding , a periodic change in contact area between two surfaces leads to a lateral separation of the charge centers, which creates a voltage driving the flow of electrons in the external load.
- The measures current is determined by the rate at which the two plates are being slid apart.
- The periodic sliding apart and closing generates an alternating current output.

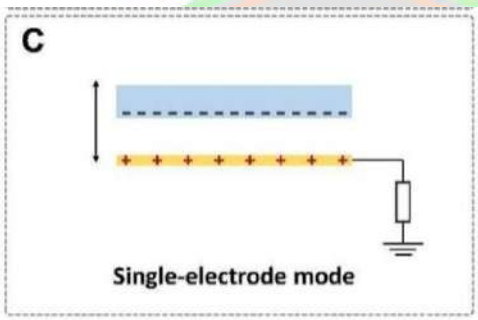


- Once the two plates reach the overlapping position, the charged surfaces come into full contact again, there will be no transferred charges left on the electrode and the device returns to the first state.
- This mechanism can work in either one directional sliding between two plates or in rotation mode.
- The most efficient means for energy harvesting is introducing linear grating or circular segmentation on the sliding surfaces.

- Few structures of lateral sliding mode are *Plain sliding structure, Rotation-disk structure, Rotation-cylinder structure, Case-encapsulated structure.*

3.Single electrode mode:

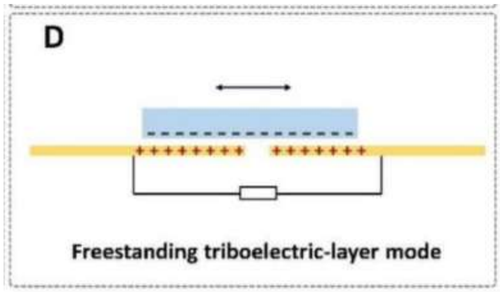
- It is more feasible and practical design for some applications such as fingertip- driven triboelectric nanogenerators.
- The working principle of single electrode triboelectric nanogenerator is by the *coupling of contact electrification and electrostatic induction*.
- In this mode, electrode on the bottom part of the TENG is grounded.
- If the size of the TENG is finite, an approaching or departing of the top object from the bottom one would change the local electrical field distribution.



- In this mode to maintain the potential change of the electrode electron exchanges between the bottom electrode and the ground.
- This energy harvesting strategy can be in both contact-separation mode and lateral sliding mode.
- Few structures of single electrode mode are Flexible single electrode structure, Arch-shaped structure, Friction surface structure and Single electrode sliding structure.

4. Freestanding triboelectric layer mode :

- In this mode, we make a pair of symmetric electrode underneath a dielectric layer to harvest triboelectric electricity.
- The object's approaching to and departing from the electrodes create an asymmetric charge distribution in the media.



- To balance the local potential distribution the electrons flow between the two electrodes.
- This approach has been very much successful in extending the durability of the TENGs as the contact between the dielectric material and electrode is cut off.
- Few structures of freestanding triboelectric layer mode are Linear-grating structure, Blade-less turbine based structure, Rolling friction structure, Rotation-disk structure.

Applications of Triboelectric nanogenerators:

❖ Harvesting energy from vibrations and body motions.
❖ Self powered keyboard.
❖ Self powered pressure sensors.
❖ Self-charging electronic devices.
❖ Powering wearable devices.
❖ Self powered active chemical sensors.
❖ Self-powered wearable flexible patch for robotic manipulation.
❖ Charging electronic gadgets.

Advantages of Triboelectric nanogenerators :

➢ It gives high voltage and low current outputs.
➢ It high efficiency at low frequency.
➢ It has low initial and maintenance cost.
➢ It is easily portable, as it is low in weight.
➢ TENG has multiple working modes.
➢ Diverse choice for the selection for the materials.

Disadvantages of Triboelectric nanogenerators :

- Protection of TENG surface from environment is a very difficult task.
- It lacks durability and stability.
- Precautions should be taken when it is combined with other energy harvesting devices.

Conclusion

Triboelectric nanogenerator is an interesting model which works on contact electrification and electrostatic induction. Due to its applications many researches are done on TENG. Energy harvesting can be done from simpler body motions too. TENGs are seen as excellent source of electricity for future endeavours.

References

Zhong Lin Wang, Long Lin, Jun chen, Simiao Niu, Yunlong Zi. 2016. Triboelectric Nanogenerators.

Zhong Lin Wang, Long Lin, Jun chen, Simiao Niu, Yunlong Zi. 2023. Hand book of Triboelectric Nanogenerators.

Volume: 03 Issue No: 11

ETHANOL: A SUSTAINABLE ALTERNATIVE TO PETROL

Article ID: AG-V03-I11-49

***Dr. Jyoti Laxman Zirmire**

Faculty, Govt.Post graduate institute of Agribusiness Management,

Chakur Dist.Latur-413513, India

*Corresponding Author Email ID: jzirmire@gmail.com

Introduction

As the world faces an ever-increasing demand for energy and grapples with environmental concerns, the search for cleaner and more sustainable fuel sources becomes paramount. Ethanol, a renewable biofuel derived from organic materials such as sugarcane, corn, or switchgrass, has emerged as a promising alternative to petrol. This article explores the advantages of ethanol as a substitute for petrol, discussing its environmental benefits, potential economic advantages, and challenges in its widespread adoption.

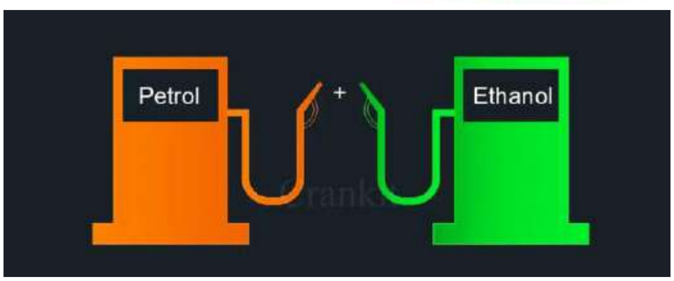


Fig:1 Ethanol alternate to Petrol

Environmental Benefits of Ethanol

One of the primary advantages of ethanol as a replacement for petrol is its significantly lower carbon footprint. When compared to conventional fossil fuels, such as petrol, ethanol emits fewer greenhouse gases during combustion, thus reducing overall carbon dioxide emissions. This reduction in carbon emissions can play a vital role in mitigating climate change and slowing down global warming, making ethanol an essential component in the fight against environmental degradation.

Furthermore, ethanol production can be more sustainable as it utilizes plant materials that absorb carbon dioxide during growth. In contrast, petroleum extraction and refining release significant amounts of greenhouse gases into the atmosphere, contributing to air pollution and climate change. By promoting the growth of crops used for ethanol production, we can effectively reduce the concentration of carbon dioxide in the atmosphere.

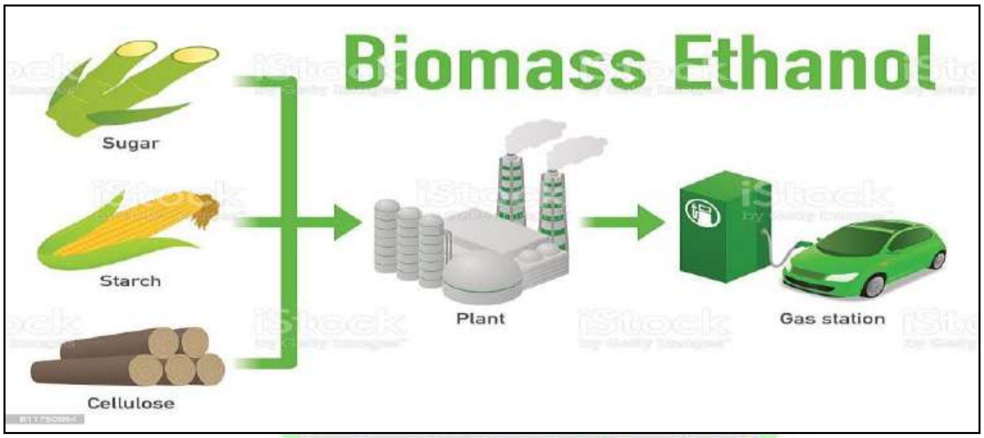


Fig:2 Biomass Ethanol Production

Ethanol Production: Ethanol is typically produced from crops such as corn, sugarcane, and wheat, as well as from various other biomass sources. It can also be made from cellulose material through advanced processes.

Ethanol Blending: In many countries, ethanol is blended with petrol to create ethanol-blended fuels, such as E10 (10% ethanol, 90% petrol) or E85 (85% ethanol, 15% petrol). These blends can be used in flex-fuel vehicles, which are designed to run on various ethanol-to-petrol ratios.

Benefits of Ethanol: Ethanol is considered a cleaner-burning fuel compared to pure petrol. It can help reduce greenhouse gas emissions and decrease the dependence on fossil fuels. Ethanol is also a renewable resource, as it can be produced from plants that can be replanted.

Challenges and Considerations: While ethanol has several advantages, there are also challenges to its use. Ethanol has a lower energy density than petrol, which means vehicles may have reduced mileage when using ethanol-blended fuels. Additionally, there are concerns about the environmental impact of large-scale monoculture farming for ethanol production and potential competition with food crops.

Engine Compatibility: Not all vehicles are designed to use ethanol-blended fuels, and modifications may be required to use higher ethanol blends like E85. Flex-fuel vehicles are equipped to handle a range of ethanol-to-petrol ratios.

Availability: The availability of ethanol-blended fuels varies by region. In some places, E10 is common, while E85 may be less readily available.

Government Support: Some governments promote the use of ethanol as a renewable energy source by providing incentives or mandates for ethanol blending in petrol. These policies can influence the adoption of ethanol as a petrol substitute.

Ethanol's Other Uses: Ethanol is also used in various industrial and chemical processes, including in the production of alcoholic beverages, pharmaceuticals, and as a solvent.

Energy Security and Economic Advantages

The increasing demand for petrol and its finite nature led to concerns about energy security and geopolitical instability. Many countries heavily rely on oil imports, making them vulnerable to sudden fluctuations in oil prices or disruptions in supply. By embracing ethanol as a viable alternative, nations can reduce their dependence on oil-producing countries and attain greater energy security. Ethanol can be domestically produced, which supports local economies and reduces reliance on foreign oil.

Furthermore, investing in the ethanol industry can create new job opportunities and stimulate economic growth. As a renewable resource, the cultivation and production of ethanol require a continuous supply of raw materials, promoting agriculture and related industries. Consequently, this diversification of economic sectors can lead to more stable and sustainable economic development.

Renewable Nature of Ethanol

Unlike finite fossil fuels, ethanol is a renewable resource. As long as we continue to grow the crops needed for its production, we can ensure a steady supply of this biofuel. Moreover, the use of ethanol in fuel blends extends the lifespan of non-renewable petrol reserves, thus reducing the rate at which they are depleted.

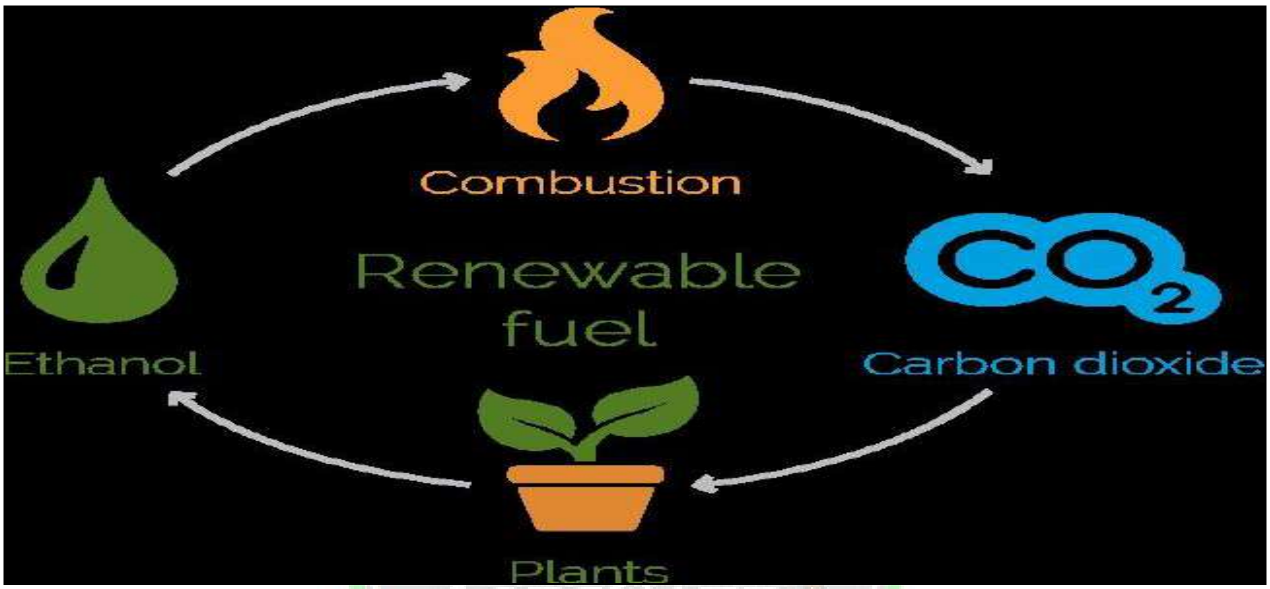


Fig:3 Renewable Nature of Ethanol

Challenges and Considerations

While ethanol presents numerous benefits, it is essential to acknowledge some challenges associated with its adoption. First, the production of ethanol requires significant amounts of water and agricultural land, potentially leading to competition with food production and stressing local water resources. To mitigate this, sustainable agricultural practices and responsible water management must be implemented.

Additionally, concerns about the energy balance of ethanol have been raised. The energy required to grow, harvest, and process crops into ethanol should not exceed the energy derived from the final product. Ensuring a positive energy balance is crucial to justify the viability of ethanol as an alternative to petrol.

Infrastructure and vehicle compatibility are also important factors. Flex-fuel vehicles, capable of running on ethanol blends, are becoming more common. However, many existing vehicles on the road are not optimized for ethanol use, requiring further investment in infrastructure and research to fully realize the potential of ethanol as a mainstream fuel.

Conclusion

In summary, ethanol is a viable substitute for petrol in some applications, especially when blended in various ratios. Its use can help reduce greenhouse gas emissions and dependence on fossil fuels, but it also comes with its own set of challenges and considerations related to engine compatibility, energy density, and environmental impacts. The use of ethanol as a petrol substitute is influenced by government policies and regional availability.

Ethanol offers a promising path toward a more sustainable and environmentally friendly future. Its lower carbon footprint, renewable nature, and potential economic benefits make it an attractive alternative to petrol. However, addressing challenges related to water usage, agricultural practices, energy balance, and infrastructure compatibility will be crucial in unlocking the full potential of ethanol. Through continued research, technological advancements, and policy support, ethanol can play a vital role in transitioning our energy systems to a more sustainable and greener future.

References

M. Akhairi and S. Kamarudin, *Int. J. Hydrogen Energy*, 2016, **41**, 4214–4228

L. An, T. Zhao and Y. Li, *Renewable Sustainable Energy Rev.*, 2015, **50**, 1462–1468

T. Radhakrishnan and N. Sandhyarani, *Int. J. Hydrogen Energy*, 2017, **42**, 7014–7022

Volume: 03 Issue No: 11

FACTORS CONTRIBUTING TO THE DECLINE SORGHUM (JAWAR) CULTIVATION AREA AND AN OPPORTUNITIES FOR IMPROVEMENTS

Article ID: AG-VO3-I11-50

***Dr. Priyanka Rajkumar Khole**

Subject Matter Specialist, Sanskriti Samvardhan Mandal's Krishi Vidyan Kendra, Sagroli, Nanded (MH), India

*Corresponding Author Email ID: ae@kvksagroli.co.in

Introduction

India is a country that relies on agriculture and produces a variety of crops. In Maharashtra Millet, Jowar, wheat, paddy, and maize are the primary crops. Millet farming declines as farmers turn to soybean cultivation in Vidarbha, Marathwada regions. There has been a steady decline in the production of millet cereals in Maharashtra between 2016 and 2022. In 2021, Jowar was sown on 2.08 lakh hectare of land. A year later in 2022, the area under jowar cultivation sharply declined to 1.42 lakh hectare.

Jowar sowing dropped by 31 per cent within a year. Whereas, the average land under jowar cultivation was 3.16 lakh hectare between 2016 and 2020 (*source The Indian Express published an article on 01 Sept 2023*).

There are several reasons for declining the area under Jawar Cultivation as discussed below. The primary reason for this is the traditional harvesting method. Jowar is manually pulled up by hand. Due to the large amount of land—hectors—farmers must invest a great deal of time and effort. Drudgery arises as a result of this injury to the worker's hand. Following their uprooting, these crops must be gathered into bundles and secured with string. Afterwards, they are allowed to dry.

The observed reduction in production and cultivated area seems to be primarily due to this process. Several innovative technologies are currently available for crop harvesting. Certain millet harvesting equipment, particularly those for Jawar, are tractor-mounted, while others are self-driven. The majority of the machinery being developed will be used to harvest crops from stem. However, the conventional method of harvesting Jowar involves pulling it up by its roots. The reason behind it that glucose which present in the crop/root which is transferred to the grains which improves the quality of grains. Also sucrose content in the Jowar reduces It also effects on grain weight. variety of agricultural harvesting machines available today but they are very expensive. It does not suitable for small and marginal farmers. Also other reason is Unavailability of labours in peak time i.e. harvesting

Conclusion

It is therefore necessary to build and develop a system that will make it affordable for farmers in order to get over the aforementioned drawbacks (long-term, labor-intensive, time-consuming, reaping, harvesting, harvesting by hand). It could have the ability to uproot the Jawar crop from the ground, prepare a bunch, or extract the seed from the stalk.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

FICUS A GREEN HOUSE PERENNIAL

Article ID: AG-VO3-I11-51

*** G.SATHISH**
Associate Professor (Horticulture)
Regional Research Station(RRS), Tamil Nadu Agricultural University(TNAU),
Vridhachalam, Cuddalore District, Tamil nadu
*Corresponding Author Email ID: sathish@tnau.ac.in

Introduction

Ficus is a diverse genus ranging from *Ficus benghalensis*, the spectacular banyan that extends itself from the main trunk by means of aerial roots that they become trunks, to *Ficus carica*, the edible fig. several of the tender species are grown as house plants for their attractive foliage.

Type : Green House Perennial
Family: Moraceae
Flowering season: Foliage plant
Propagation : Sow seed in early spring (Febuary); take cuttings or air layer mid to late spring (March- April)
Mature size/ shape: 30 m (100 ft.) trailing, climbing or single stem specimens

Ficus benghalensis

Ficus carica

***Ficus elastica* (India Rubber Tree):**

This most popular species is native to tropical Asia where it grows into a 30m forest tree, but as a house plant it makes a single erect stem, clothed with large and leathery evergreen leaves. It will grow rapidly enough if given warm and moist conditions, and it also tolerates cool, dry atmospheres although this reduces its rate of growth. Its adaptability to so many climatic conditions means that the *Ficus* will suit anywhere that has a minimum winter temperature of 10^{o}c; it can even survive at 7^{0}c though some of the lower leaves will be lost under these conditions.

The commonest wild form of *Ficus elastica* grows outdoors in southern Spain. There are several cultivars that are used as house plants. Decora has large rounded leaves that are up to 30 cm long. These leaves have a large reddish midrib on the underside and a bright red, almost scarlet, sheath that protects the growing points. When the plant is making its new growth usually in early summer (May), this sheath is thrown off, but make sure that its falls right way, otherwise it may rot and damage the young leaves.

Ficus elastic

Robusta lacks this red sheath, but has even larger leaves, upto 45cm long and half as wide; it also makes a more compact plant. For most of the time, the India rubber tree can be put in any position. It will never be happy in very deep shade, but when new leaves are coming out it doesn't want to be directly in the sun's path either. Young leaves are soft and are easily scorched and distorted in a hot sun, while mature leaves are tough and leathery

Variegated forms

Besides the green – leaved Decora and Robusta, two cultivars with variegated leaves are also available. Variegated plants are often rather more delicate than the green leaved forms and this is especially true of *Ficus elastica*. The variegated plants like a winter temperature of 15^0c with a minimum of 13^oc. The leaves need good light for the variegation to become pronounced, but here too you must ensure that the newly emerging leaves are not subjected to scorching sun.

The cultivar known as Schryveriana has a cream margin to the leaves, while the centre is mottled cream and dark green, the mottling is more or less rectangular in shape. The leaves of *Ficus tricolor* are mottled with light and dark green and yellow. The old variegated Doescheri has been suppressed by other variegated foms, but you might possibly come across it; it has small, elliptical leaves that are pink when young and have light and dark green mottling with an ivory margin.

Schryveriana

Black Prince is a newly introduced form with black leaves.

Black Prince

Other species

At one time, a large number of other *Ficus* were grown in the home, but not so many are available these days.

***Ficus lyrata* (Fiddle back fig)**

A very imposing pant, it has large, rather light green leaves about 30cm long and 25cm across, and is shaped like the body of a violin.

Ideally, it likes a minimum winter temperature of 18^0c, but will survive in 15^0c. When syringeing the leaves of this plant, it is fascinating to observe how all the water is channeled down the leaves and trunk, to emerge around the roots.

This shows that it is native to a dry region and so, occasionally, it will not mind drying out completely, although naturally it will resent being too wet. Otherwise, treat it in the same way as *Ficus elastic*a, but always give it full light.

Ficus lyrata

Ficus benjamina

Not all *Ficus* have large leaves and this species is a very different looking plant. It makes a small and graceful pendulous shrub (eventually becoming a tree) that has thin wiry branches. These are thickly covered with leaves that are bright green when young and the colour of privet leaves when old. They are elliptically shaped, about 10cm long and 3 cm wide, and end in a long thin point. This evergreen plant is almost certainly going to shed some leaves during the winter, but do not be unduly alarmed about this, unless it becomes excessive, as they will all be replaced when growth stars again.

The winter temperature should not fall below 13^0c. If the plat becomes too dry, it wilts, but will quickly recover when watered. During the late spring and summer it will take plenty of water (but do not overdo this) and every two years it will need to be potted on. It likes a well-lit position without too much direct sunlight.

Ficus benjamina

Ficus diversifolia **(Misletoe fig)**

Ficus diversifoli, that you may encounter as *Ficus deltoidea,* is interesting as it is the only *Ficus* that normally fruits at home. This small twiggy shrub has thick, dark green leaves, nearly circular in shape and only about 2.5 cm long and wide. Little round berries, pale yellow or red in colour and on thin stalks, appear from the leaf axils; they are fig shaped, but you need a magnifying glass to appreciate this fact. These fruits appear on quite small plants and persist throughout the year.

This native of India and Malayam requires a fairly moist atmosphere, but it is surprisingly hardy and will survive happily with a winter temperature as low as 10^0c. If the tips of the twigs are just pinched out in mid spring (March) it will further the production of side shoots and also seems to encourage fruiting. The plant is usually purchased in an 8cm pot and should be moved into a 23 cm pot after a year, where it can remain for two or three years before its needs a bigger one.

Ficus diversifolia

Ficus radicans

You may still see occasionally the plant known as *Ficus radicans* Variegata. This has the same creeping habit as *Ficus pumila*, but larger leaves, up to 6cm long and 2.5 cm wide, that are triangular in shape, coming to a long thin point.

They have a cream margin that may sometimes take over most of the leaf surface.

This *Ficus* needs a warm moist atmosphere and is unlikely to thrive in the home where the air will probably be too dry. The winter temperature should be around 150c and the plant should never be allowed to dry out entirely, even during the winter. It requires ample light, but must be shielded from any burning sun.

Ficus radicans

Ficus pumila

Finally, we come to a plant that breaks all the usual rules for house plants. This trailing or climbing species will survive out of doors in south –West England in places such as Corn wall and so only needs to be kept frost free indoors and is not suited to very warm rooms. It will support itself on a wall by means of aerial roots in the same way as ivy, but is normally used as a trailing plant in the home. The thin wiry stems are densely covered with heart- shaped leaves only 2.5 cm long and 13mm wide that set so thickly that the stems are invisible. This is a plant that should never be allowed to dry out, as once the leaves shrivel, they are unlikely to revive. It is possible, but not easy, to overwater this plant and the soil should always be kept moist. It does not like direct sunlight on its leaves for long and has the advantage of being tolerant of deep shade, though naturally some light is essential.

Ficus pumila

Cutting and Propagation

In the case of *Ficus elastic*, take leaf-bud or terminal cuttings in the spring. This will need a high temperature of 21^0c, if possible, until rooted. Air layering, when the stem has lost its lower leaves due to over watering, or grown too tall, is another suitable method of propagation.

For *Ficus benjamina*, take heeled leaf cuttings; these will need a temperature of 18^0c when rooting. Once the plants are established you should stop them, to promote branching. Propagate *Ficus radicans* Variegata and *Ficus pumila* by taking leaf bud or terminal stem cuttings. These will root quickly if kept at a temperature of 21^0c.

All these *Ficus* can be rooted in a peat sand medium using a propagator, or else pots kept in a warm place.

Potting and Pruning

Ficus are normally purchased in 13 cm pots and grown in potting compost. The soilless composts are perfectly adequate, but light, and as India rubber plants grow they are liable to become unstable in such a light mixture. They should stay in this size pot for several years, provided that they are fed regularly in the growing season.

When they do have to be potted on, they should go into an 18 cm pot with compost; this soil should be firmly compressed. If the plant become too tall it can be pruned back, but this will release the latex, a milky juice from which rubber was extracted by the Aztecs and the Haitians at the time of the European discovery of the new world(commercial rubber is now obtained from the genus *Hevea* and from synthetics). Have some powdered charcoal ready to sprinkle immediately onto the wound. The plant as a result, will probably produce about three stems where you had only the single trunk before, giving it a fuller and more attractive shape. The best time to prune is in late spring when the roots are starting to make fresh growth before the new leaves appear.

Care of *Ficus*

The *Ficus* is straightforward to treat. Like most house plants, it appreciates a moist air around its leaves and benefits from being syringed in hot weather, but the soil ball should be kept on the dry side except in times of new growth when it will need plenty of water. On the other hand, it is inadvisable to let the soil dry out completely; water it well, wait until a day after the soil appears to be dry again and then give it another good soak.

The large leaves attract dust, so it is a good idea to sponge them once every ten days, water and cotton wool. However, you must bear in mind that the newly –unfurled leaves are soft and tender and should not be sponged until they mature.

Volume: 03 Issue No: 11

GANGAMA MANDAL -A PROMISING NUTRIGARDEN MODEL TO ENHANCE NUTRITIONAL SECURITY AMONGST TRIBAL FARM FAMILIES

Article ID: AG-VO3-I11-52

[1*]Premila Ahir, [2]R. F. Thakor and [3]Lalit Kapur

1 Programme Assistant (Home Sci), GVPKVK, Valsad-Gujarat

2 Senior scientist and Head, GVPKVK, Valsad-Gujarat

3 Subject Matter Specialist (Soil Sci), GVPKVK, Valsad-Gujarat

*Corresponding Author Email ID: premila1205@gmail.com

Abstract

Nutritional deficiency is found to be the most important cause of malnutrition among the tribal children and women. It is well known fact that inclusion of fruits and vegetables in the daily diet play significant role in nutritional security. The nutria-kitchen garden offers great potential for improving household food security and alleviating micronutrient deficiencies. It has the potential, to supply most of the non-staple foods that a family needs every day of the year, including roots and tubers, vegetables, legumes, herbs and spices. Roots and tubers are rich in energy and legumes are important sources of protein, fat, iron and vitamins. It was clearly understood that unless the vegetables are being produced by the tribal farmers at their home they will not include it in the daily diet. With a view to address the nutritional problems of resource poor tribal families, the Gujarat Vidyapith Krishi Vigyan Kendra has undertaken many extension activities including Front Line Demonstration on kitchen gardening. Gangama mandal is a sacred geometrical diagram representing the cosmos, used in meditation and yoga. This mandala is a circular garden 30feet in diameter, covering less than 800 square feet area. The total average vegetable production of Gangama mandal with as many as 25 vegetable crops was 229 kgs. valued Rs.6940, With growing access to vegetables on a daily basis, these families no longer have to buy vegetables from the market.

Introduction

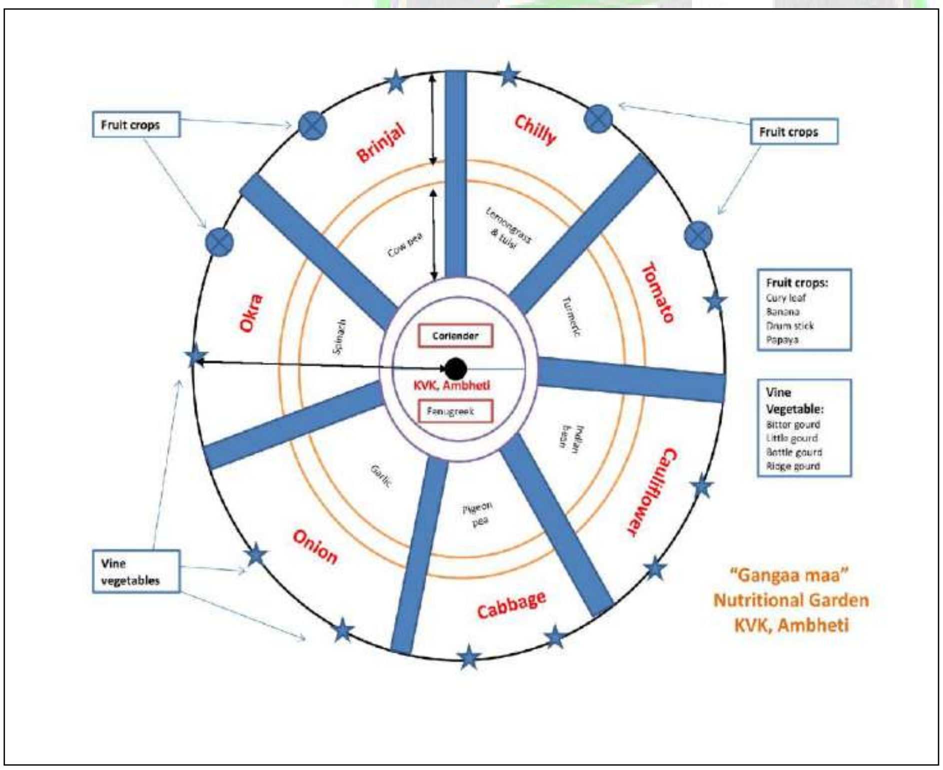
Valsad district belongs to south eastern parts of Gujarat characterized by the heavy rainfall, undulating topography, poor fertility of soils and predominant tribal area. Majority of the farmers are small and marginal resource poor tribal growing rice under rainfed condition. The continuous consumption of rice in the daily diet caused nutritional imbalance. Large population of women and children of the district is suffering from the sickle cell anemia. Green leafy vegetables provide essential vitamins and minerals, thus are a vital component of a healthy diet and should be eaten as part of every meal. Availability of the fruits and vegetables to the end user at affordable price is still become an important issue. It was clearly understood that unless the vegetables are being produced by the tribal farmers at their home they will not include it in the daily diet.

With a view to address the nutritional problems of resource poor tribal families, the Gujarat Vidyapith Krishi Vigyan Kendra has undertaken many extension activities including Front Line Demonstration on kitchen gardening. But the desired outcome was not obtained. Non -adoption of the technology has compelled the scientist to re-design the traditional nutri garden in such a way that it enabled to accommodate more no of vegetables in smaller area, which gave fresh vegetable production at regular intervals and that too satisfy the nutritional needs of the family.

From among the many designs of nutritional garden, KVK scientists has finally chosen Gangama mandal design developed by the Malpani trust of Devas, (MP) with slight modification in accordance with the local specific situation. Gangama mandal nutri- garden enables to produce large no. of vegetables with limited resources like land, water, labour etc. and aims to provide nutritional security to a family of five persons. This model envisages use of organic materials such as vermi compost, neem oil liquid bio fertilizer (LBF) compost etc. The total average vegetable production of Gangama mandal was 229 kgs. from 25 different vegetable crops valued Rs. 6940 within 100 days.

GANGAMA MANDAL - The design

The design is named after a girl who tries it on her farm. A mandal is a sacred geometrical diagram representing the cosmos, used in meditation and yoga. This mandala is a circular garden 30 feet in diameter, covering less than 800 square feet area. There are four circles. The diameter of outer circle is 30 ft. The radius of two inner circles is 5ft. and 4 ft, respectively. The inner most circle is having radius of 2 ft. The whole circle is divided in to seven equal parts by 1.5 ft pathway. Each circle has approximately 1 ft width useful for observation of each portion and carryout various operations without disturbing adjacent plot/plants. The Plants are grown in a circular bed arrayed in the centre as well as on both the sides of the path way. Fruit plants like banana or papaya may be planted in the centre or on the outer periphery. The nutritional garden is a proper combination of short and long duration vegetables including vine crops and herbal medicinal plants such as Ginger, Turmeric, Basil, Lemongrass, Mint, etc. It was grown in a manner that each portion gave fresh vegetable in a required quantity to small family of five persons. On the border of outer most circle vine crops like yam, sweet potato, bottle gourd and fruit crops like papaya, banana etc are grown. Due care was taken while growing different crops so that each crop can harvest proper sunlight at different stages of growth. Plant with less height grown in E-W direction. It is very flexible design can be change in accordance with the soil types, season, availability of land etc.



Layout of Nutri garden (GANGAMA MANDAL)

Intervention of KVK

Initially 30 farm women from 02 villages were trained on establishing Gangama nutritional gardens using eco friendly inputs. For the first instance the demonstration were laid out on five families of kaparada block. Based on the primary success, twenty- five demonstrations were laid down in three blocks during Rabi season. The av. Plot size of demo was 800-900 sq. ft. Since the soils are poor in organic carbon content well rottened FYM/Vermi compost @ 40 Kgs + Neem cake @ 5 Kgs was applied at the time of preparation of soil to avoid mortality of seeds and seedlings caused by soil born diseases. The seedlings of the Brinjal, Tomato, Cabbage, Cauliflower, marigold etc. were dipped in to the bacterial culture solution (1 lit water + 100 gms jaggery + liquid biofertiliser 100 ml each of PSB, azo tobactor and potash mobilizing bacteria) for about 12-15 minutes before being transplanted in to the field. The Seeds /seedlings of vegetables treated with liquid bio fertilizer strains were also provided. As many as 32 crops which includes 3 fruit crops and 5 herbal medicinal crops were accommodated in the 800 sq. ft. area. Two spray of neem kernel extract were applied in the initial stage of the crop growth as precaution measure against attack of sucking pests. The total cost of each demonstration units including all inputs and labour charges gone up to Rs. 1200/-. The production data of each crop was maintained by the demo farmer in the separate sheet provided to them.

Harvesting Nutrition from Nutri garden

The results speak for themselves: each family could harvest 11-12 Kgs of brinjal; 7-10kgs of bottle gourd; 9-11kgs of tomato; 4-6kgs of pointed gourd, 4-6 Kgs of Chilly, 8-10 Kgs of ladies finger, 3-4 Kgs cluster bean, etc. in addition to Coriander, Garlic, Ginger, Mint, Fenugreek, Palak, Turmeric, Onion, Elephant food etc. in their backyards. The total average vegetable production of Gangama mandal with as many as 25 vegetable crops was 229 kgs. valued Rs. 6940. Many of them has sold about 30 per cent of their produce amongst neighbor by which they received an income of Rs.600-700.With growing access to vegetables on a daily basis, these families no longer have to buy vegetables from the market. This means they save around Rs.1200 every month. Many of the families reuse the kitchen waste water. There is a visible change in food consumption pattern as the families include variety of vegetables in their daily diet.

Spreading Success

The extension strategy has been planned to extrapolate the technology among other farmers through publication of literature, arranging visit of group of farmers on demo units, organizing Video shows, etc. As many as 133 units of Gangama nutri- garden were developed in the schools with the active involvement of the students and teachers through District Institute of Training and Education. More than 350 officials of integrated child development schemes (ICDS) and 245 teachers were trained by KVK on nutria kitchen garden development thought the district.

Conclusion

Nearly every second tribal family is food-insecure, with low caloric and protein consumption. It is clear that improving the 'nutrition of tribal' needs to become the heart of the equity agenda cutting across departments for significant and sustained impact. The scaling up of proven nutrition interventions like Gangama nutri- kitchen garden model may be useful to some extent to improve household food security by growing and alleviating macro and micronutrient deficiencies amongst resource poor tribal.

Volume: 03 Issue No: 11

GEOGRAPHICAL INDICATION TAGS –AN INVALUABLE TREASURES OF INCREDIBLE INDIA

Article ID: AG-V03-I11-53

[1]Preetha, K., [2*]V. Krishnan, [1]S. Lakshmipriya, [1]J. Arathi, [1]Praveen, R., [1]FS. Aparna and [2]V. Vengadessan

[1]PG Scholar & [2]Faculty, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal 609603, U. T. of Puducherry

*Corresponding Author Email ID: anurathakrishnan66@gmail.com

Introduction

In this changing world, to know about the origin and heritage of our country, this geographical indication tag acts as an incredible tool. Geographical Indication (GI) has developed as a significant type of Intellectual Property Rights issue in India. It provides the right to use the indication for the product to their manufacturers or producers from that particular region. It also means that they have the legal right to prohibit the use of the sign or name which doesn't have certain qualities and characteristics ensured by the GI of that particular product. Till 30th September, 2020 out of 706 applications, 370 products were registered under GI in India. Some products were also registered by foreign countries in India. 15 products from 9 countries were registered for GI. A Geographical Indication (GI) is a sign or tricolour logo used on products that have a specific geographical origin and required qualities or a reputation.

GI TAG:

According to World Trade Organization Geographical Indication means "Indications which identify a good as originating in the territory of a country, or a region or locality in that territory, where a given quality, reputation or other characteristics of the good is essentially attributable to its geographical origin". (Geographical Indication, n.d.)

COMMENCEMENT OF GI TAG IN INDIA:

"A pride to our treasures is installed"

GI tags was issued by the **Geographical Indication Registry, under the Department of Industry Promotion and Internal Trade, Ministry of Commerce and Industry.** This was enacted by the government as **Geographical Indications of Goods (Registration and Protection) Act, 1999** and came into force from September, 2003. The main headquarters is located in **Chennai** where all new applications are registered. At the International level, GI is governed by the World Trade Organisation's (WTO's) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). **"Its renewal period is for about 10 years.** Though worldwide, France was the first country to enact a comprehensive system for the protection of GIs.

Laws Concerning GI Tag Are Article 22 & Article 23

OBJECTIVES:

- To provides security to the new or unique goods manufactured or produced by an individual or association of person.
- To prevent unauthorised use of a Registered Geographical Indication by others.
- To help consumers to get quality products of desired traits and is assured of authenticity.
- To increases the trade and tourism.
- To prohibits malpractice and avoids sale of low-quality products in the market.
- Most of the traditional products, produced by rural communities gained prominence on the markets for their precise qualities.

"Exporters Claim:- The Recognition That Gi Tags Bring to Products in Foreign Markets Is Helpful"

GEOGRAPHICAL INDICATION TAG IN INDIA:

Some of the invaluable treasures of incredible India **are Darjeeling Tea** (**first Indian product** came to effect from 15th September 2003)**, Mysore betel leaf, leather toys of Indore, Odisha rasgulla, Kandangi saree and Kashmir saffron** are given GI tags in India.

Dubraj rice, also known as the "Basmati of Chhattisgarh," is highly aromatic.

Top 5 states in India with maximum of GI tags includes **Uttar Pradesh, Tamil Nadu, Karnataka, Maharashtra, and Kerala**.

PROCESS OF GI REGISTRATION IN INDIA:

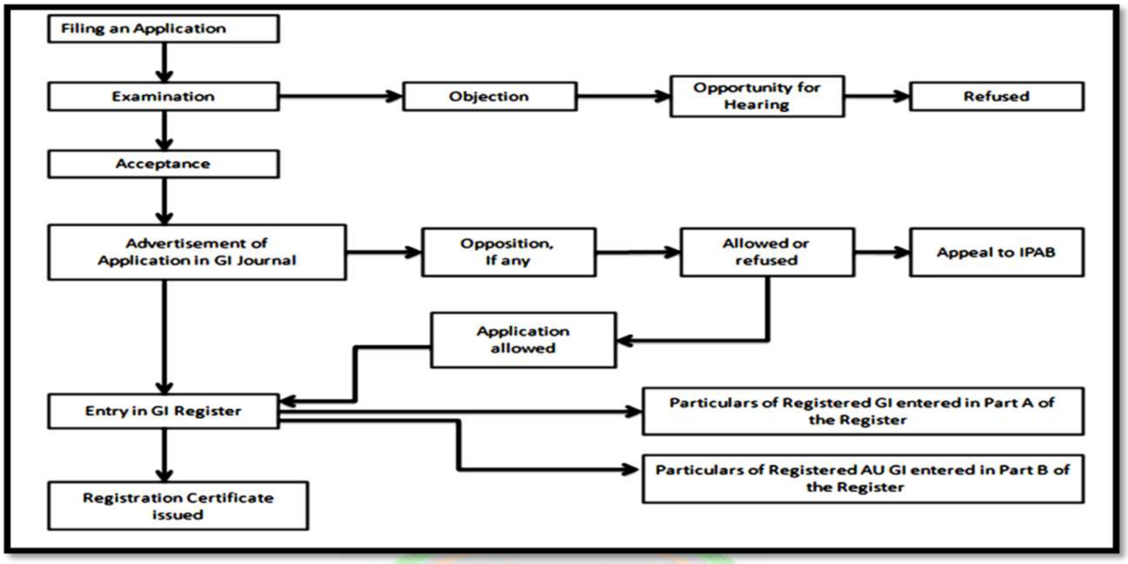


Fig. 1. The process of registering for GI Tag

LIST OF GEOGRAPHICAL INFORMATION TAGS:

- Amroha Dholak Mahoba
- Gaura Patthar Hastashlip
- Mainpuri Tarkashi
- Sambhal Horn Craft
- Baghpat Home Furnishings
- Barabanki Handloom Product
- Kalpi Handmade Paper

Fig.2. GI tag

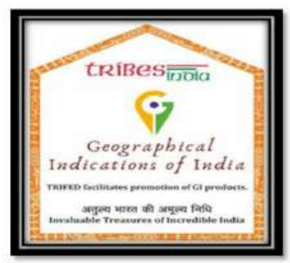


Fig.3. GI Certification

Fig. 4. Some of our GI Registered products

LIST OF OUR INCREDIBLE GI TAGED PRODUCTS:

PRODUCTS	CATEGORIES	STATES/UTS
Kashmir Saffron	Agriculture	Jammu & Kashmir
Manipuri Black Rice	Food Stuff	Manipur
Kandhamal Haladi	Agricultural	Odisha
Rasagola	Food Stuff	Odisha
Kodaikanal Malai Poondu	Agricultural	Tamil Nadu
Pawndum	Handicraft	Mizoram
Ngotekherh	Handicraft	Mizoram
Hmaram	Handicraft	Mizoram
Palani Panchamirtham	Food Stuff	Tamil Nadu
Tawlhlohpuan	Handicraft	Mizoram
Mizo Puanchei	Handicraft	Mizoram
Gulbarga Tur Dal	Agricultural	Karnataka
Tirur Betel Leaf (Tirur Vettila)	Agricultural	Kerala
Khola Chilli	Agricultural	Goa
Idu Mishmi Textiles	Handicraft	Arunachal Pradesh
Dindigul Locks	Manufactured	Tamil Nadu
Kandangi Saree	Handicraft	Tamil Nadu
Srivilliputtur Palkova	Food Stuff	Tamil Nadu
Amroha Dholak	Handicraft	Uttar Pradesh
Mahoba Gaura Patthar Hastashilp	Handicraft	Uttar Pradesh
Sambhal Horn Craft	Handicraft	Uttar Pradesh
Baghpat Home Furnishings	Handicraft	Uttar Pradesh
Barabanki Handloom Product	Handicraft	Uttar Pradesh
Kalpi Handmade Paper	Handicraft	Uttar Pradesh

STATEWISE REGISTRATION STATUS OF GI TAG

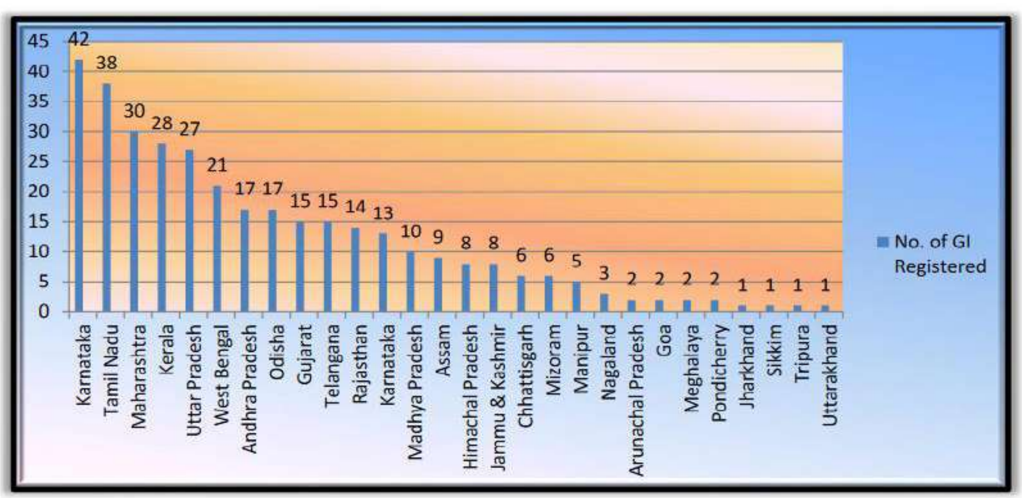


Fig.5.State wise registration status

INTRASTATE REGISTRATION STATUS

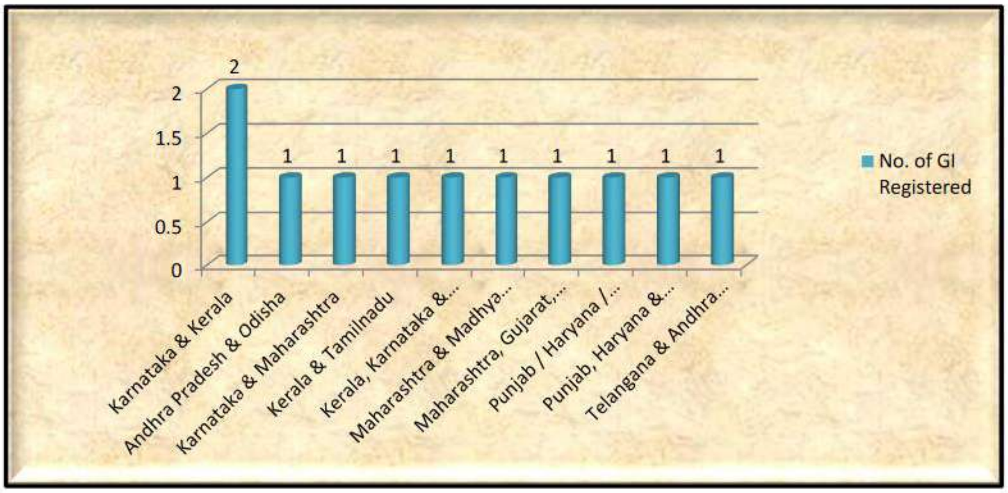


Fig.6. Intrastate Registration Status

CONCLUSION:

It's not bad to say that geographical information tag in India is still emerging and its roots are still penetration in its way, as we all know its new to our country. It matters as a pride to both of manufacturer and consumer as a symbol of excellence. The poor craftsmen efforts to maintain such a good quality that is known and retained worldwide. Before registering GI, all the criteria should be kept in our mind. From the commercial point of view, every entrepreneur wants to earn more and more profit by selling the products which consumers demand and every customer wants standard quality product, thus this GI satisfies both of them needs and captures the hearts of people.

"Forget Not to Protect Our Valuables"

References

World Trade Organisation. Agreement on Trade Related Aspects of Intellectual Property Rights. Protection of Geographical Indication. Article 22.1. Retrieved from.httpswww.wto.orgenglishdocs_elegal_e27-trips_04b_e.htm..htm

World Intellectual Property Organization. Geographical Indication. Retrieved from. https://www.wipo.int/geo_indications/en/.

Rangnekar, Dwijen (2003). Geographical Indications: A Review of Proposals at the TRIPS Council.UNCTAD-ICTSD Project on IPRs and Sustainable Development. Retrieved from https://unctad.org/en/PublicationsLibrary/ictsd2003ipd4_en.pdf on 25th August, 2020.

Hirwade, Mangala & Hirwade, Anil W. (2006). Geographical Indications: Indian scenario. Retrieved from https://www.researchgate.net/publication/28805024 on 25thAugust, 2020.

Mir, Farooq Ahmad & Ain, Fartual (2010). Legal Protection of Geographical Indications in Jammu and Kashmir: A Study of Kashmiri Handicrafts, Journal of Intellectual Property Rights, Vol.15 (3), 220-227.

Chikate, Anil Nanji & Gadge, Sharmila V. (2014) Geographical Indications: A Brief Appraisal of Indian Scenario,SRELS Journal of Information Management, Vol. 51 (6). 377-385.

Gulati, Shruti. (2016). Geographical Indications in India & the Case of Famous Indian Weave: Banarasi Brocade, International Journal of Research – Granthaalayah, Vol. 4 (12), 137-146.

Yadav, Sujitkumar, et.el. (2018). Geographical Indication and Registration for it in Uttar Pradesh, India: Present and Future Potential, International Journal of Research in Agricultural Sciences, Vol. 5 (1), 48-57.

WIPO IP Statistics Data Center. Retrieved from. httpswww3.wipo.intipstatsindex.htmtab=geographical.htm

Volume: 03 Issue No: 11

WATER QUALITY PARAMETERS

Article ID: AG-VO3-I11-54

GNANA KEERTHI SAHASA RAVEENDRA[1*]

[1]Assistant Professor (Environmental Sciences), Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri, Tamil Nadu – 635 105.

*Corresponding Author Email ID: gnanakeerthisahasa2020@gmail.com

Abstract

The most important parameters which are used to assess the quality of water include temperature, total solids (suspended and dissolved), dissolved gases (dissolved oxygen in particular), pH, acidity/alkalinity, total hardness, nitrogen, phosphorus and levels of micronutrients and trace elements (including heavy metals) as well as microorganisms. Based on the levels on the levels of these parameters, the health of a water resource is usually determined, i.e. at desirable levels, the water is deemed to be fit for both natural and human activities; while at higher or lower levels the water loses its desirability.

Keywords: Water quality, pH, Dissolved oxygen, Total hardness, Suspended solids

Introduction

Water is the most important natural resource which is required by living organisms for their growth and development. It is also a common substrate for various other physicochemical and biological processes that occur in the nature. Nearly every human activity is dependent on water. Water in nature is not pure and is always mixed with different substances, which interfere or promote a particular process in the environment. This article discusses various water quality parameters which influence the utility and desirability of the water for various purposes.

Water Quality Parameters

a. Water temperature

Natural water bodies have different temperatures in response to seasonal and diurnal variations in solar radiation.

Water clarity has a significant impact on light penetration into water bodies, which controls the depth at which photosynthesis takes place. In surface water bodies, the upper layers of water warm up faster than the deeper water due to solar radiation. Thermal stratification, whereby warmer, lighter water from the surface layer mixes with colder, heavier water from deeper layers, is a common occurrence in aquatic bodies. Additionally, most physicochemical and biological processes occur more quickly in warm environments, and with increasing temperature respiration rate of aquatic organisms also increase.

b. Dissolved solids

Natural waters are composites of different solutes. These solutes might be liquids, solids, or gases, but the most significant solutes in terms of water quality are solids and gases. Dissolvable minerals from surface soils and subterranean geological formations make up the majority of dissolved solids in water bodies that exist. Each mineral has a unique solubility, which is further influenced by factors like as pH, temperature, oxidation-reduction potential, the presence of other dissolved materials, and the laws of chemical equilibrium.

c. Suspended Solids, Colour, Turbidity and Light

Suspended particles in natural water bodies cause turbidity increase and give the water an apparent color, and obstruct light penetration. These particles come from microbes created in water bodies, vegetation detritus from watersheds, and erosion. The suspended particles consist of bigger silt and sand particles retained in suspension by turbulence, as well as colloids that stay suspended forever. Due to their low density, organic particles settle slowly; yet, planktonic organisms also possess adaptations that decrease the speed of settling. Water bodies may gradually "fill in" as a result of suspended solids sedimentation, and benthic creatures may deteriorate. Water bodies with turbidity and color have lower rates of photosynthesis and reduced productivity.

d. Dissolved oxygen

The biological processes associated with plant photosynthesis and aquatic organism respiration both affect the amounts of dissolved oxygen in water. Photosynthesis often happens more quickly during the day than respiration, and the concentration of dissolved oxygen rises. In waters with thriving plant communities, the concentration of dissolved oxygen in the afternoon will usually be higher than saturation. While respiration proceeds to use oxygen during the night, photosynthesis pauses, causing the dissolved oxygen concentration to drop to less than saturation. Since deeper waters have less light, the dissolved oxygen concentration likewise tends to decrease with increasing sea depth.

Table 1. Response of warm water fish to different levels of Dissolved O_2

Dissolved O_2 (mg L^{-1})	Effect
0 – 0.3	Small fish live if the exposure period is short
0.3 – 1.5	Prolonged exposure (several hours) can cause death
1.5 – 5.0	Fish can survive with growth slowed down and increased disease susceptibility
5.0 - Saturation	Desired range for normal fish growth
Above saturation	Prolonged exposure might cause Gas bubble trauma

(Source: Claude, 2020)

e. pH, CO_2 and Acidity/Alkalinity

Although fish have been proven to avoid concentrations of CO_2 of 10 mg L^{-1} or more, most aquatic creatures do not find CO_2 to be very hazardous. When there is enough dissolved oxygen present, the majority of species can withstand up to 60 mg L^{-1} of CO_2; nonetheless, fish are paralyzed when exposed to elevated levels of CO_2. Due to the fact that the hydrogen ion affects numerous reactions, pH acts as a master variable in water quality. Soils as well as other geological formations contain feldspars, limestone, and calcium silicate, which dissolve when exposed to CO_2, raising the pH and bicarbonate concentration in water. In waters of humid regions with heavily leached soils, total alkalinity is usually less than 50 mg L^{-1}; however, in regions with more fertile soils, limestone formations, or arid climates, it is higher.

In low- to moderate-pH waters, alkalinity increases the amount of inorganic carbon available for photosynthesis. Water bodies exhibiting a medium to high alkalinity are resilient to significant daily fluctuations in pH, which arise from the net removal of CO_2 during the daytime due to photosynthesis and the reintroduction of CO_2 to the water through respiration during the night, when photosynthesis is not occurring. Most aquatic organisms thrive in a pH range of 6.5 to 8.5, with pH 4 and pH 11 serving as the acid and alkaline death points, respectively. For aquatic life, an alkalinity of 50–150 mg L^{-1} is ideal.

Humic substances, which are also weak acids, and CO_2, which functions like a weak acid, are the main causes of acidity in natural waters. The pH can be lowered by humic substances to as little as 3.7 or 3.8, but CO_2 concentrations are typically insufficient to reduce pH below 4.5.

Strong acids are present in lower pH waters. A water sample is regarded as having only CO_2 acidity if its pH ≥ 4.5. Water bodies with high humic substance concentrations have low productivity due to low pH, inadequate nutrient concentrations, and limited light penetration. These waters will also have a low level of biodiversity. Acidity typically has the most detrimental effects on biodiversity and productivity when the pH is less than 5.

f. Total Hardness

Divalent cations, primarily from calcium and magnesium, expressed as equivalent calcium carbonate, are what cause the overall hardness of water. For example, 1 mg L^{-1} of magnesium is equivalent to 4.12 mg L^{-1} of total hardness, whereas 1 mg L^{-1} of calcium is equivalent to 2.5 mg L^{-1}. In waters from humid regions, the concentration of hardness and alkalinity is often similar, but in waters from arid regions, hardness usually outweighs alkalinity. As a biological variable, hardness is generally less significant than alkalinity; however, hardness plays a significant role in the supply and use of water. When water with significant alkalinity is heated or its pH rises, high calcium and magnesium concentrations cause scale to form. This causes scale buildup in the boilers and in heat exchangers, as well as blockage of water pipes. Additionally, soap is precipitated by divalent ions, which increases the use of soap in both residential and commercial laundries.

g. Microorganisms

Numerous kinds of microorganisms, such as bacteria, fungi, arthropods, rotifers, protozoa, and bryozoa, live in aquatic environments. Ecologically speaking, all of these organisms are significant, but bacteria that live in the sediment and suspended in the water column, as well as microscopic algae known as phytoplankton, have a bigger influence on water quality than other microorganisms. Through photosynthesis, phytoplankton generates huge quantities of organic matter and enormous amounts of oxygen that are released into the water. In order to release inorganic nutrients, bacteria break down organic matter. The pH and the levels of CO_2 and dissolved oxygen in water are significantly impacted by the respiration of bacteria and the respiration and photosynthesis of phytoplankton.

Certain species of algae can give water and the meat of fish as well as other aquatic edible creatures unpleasant tastes and odors, while some microorganism like E. coli are pathogenic. Shellfish poisoning is a result of algal toxins and it can lead to various painful symptoms or even death in humans. The concentration of dissolved oxygen is arguably the most significant factor affecting the general health of aquatic ecosystems.

h. Nitrogen and Phosphorus

Increased nitrogen concentrations frequently cause an increase in plant growth because many aquatic ecosystems have limited amounts of available nitrogen. Although nitrogen is employed as a fertilizer in aquaculture and agriculture, adding nitrogen to the majority of water bodies is regarded as nutrient pollution because it promotes dense phytoplankton blooms, or eutrophication. Aquatic organisms may be poisoned by excessive levels of nitrite, ammonia, and dinitrogen gas (N_2).

It is rare for total phosphorus concentrations in water bodies to be higher than 0.5 mg L^{-1} and inorganic phosphorus concentrations to be higher than 0.1 mg L^{-1}. Iron phosphate solubility rises in anaerobic zones; phosphate concentrations above 1 mg L^{-1} can be found in hypolimnetic water of eutrophic lakes and sediment pore water. While phosphorus alone is not harmful at high concentrations, it can cause eutrophication when combined with nitrogen.

i. Sulfur

Fish along with other aquatic animals are highly susceptible to sulfur in its unionized form (H_2S), but the ionized forms (HS and S_2) are not as toxic. The quality of drinking water is the main concern when it comes to sulfur concentration. Drinking water containing sulfur can taste bitter. People experience a bitter taste at 250–1000 mg L^{-1} of sulfate, depending on their sensitivity. Those who are not accustomed to drinking water with high sulfate concentrations may also experience laxative effects. Chlorination is also hampered by high sulfate concentrations in water.

Well water may contain contaminants such as hydrogen sulfide. At sulfide levels of 0.1 to 0.5 mg L^{-1}, most of the people can detect an unpleasant odor. The odor of hydrogen sulfide is commonly characterized as musty at concentrations up to 1 mg L^{-1}, but at higher concentrations, it takes on the characteristic smell of a rotten egg. Elevated quantities of hydrogen sulfide not only smell bad, but they also severely corrode water fixture and pipes.

j. Micronutrients

Natural water frequently contains dissolved materials that fall into one of the two groups. Major elements are typically defined as those with concentrations > 1 mg L^{-1}, whereas trace elements are defined as those with concentrations < 1 mg L^{-1}. Ultra-trace elements are elements that are present in the lowest concentrations. Micronutrients or trace nutrients include manganese, iron, copper, zinc, and a few other trace minerals that are vital to aquatic life. In certain freshwater and marine environments, the amounts of iron and occasionally other micronutrients can be so low as to restrict productivity. For species, including humans who consume water with high quantities of some trace elements, excessive concentrations of non-essential trace elements and micronutrients can prove harmful. Pollution is frequently the cause of higher-than-normal concentrations of trace elements, although elevated concentrations can also occasionally occur naturally.

Conclusion

The important parameters which influence the quality of water are explained above. Hence, it can be understood that for a water body to remain healthy or fit for use, the water quality parameters like pH, total hardness, turbidity, levels of dissolved gases and the others must remain within the desirable limits. Despite the high requirement of water, it is well known fact that fresh water available for utilization on the earth is less than 1%. Therefore, humans need to use water resources with discretion, reduce water pollution alongside and develop new techniques to increase reusable water levels. Knowing more about factors governing water quality helps in developing such treatment technologies.

References

Claude E. B. Water Quality: An introduction. Edn 3, Springer Nature, Switzerland, 2020.

Kumar U. Water, Environment and Pollution. Agrobios (India), Jodhpur, 2016. 31-38.

Gorde, S. P., & Jadhav, M. V. 2013. Assessment of water quality parameters: a review. *J Eng Res Appl*, *3*(6), 2029-2035.

Volume: 03 Issue No: 11

GONIOMETRY AND ITS IMPORTANCE IN CATTLE

Article ID: AG-V03-I11-55

Dr. S. Rajathi* and Pavithra P

Assistant Professor, Department of Veterinary Anatomy

Veterinary College and Research Institute, TANUVAS, Tirunelveli, Tamil Nadu, India

*Corresponding Author Email ID: rameshppphy@gmail.com

Introduction

It is the measuring of angles created by the bones of the body at the joints. The term goniometry is derived from two Greek words, "gonia" meaning angle and "metron" meaning measure.

PRINCIPLES OF GONIOMETRY:

- Position and stabilize the joint correctly
- Palpate the appropriate bony landmarks
- Align the goniometer with the landmarks
- Move a bony part through its appropriate range of motion
- Read the measuring instrument properly

STANDARD SIZE GONIOMETER:

12-1/2" L. Medium international standard goniometer has two rows of numbers. Outer row measures 0 degree to 180 degree in 1 degree increments. It is made of transparent plastic.

Goniometer invented by SAMUEL LEWIS PENFIELD, a geology professor at Yale university

RANGE OF MOTION:

Range of motion refers to how far you can move or stretch a part of your body, such as a joint or a muscle. The center of the goniometer is also called the fulcrum should place right on the fulcrum of the point you are measuring. The center is the round section attached to the stationary arm. Aligning the fulcrums of both the goniometer and the joint will ensure an accurate measurement.

IMPORTANCE OF GONIOMETRY:

Goniometric measurements can be useful in a variety of clinical scenarios. They range from mapping the spine mobility in cases of Ankylosing spondylitis to checking the range of motion of the spine after fusion surgeries for scoliosis.

The axis of the goniometer is placed 15 mm inferior to the lateral malleolus. The static arm should be parallel to the fibula. The dynamic arm should be parallel to the long axis of the fifth metatarsal. Normal range of plantar flexion is approximately 50-55 degrees.

LIMITATIONS OF GONIOMETRY:

A limitation of goniometry is that it requires the clinician to use both hands making stabilization of the extremity more difficult and thus increasing the risk of error in reading the instrument.

ARCHITECTURE OF GRIDLES AND LIMBS:

The loading of the girdles and limbs takes place through the thoracic and pelvic pension mechanism; the first is a synsarcosis, the latter the almost the immovable iliosacral joint.

The distribution of the load over the limbs is primarily related to the location of the center of gravity, which is determined as platform, “AB” of convenient length say 3 m ; “W” is the weight of the animal which is previously determined “w” is center of gravity; “C” is the point of intersection of the working line of W and AB. “V” is the weight indicated by the weighing machine.

AB = V; W

AC= AB*V/W; AB=3m

Suppose that V=6 kg and W=14 kg, then AC=1.28 m. Accordingly EC and EF can be measured; let EC be 35 cm and CF be 45 cm.

The reaction at E=b/a+b*W=7.875 kg and at F=a/a+b*W=6.125 kg

The location of the center of gravity has its bearing on the type of support. ABCD represent the points of contact between the feet and the ground in a quadrupedal mammal.

Girdles, Stylopodial and Zeugopodial elements of Thoracic and Pelvic limbs

The shoulder suspension mechanism has been previously reported. Inspection of the muscular topography around the scapula reveals certain symmetry of muscles around the scapular spine, and it is not too difficult to detect that these muscles, especially in the lateral aspect, exert a number of functional couples that tend to counteract the rotations of the shoulder blade produced by the limb. In the standing animal, the moment of the normal reaction, N at the shoulder joint tends to turn the ventral (glenoid) angle of rotation, H at the facies serrata. A combined action of the deep pectoral(P) and cervical part of the trapezius (T) possibly assisted by the lattissimus dorsi(L) fibres forms a couple that produces a counteracting moment. In the case of a retraction of the upper arm and shoulder joint by the deep pectoral and the lattisimus dorsi, the ventral angle of the scapula is drawn ventrally caudate- a balancing couple can be established by the thoracic part of the trapezius and the omotransversus muscles. The symmetrical arrangement of the muscles around the scapular spine.

ARTHRITIS:

Inflammation of the joint and its consequences are important from economic point of view. The classification of arthritis is a subject of constant debate but joint lesions which leads to arthritis are broadly divided into two main categories i.e., infectious and non-infectious.

Frequency of occurance of degenerative arthritis in ruminants is far less than infectious arthritis.

DEGENERATIVE ARTHRITIS:

Degenerative arthritis is characterized by degeneration and erosion of the articular cartilage,eburnation of the subchondral zone and lipping and osteophyte formation at the joint margins. Synovitis and joint effusions are associated with the disease.

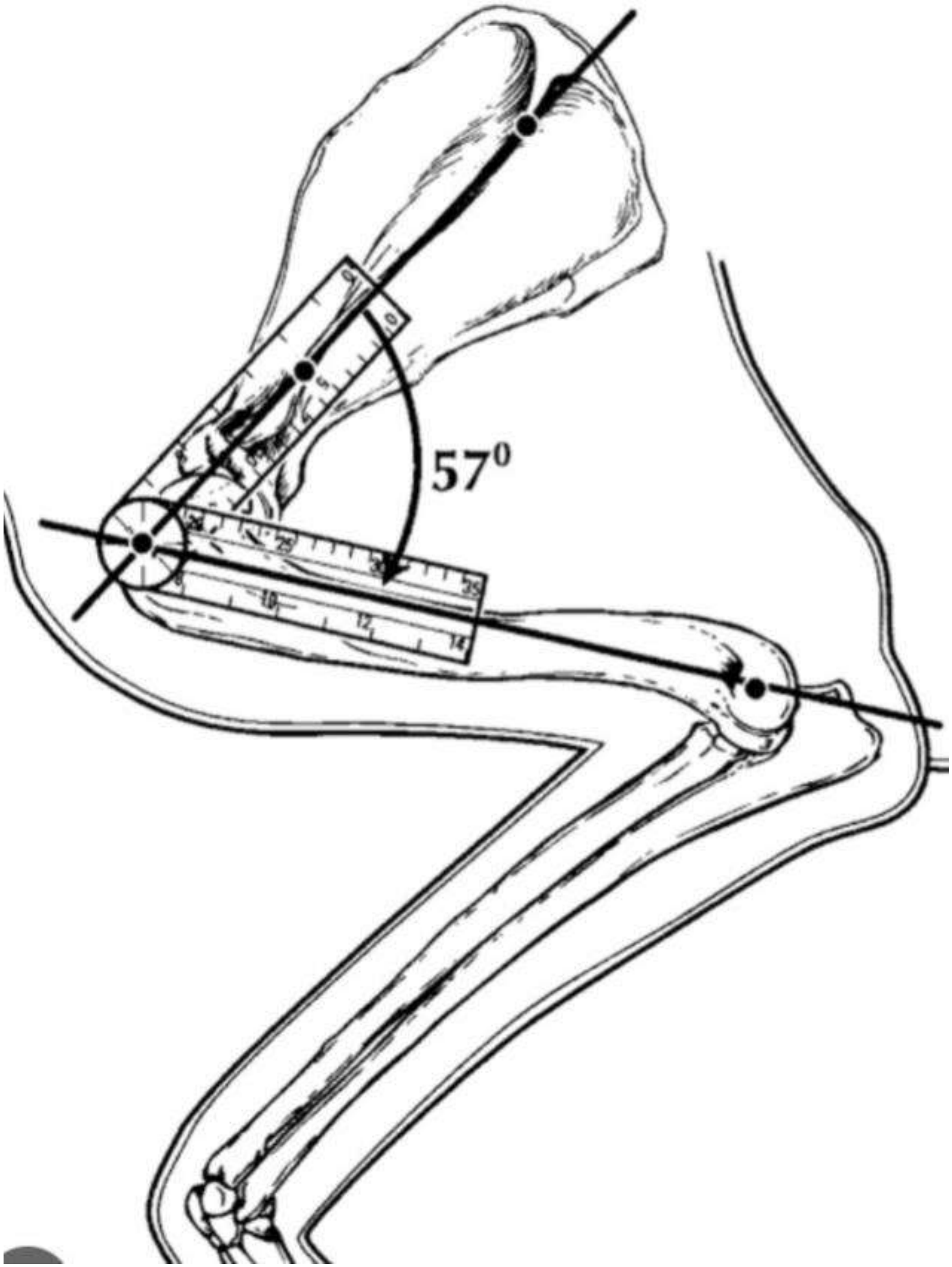
PATHOGENESIS:

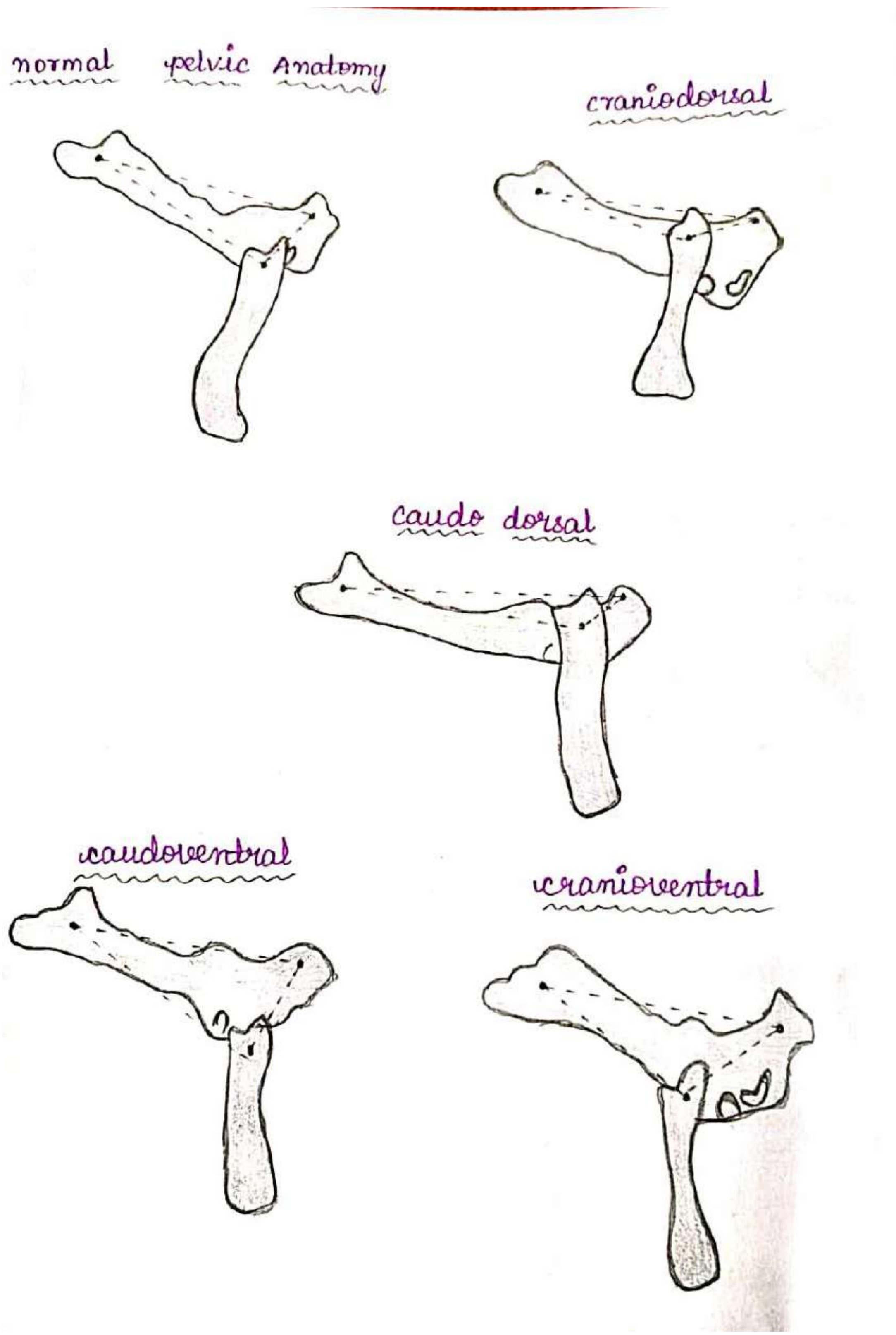
In ruminants, Degenerative joint disease (DJD) either primary or secondary. In primary DJD, changes occurs in articular cartilage with the advancing age due to wear and tear of the joints as a result of their normal use.

In secondary DJD, changes in the cartilages are a consequences of abnormal mechanical stresses acting on the joint.

INFECTIOUS ARTHRITIS:

Infectious arthritis is the inflammation of the synovial membrane and articular surfaces that results from localization of bacterial, viral, mycotic or mycoplasma infection in a joint.


57⁰


normal pelvic Anatomy
craniodorsal
caudo dorsal
caudoventral
cranioventral

PELVIMETRY:

- It is the measurement of dimensions of the bony pelvis undertaken chiefly to help determine whether a women can give birth normally or will require a caesarean section
- Pelvimetry is the measurement of the female pelvis. It can theoretically identify the cephalo-pelvic disproportion, which is when the capacity of the pelvis is inadequate to allow the foetus to negotiate the birth canal.
- Instrument is used for pelvimetry is Pelvimeter. It is a measuring device used and assessed the size of the birth canal to assess how far along the labour

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

HIRSCHSPRUNG'S DISEASE: A COMPREHENSIVE OVERVIEW OF PATHOPHYSIOLOGY AND GENETIC FACTORS

Article ID: AG-V03-I11-56

***Ravi Prakash G[1], Abhiramnaidu K[2], J Sathya[3]**

[1]Division of Pharmacology & Toxicology, IVRI, Izzatnagr, Barelly-243122

[2]Department of Veterinary Public Health and Epidemiology, RIVER, Puducherry

[3]Alagappa University Karaikudi, Tamil Nadu

*Corresponding Author Email ID: rprakash376.rp@gmail.com

Introduction

Hirschsprung's disease (HD) is a common cause of intestinal obstruction in newborns, characterized by the absence of ganglion cells in the lower bowel starting from the internal sphincter and extending upwards for varying distances. In the developing fetus, neural crest-derived cells typically appear in the oesophagus around 5 weeks of gestation and migrate towards the anal canal in a craniocaudal direction between the 5th and 12th weeks of gestation. The lack of ganglion cells in HD is due to the failure of these neural crest cells to migrate properly. The earlier this migration is interrupted, the longer the segment without ganglion cells becomes. The absence of these cells results in a lack of peristalsis in the affected bowel, leading to functional intestinal obstruction (1).

In simpler terms, Hirschsprung's disease involves a missing type of nerve cell in the lower bowel, which disrupts the normal movement of the intestine and can cause bowel obstruction. This condition typically arises during fetal development when certain nerve cells fail to reach their proper destination in the bowel (2).

Harald Hirschsprung first described Hirschsprung's disease (HD) in 1888. However, it wasn't until the 1940s that the pathological features of the condition were fully understood. Researchers, Whitehouse and Kernohan, demonstrated that aganglionosis, the absence of ganglion cells within the distal colon or rectum, was the root cause of the functional obstruction associated with HD.

In 1948, Swenson and Bill introduced a significant development in the treatment of HD. They reported that rectosigmoidectomy with the preservation of the sphincter was the optimal treatment for this condition. In recent years, there has been a shift in the diagnosis and management of HD. Most cases are now diagnosed in the neonatal period, and many medical centres have adopted one-stage pull-through operations in newborns. This approach has shown minimal morbidity and encouraging results. Hirschsprung's disease, a congenital disorder characterized by the absence of ganglion cells in the lower intestine, has seen notable advancements in understanding and treatment over the years (2).

INCIDENCE OF HD

Multiple studies have examined the frequency of Hirschsprung's disease (HD). The estimated incidence of HD is approximately 1 in 5,000 live births, although it can vary within a range from 1 in 2,000 to 1 in 12,000 live births. Notably, a comprehensive survey conducted by the California Birth Defects Monitoring Program from 1983 to 1997 revealed differing incidence rates among ethnic groups. It reported an incidence of 1.5 in 10,000 live births among whites, 2.1 in 10,000 live births in African Americans, 1 in 10,000 live births in Hispanics, and 2.8 in 10,000 live births in Asians.

Furthermore, a recent nationwide survey in Japan from 1998 to 2002 identified an incidence of HD at 1 in 5,343 live births. These findings underscore the variability in HD incidence across different populations and regions (3).

FACTORS INVOLVED IN THE OCCURRENCE OF HD

1. Sex

Hirschsprung's disease (HD) exhibits a notable gender disparity, with males being more commonly affected than females, with a male-to-female ratio of 4:1. However, this male preponderance is less pronounced in cases of long-segment HD, where the male-to-female ratio ranges from 1:1 to 2:1. Interestingly, in total colonic aganglionosis, the gender ratio is even reversed, with a male-to-female ratio of 0.8:1.

The specific reasons for these skewed gender ratios in HD are not entirely clear, and no X-linked loci associated with the condition have been identified.

In summary, while HD predominantly affects males, the gender distribution can vary depending on the specific form of the condition, and recurrence risk in families is influenced by both the sex and extent of aganglionosis in affected individuals (4).

2. Race

Recent research, including data from the California Birth Defects Monitoring Program, has shed light on the incidence of Hirschsprung's disease (HD) across different racial and ethnic groups. The findings indicate variations in the occurrence of HD among these populations.

Asians: The California Birth Defects Monitoring Program reported the highest incidence of HD among Asians, with a frequency of 2.8 cases per 10,000 live births.

African Americans: Following Asians, African Americans also exhibited a notable incidence of HD, with a frequency of 2.1 cases per 10,000 live births (2).

Nonwhite Males: In a previous epidemiological study by Goldberg, the incidence of HD among nonwhite males was found to be 3.76 cases per 10,000 live births, indicating a relatively higher occurrence.

Long-Segment Disease: While there may not be significant differences in the overall incidence of HD between whites and African Americans, it's worth noting that long-segment HD occurs significantly less frequently in nonwhite populations compared to whites. This finding suggests a variation in the presentation of the disease within different racial groups.

Oman: It's important to mention that a survey in Oman reported an exceptionally high incidence of HD, with 1 case in 3,070 live births. However, this is unlikely to be solely attributed to racial differences but rather may be influenced by a high rate of consanguinity within the population (5).

These findings highlight the complexity of HD incidence and suggest that both genetic and environmental factors may play a role in its prevalence among different racial and ethnic groups.

3. Heredity

Hirschsprung's disease (HD) has a genetic component and can be hereditary. Some of the key points related to the genetic factors associated with HD:

Familial Incidence: HD is known to occur in families, and there is a reported incidence of familial cases. The familial incidence varies depending on the type and extent of aganglionosis. For rectosigmoid HD, the incidence ranges from 3.6% to 7.8% in different series. In cases of total colonic aganglionosis, a familial incidence of 15% to 21% has been reported. Moreover, total intestinal aganglionosis, a rare form of the condition, has a very high familial incidence of 50% (2).

Variation in Aganglionosis Level: HD can manifest with varying levels of aganglionosis. Some individuals may have aganglionosis in the rectal or rectosigmoid area, while others may experience it in the left colon, transverse, or right colon, or even total colonic ganglionosis with variable small bowel involvement.

Isolated Trait: In approximately 70% of patients with HD, the condition occurs as an isolated trait, not associated with other genetic abnormalities.

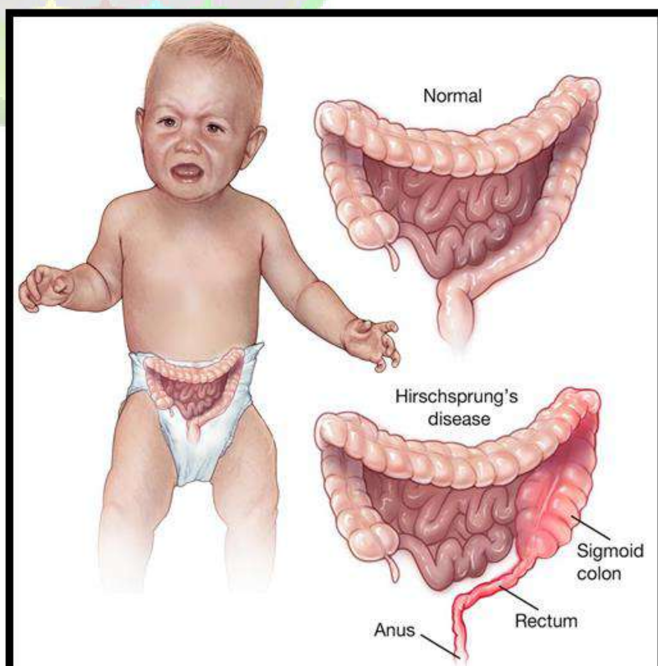
Chromosomal Abnormality: Genetic studies have shown that a chromosomal abnormality is associated with HD in about 12% of patients. The most common chromosomal abnormality associated with HD is trisomy 21 (Down syndrome), which accounts for over 90% of these cases.

Link to Down Syndrome: The presence of Down syndrome in some HD patients suggests a potential genetic component in the etiology of HD. Down syndrome is the most common chromosomal abnormality associated with aganglionosis and can occur in a significant percentage of individuals with HD (3).

These findings underscore the importance of genetic factors in the development of Hirschsprung's disease, particularly the strong association with trisomy 21 (Down syndrome) in a substantial proportion of cases.

PATHOPHYSIOLOGICAL CHANGES IN HD

Hirschsprung's disease (HD) is a condition where the distal portion of the colon becomes narrowed and lacks the necessary nerve cells to facilitate peristaltic waves, causing a blockage to the natural movement of digestive material through the affected area. Gastrointestinal motility is governed by a coordinated interplay among four essential cell groups: the enteric nervous system (ENS), smooth muscle cells (SMCs), interstitial cells of Cajal



(ICCs), and cells expressing the platelet-derived growth factor receptor alpha (PDGFRα+), often collectively referred to as the "SIP" syncytium (6). Hirschsprung's disease (HD) is characterized by a distinctive gross pathological feature: a narrowed distal colon leading to a funnel-shaped transition zone, beyond which the proximal colon becomes dilated and thickened. These characteristics can vary depending on the duration of untreated disease. During the neonatal period, the intestines may appear normal, but as the child grows, the proximal part of the intestine enlarges and thickens, losing its normal taeniae and seemingly surrounded by the longitudinal muscle layer. HD patients can display a wide range of clinical presentations, from almost asymptomatic individuals to those experiencing intestinal obstruction from the time of birth (7). The absence of the enteric nervous system is the most remarkable finding in the narrow distal colon in HD.

Hirschsprung's disease is distinguished by a notable deficiency of ganglion cells in both the myenteric and submucous plexuses of the lower intestine. In approximately 80% of instances, this deficiency of ganglion cells extends continuously into the rectosigmoid region and endures until it reaches the proximal transitional zone (8).

Along with the aganglionosis, the intermuscular area and submucosa of the involved segment show a noticeable increase in cholinergic nerve fibres. These fibres, which appear as large nerve bundles, are connected to parasympathetic nerves that emerge from the ganglion (9&10). The continuous release of acetylcholine from the axons of these parasympathetic nerves leads to an excessive buildup of acetylcholinesterase, which can be typically detected in the lamina propria mucosae, muscularis mucosae, and circular muscle using staining techniques (7). The presence of both these thick nerve bundles and heightened acetylcholinesterase activity is most pronounced in the furthest distal aganglionic rectum, gradually diminishing as one moves proximally toward the healthy bowel (11).

Fluorescent-histochemical studies aimed at locating adrenergic nerves have shown that their quantity is notably higher in the aganglionic colon of Hirschsprung's disease, and they exhibit an irregular distribution pattern (12).

The neurotransmitter nitric oxide (NO) is one of the most crucial in intestinal smooth muscle relaxation (13). In both normal and ganglionic colon tissue from individuals with Hirschsprung's disease (HD), we observe robust NADPH diaphorase staining in the submucous and myenteric plexuses, along with a substantial number of positive nerve fibres within the circular and longitudinal muscle layers, as well as the muscularis mucosae (14). In contrast, within the aganglionic segment of HD patients, where ganglia are absent, there is a notable absence or significant reduction in NADPH diaphorase-positive nerve fibres in both muscle layers and the muscularis mucosae. This area's characteristic hypertrophied nerve trunks display weak staining (14).

DIAGNOSIS:

1. Removing a sample of colon tissue for testing (biopsy)

A biopsy examination under a microscope to determine whether nerve cells are missing.

2. Abdominal X-ray using a contrast dye.

There are four radiologic anatomical signs used to diagnose Hirschsprung's disease: a transition zone with proximal dilated bowel, microcolon, retention of contrast on post-evacuation film, and an abnormal rectosigmoid ratio (15).

3. Measuring control of the muscles around the rectum (anal manometry)

TREATMENT:

1. Total Trans anal Endorectal Pull-Through
2. Laparoscopic-Assisted Pull-Through
3. Botulinum toxin injection
4. Myectomy
5. Redo pull-through (16).

References

1. Mukhopadhyay, B., Mukhopadhyay, M., Mondal, K. C., Sengupta, M., & Paul, A. (2015). Hirschsprung's Disease in Neonates with Special Reference to Calretinin Immunohistochemistry. Journal of clinical and diagnostic research: JCDR, 9(7), EC06–EC9. https://doi.org/10.7860/JCDR/2015/12470.6180.
2. Holschneider, A. M., & Puri, P. (Eds.). (2008). Hirschsprung's disease and allied disorders (pp. 115-123). Berlin: Springer.
3. Amiel, J., Sproat-Emison, E., Garcia-Barcelo, M., Lantieri, F., Burzynski, G., Borrego, S.,& Hirschsprung Disease Consortium. (2008). Hirschsprung disease, associated syndromes and genetics: a review. Journal of Medical Genetics, 45(1), 1-14.

4. Granéli, C., Dahlin, E., Börjesson, A., Arnbjörnsson, E., & Stenström, P. (2017). Diagnosis, symptoms, and outcomes of Hirschsprung's disease from the perspective of gender. Surgery research and practice, 2017.
5. Egbe, A. C. (2015). Birth defects in the newborn population: race and ethnicity. Pediatrics & Neonatology, 56(3), 183-188.
6. Sanders K, Ward S, Koh S. Interstitial cells: regulators of smooth muscle function. Physiol Rev. 2014;94(3):859–907.
7. Heuckeroth RO. Hirschsprung disease – integrating basic science and clinical medicine to improve outcomes. Nat Rev Gastroenterol Hepatol. 2018;15(3):152–67.
8. Meier-Ruge W, Bruder E. Histopathological diagnosis and differential diagnosis in Hirschsprung's disease. In: Holschneider A, Puri P, editors. Hirschsprung's disease and allied disorders. Berlin, Heidelberg: Springer; 2008. p. 185–94.
9. Kakita Y, et al. Selective demonstration of mural nerves in ganglionic and aganglionic colon by immunohistochemistry for glucose transporter-1: prominent extrinsic nerve pattern staining in Hirschsprung disease. Arch Pathol Lab Med. 2000;124(9):1314–9.
10. Kobayashi H, O'Briain DS, Puri P. Nerve growth factor receptor immunostaining suggests an extrinsic origin for hypertrophic nerves in Hirschsprung's disease. Gut. 1994;35(11):1605–7.
11. Weinberg AG. Hirschsprung's disease – a pathologist's view. Perspect Pediatr Pathol. 1975;2:207–39.
12. Nirasawa Y, et al. Hirschsprung's disease: catecholamine content, alpha-adrenoceptors, and the effect of electrical stimulation in aganglionic colon. J Pediatr Surg. 1986;21(2):136–42.
13. Bult H, et al. Nitric oxide as an inhibitory non-adrenergic non-cholinergic neurotransmitter. Nature. 1990;345(6273):346–7.
14. Rolle U, Nemeth L, Puri P. Nitrergic innervation of the normal gut and in motility disorders of childhood. J Pediatr Surg. 2002;37(4):551–67.
15. Levin, M. D. (2021). Diagnosis and pathophysiology of Hirschsprung's disease. Pelviperineology, 40(2).
16. Gunnarsdóttir, A., & Wester, T. (2011). Modern treatment of Hirschsprung's disease. Scandinavian Journal of Surgery, 100(4), 243-249.

Volume: 03 Issue No: 11

THE SWEET ESSENCE OF JAGGERY: NATURE'S HEALTHFUL SWEETNER

Article ID: AG-VO3-I11-57

***Dr Seema Sonkar and Shivani Singh**

Associate Professor, Department of Food Science & Nutrition, Chandra Shekhar Azad University Of Agriculture & Technology, Kanpur ,UP-208002.

Ph.D Research Scholar ,Department Of Food Science & Nutrition,Chandra Shekhar Azad University of Agriculture & Technonogy,Kanpur,UP-208002.

*Corresponding Author Email ID: seema07csa@gmail.com

Introduction

The Indian population is predominantly rural, with over 65% of the production living in rural villages .since the common Indian diet is nutritionally deficient, the majority of the population suffers from undernutrition or malnutrition. The health food is considered to be the food which is beneficial to health, beyond a normal diet required for human nutrition. It is also referred to as function food, which is food that makes a specific claim of health benefits, such as that consumption of food may prevent diseases. Jaggery is a natural sweetner can be a good source for nutritional deficiency obtained by concentration the juices of sugarcane and or palm trees ,it can be solid, liquid ,or granular.

Because of its delicious flavor that falls between molasses and brown sugar and its sweet, winy aroma, jaggery can be used as a base for many sweet dishes around thee world. One such sugarcane product is jaggery, which contains significant amounts of important minerals and vitamins(Energy 338kcal,Fat-0g, Saturated fat 0g, Monounsaturated fat 0g,polyunsaturated fat 0g ,Carbohydrates 98.96g,Sugar 98.13g,Fiber 0g,protein 0.09g,Cholestrol 0mg,Calcium 40-100mg,Magnesium 70-90mg, ,Potassium 1056mg,Phosphorous 20-90mg,Sodium 19-30mg, Iron 10-13mg, Magnesium 0.2-0.5mg, Zinc0.2-0.4mg, Copper 0.1-0.9mg,and chloride 5.3mg per100gm of Jaggery),Viz (vitamins A 3.8mg, Vitamin B1 0.01mg, VitaminB2 0.06mg, VitaminB5 0.01mg, vitaminB60.01mg,VitaminC &.00mg, VitaminD2 6.50mg ,Vitamin E 111.3mg).Magnesium help to relax our muscles, strenghthens our nervous system, relives fatique, and looks after our blood vessels. Along with selenium, it also functions as an antioxidant and has the ability to remove free redicals from bodies .Jaggery contains potassium and a negligible amount of sodium, which help to maintain the proper balance of acids in our body cells, fight off acids and acetone and regulate blood pressure. Anemia can be prevented with iron, because it has anti-allegry and it also ease stress and treats asthma.

Ayurveda also prescribed jaggery for migrane, and at the time of post pregnancy, for removing all clotted blood from the body, within 40days after the birth of the baby. It can be used for blood purification normal liver function ,and blood health because it also is also used as an energy food with therapeutic benefits. Ice-cream,sapota milkshake, milkshake and kulfi, biscuits ,bread, cakes, pastries, buns, rusks, and rolls among other food, have all made with jaggery. Jaggery is a better option than sugar due to a number of advantages ,good quality jiggery has golden yellow color ,a hard texture, a crystalline, a sweet taste and a low moisture content. In now a days, Manufactures now create organic jiggery free of chemicals like sodium bicarbonate, sulphur dioxide,citric acid ,alum etc. Jaggery is known as"MEDICINAL SUGAR" which is used for pharmaceuticals formulations.

Volume: 03 Issue No: 11

HORTICULTURAL CROPS: AN OVERVIEW OF CHANGING CLIMATE

Article ID: AG-V03-I11-58

Dr. H. L. Kacha*, Urmi Chawra and Dr. N. D. Makwana
Krishi Vigyan Kendra, Anand Agricultural University, Dahod, Gujarat, India
*Corresponding Author Email ID: kvkdahod@aau.in

Introduction

Climate change is one of the most complex and challenging environmental threat faced by the world and it is predicted that the global temperature may rise by 1.5– 2°C over the next decade. IPCC defines climate change as "a change in the state of the climate that can be identified by changes in the mean and /or the variability of its properties, and that persists for an extended period, typically decades or longer".

Agriculture, the cause of climate change and also suffers of the consequences. India is more vulnerable to climate risks due to its diverse climatic zones, ecosystems, and topography. The level of risk depends on con-current trends in vulnerability, exposure, level of socio-economic development and adaptations. Climate change is projected to cause an aberrant increase in temperature, variations in rainfall patterns, and an increase in frequency of extreme events such as heat waves, cold waves, frost, droughts, floods, etc. Extreme climatic factors are known to influence production of horticultural crops due to their adverse effects on flowering, fruit development, fruit quality, and pest-diseases infestation. Two major parameters of climate changes that have far reaching implications on plants are erratic rainfall patterns and unpredictable high temperature spells which are consequently expected to reduce crop productivity.

India with diverse soil and climate comprising several agro-ecological regions provides ample opportunity to grow a variety of horticultural crops which form a significant part of total agricultural produce in the country comprising of fruits, vegetables, root and tuber crops, flowers and other ornamentals, medicinal and aromatic plants, spices, condiments, plantation crops and mushrooms. Vegetable crops dominate with about 45 percent share in the area, followed by spices at 35 percent, fruits at 18 percent, and flowers contributing 2 percent. It is estimated that all the horticulture crops put together cover nearly 28.08 million hectares area with an annual production of 342.33 million tonnes. Though, these crops occupy hardly 13.1 percent of the gross cropped area in India with approximately 30.4 percent contribution in agricultural GDP. (pib.gov.in)

In recent times, the landscape of agriculture has changed from subsistence farming to commercialized one. Population is increasing at an alarming rate. Increased hunger and malnutrition are challenging issues for the nation. Fruits and vegetables are rich source of vitamins, minerals, proteins, and carbohydrates etc. which are essential in human nutrition. They are referred to as protective foods and assumed to have great importance in nutritional security. Thus, cultivation of horticultural crops plays a vital role in the prosperity of a nation and is directly linked with the health and happiness of the people.

The production and quality of fresh fruit and vegetable crops can be directly and indirectly affected by exposure to high temperatures and elevated levels of carbon dioxide and ozone. The complex process of growth and development in plants is significantly affected by different agro climatic factors. Any weather abbreviations due to climate change can impose unpredictable stress on plants which may lead to complete failure in growers' own field. Based on response to different climatic conditions and temperature requirements, horticultural crops are classified into tropical, sub-tropical and temperate. Accordingly, crops can be selected by looking into season and in which regional zone it falls. Still every crop has its own temperature regimes throughout its growth and development.

Table 1: Classification based on climatic requirements

Category	**Examples**
Tropical	Mango, Banana, Citrus, Papaya, Sapota, Pineapple, Grapes

Sub-tropical	Litchi, Fig, Falsa, Anola, Passion fruit
Temperate	Apple, Pear, Peach, Plum, Strawberry, Almond, Apricot, Kiwi
Arid and Semi-arid	Ber, Pomegranate, Date palm, Bael, Jamun

Effect of Air Temperature

Temperature is the most important variable of weather. Atmospheric temperature is continuously changing during the day. It is never steady or constant for a long time. The three temperature of vital activity related to plant growth have been recognized, and termed as cardinal points. A minimum temperature below which no plant growth take place, which is often termed as base or threshold temperature. An optimum temperature at which maximum plant growth occurs and a maximum temperature above which plant growth stops. Table 2 and Table 3 depicts cardinal points and threshold temperature for various vegetable crops.

Table 2: Cardinal points for growth and development of vegetable crops

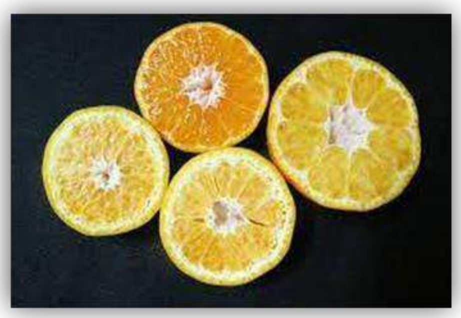
Season	Vegetable crops	Minimum (ºC)	Optimum (ºC)	Maximum (ºC)
Hot season	Okra, Water melon, Musk melon, Chilli, Sweet potato, Amaranthus, Cluster bean, Yam	18	25	35
Warm season	Tomato, Brinjal, Sem bean, Sweet corn, gourds, Pumpkin, Aquashes, Cucumber, French bean, Cowpea, Palak, Drumstick	10	20-25	35
Cool-Hot season	Onion, Garlic, Chikory, Cauliflower	5	20-25	30

Cool-Warm season	Pea, Potato, Lettuce, Aspargus, Fennel, Dill, Mustard, Cole crops, Root crops, Beet	5	18-25	25

Table 3: Threshold temperature for different vegetable crops

Crops	Spinach	Lettuce	Pea	Asparagus	French bean	Bottle gourd	Pumpkin	Tomato
Base temp. (°C)	2.0	4.4	4.4	5.5	10.0	12.0	13.0	15.0

Higher temperature during fruit growth and development increased the incidence of several physiological disorders like spongy tissue and black tip in mango, cracking of fruits, granulation in citrus, etc. At time of flowering in mango, day temperature of 25 °C and night temperature of 15 °C is favorable. Similarly, 10 °C to 40 °C temperature is favorable for good cultivation of banana. In cucumber, low temperatures helps female flower production, whereas high temperatures lead to production of more male flowers hindering production. High temperature shortens the duration of onion bulb size leading to reduced yields. Pest ecology of certain crops is also changing due to climate change. Fruit fly in guava, carambola, citrus, etc. is becoming alarming due to hot and humid conditions. Warm and humid conditions are also favorable for pests like beetles, bugs and other sucking pests and diseases like mildew, blight, etc. Table 4 shows influence of temperature on disease and pest in horticultural crops.



Granulation in citrus

Spongy tissue in mango

Table 4: Influence of temperature on disease and pest

Crops	**Disease/Pest**	**Favorable environmental conditions**
Potato Tomato	Early blight	20-25°C and dry weather with intermittent rains
Potato Tomato	Leaf blight	Cool temperature, (10-20 °C), high humidity (>80%)
Cole crops	Black rot	Warm and humid climate
Most of vegetable crops	Fusarium wilt	18-24 °C, inhibited at 35 °C
Most of vegetable crops	White fly and Aphids-virus vector	Warm and humid climate
Most of vegetable crops	Trips	Rise in temperature after winter

Effect of Soil Temperature

Soil temperature is an important parameter in plant growth and distribution. It controls microbial activity, the rate of organic matter decomposition increases with increase in temperature. It affects plant growth first during germination of seeds. The activity of roots i.e., absorption of water and nutrients is affected by both low and high soil temperatures. Seeds of different crops vary in their ability to germinate at low temperatures. The soil temperature requirement of different vegetable crops are given in table 5. Seed germination, survivability, growth, flowering, pollination, fruit set, development of economic part, quality of produce, occurrence of disease and pest etc. are influenced by temperature.

Table 5: Soil temperature requirement for germination of vegetable crop seed

Crop	Minimum (°C)	Optimum (°C)	Maximum (°C)
Onion	1.6	23.9	35.0
Carrot	4.4	24.0	35.0
Radish	4.4	28.0	35.0
Beet	4.4	26.0	35.0
Cabbage	4.4	20.0	37.8
Cauliflower	4.4	25.0	37.8
Tomato	10.0	25.0	30.0
Potato	10.0	25.0	30.0
Sweet corn	10.0	35.0	40.5
Palak	10.0	25.0	35.0
Amaranthus	10.0	32.0	35.0
Brinjal	15.5	28.0	35.0
Cow pea	15.5	28.5	40.5
Chilli	15.5	29.0	35.0
Cluster bean	15.5	29.0	35.0
Drumstick	15.5	29.0	40.0
Muskmelon	15.5	30.0	37.8

Cucumber	15.5	30.0	40.5
Watermelon	15.5	30.0	40.5
Ridge gourd	15.5	30.0	40.5
Bitter gourd	15.5	32.0	37.8
Okra	17.0	29.0	40.5

The combined morphological and physiological effect of the plants allow them to withstand temperature variations. Small leaves, well rooted plants, little water loss, leaf orientation, etc. are all influenced by high temperatures. Similar to this, in low temperature regimes, survival depend on adaptation, the developmental phases, the length of cold stress, the degree of dormancy, and cultivar variances.

Effect of Solar radiation

Production is exploitation of solar radiation. It plays an important role as regulator and controller of growth and development. Additionally, it affects the distribution of dry matter and nutrient assimilation. Solar energy provides light required for the physiological functions of the plant. Solar radiation higher than visible wavelength, referred as infrared radiation has thermal effect on plants. In presence of water vapor the radiation doesn't harm plants, rather supplies necessary thermal energy to plant environment. The visible part, light is indispensable to photosynthesis. Light of correct intensity, quality and duration is essential for normal plant growth. Based on response to light intensities plants are classified as sciophytes (shade loving), heliophytes (sun loving). Table 6 depicts light intensity required for vegetables. Light affects the stability, strength, the yield, total weight of plant structures, the size of leaves and the root development. The length of the day or the duration of the light period determines the flowering. The response of plants to the duration of heat is called thermoperiodism while the relative length of day and night is known as photoperiodism. Table 7 shows plants classifies on extent of day length.

Table 6: Light intensity required for vegetables

Category	Examples	Light intensity (Foot candle)
Shade loving plants		500-1000
Partial shade and sun plants		1000-3000
Direct sun tolerant plants	Cabbage, Potato	2000-8000
Sun loving plants	Tomato, Chilli, Brinjal, Pea	3000-8000

Table 7: Classification of plants based on photoperoidism

Category	Examples
Long day plants (more than 12 hrs)	Potato, Sugarbeet, Apple, Passion fruit, Banana, Onion, Lettuce, Cabbage, Cauliflower, Radish, Carrot, Turnip
Short day plant (less than 12 hrs)	Pineapple, Coffee, Strawberry, Sweet potato, Cluster bean, Winged bean, Indian spinach
Intermediate or day neutral plants	Tomato, Papaya, Guvava, Brinjal, Chilli, Okra, French bean, Cucurbits

The photoperiodism influences plant characters such as floral initiation, development, bulb and rhizome production. When long days plant are subjected to short day periods, or vice versa plant shows abnormal vegetative growth and there may not be any floral initiation. Consequence of low light intensity is reduction in chlorophyll content which resists photosynthesis which results in reduction in yield levels. Further, high light intensity causes increase in respiration rate, transpiration rate which further increases evapotranspiration of crops i.e., increasing water demand. At high light intensity there is increase in number of male flowers in monoecious cucumber.

Effect of Humidity

It is associated with moisture content of air. As atmospheric humidity increases, the temperature decreases. This phenomena increase the heat load of plant as not much of energy is lost in transpiration. As a result, leaves suffers from excessive heat and due to closure of stomata the entry of CO_2 is reduced. Reduction in transpiration reduces the translocation of food materials and reduces uptake of nutrient and minerals from soil via root hairs. A moderately high RH of 60-70% is beneficial for growth and development of plants. Riceyness, a physiological disorder in cauliflower results of high humidity. Internal brown spot in potato is due to moisture deficiency.


Riceyness in cauliflower


Internal brown spot in potato

Effect of Dew

Dew is formed when water vapors are condensed on cool and still nights. This is a phenomenon mainly witnessed in winters. Vegetation on ground is found to carry small droplets of water over them. Generally it is believed that more the dew nights in winter, better the winter growing crops. In the form of dew, partial water requirement of crops gets satisfied, relative humidity of air is increased thereby reducing evapotranspiration and transpiration losses of soil moisture. Below, Table 8 depicts the water demands of different vegetable crops

Table 8: Classification based on water demands

Water demands	Examples
High	Sweet pepper, Cole crops, Raddish, Ridge guard, Turnip, Beetroot
Moderate	Tomato, Brinjal, Chilli, Cucumber, Onion, Carrot, Potato
Low	Peas and Beans
Very Low	Watermelon, Muskmelon, Pumpkin, Ash gourd

Effect of Frost

Frost occurs when the temperature of the atmosphere cools down suddenly to the freezing point and water vapor is changed into solid pellets without passing through the intermediate stage. Unlike dew, frost is undesirable. The crops which are highly susceptible to frost are potato, tomato and other solanaceous crops. Crops turns black and similar effect to burning. Fruits may crack and become hard and patchy. Leaves may fall down and wilt. These effects are due to upset in physiological process of the plant in frost conditions. Table 9 shows different vegetable crops who has the ability to withstand frost and low temperatures. This is useful for one to know season of cultivation of crops.

Table 9: Classification based on ability to withstand frost conditions

Hardy vegetables	Semi-hardy vegetables	Tender vegetables
Aspargus	Carrot	Amaranth
Crucifers	Celery	Okra
Garlic	Beet root	Brinjal
Onion	Globe artichoke	Chilli
Peas	Lettuce	Cluster bean
Radish	Palak	Cucurbits
Rhubarb	Parsnip	Tomato
Spinach	Potato	Yams
		Sweet potato

Furthermore, low temperature below 15 ºC and above 0 ºC leads to chilling injury in plants which is most commonly seen in vegetable crops i.e., tomatoes, potatoes etc. However, temperature below 0 ºC, the injury refers to freezing injury. Blindness in cauliflower is due to frost conditions.

Chilling injury in bell pepper   Blindness in cauliflower

Effect of Rainfall

About 70 percent of cultivation in India is carried out in rainfed areas which accounts for 42 percent of total food production. Deficient rains limit crop growth and heavy rainfall are even more harmful. They induce soil erosion and encourages leaching of the nutrients. In horticultural crops, the damage is more if rain coincides with flower initiation stage. For a period of time, if rain is consistent, it will lead to washing off of pollen grains which results in less flower and fruit yields. Showers of rain in summer is beneficial for crops like coffee and cardamom whereas it destruct the crop of mango. Similarly, it leads to less production of crops which is about to harvest in upcoming *kharif* season.

Effect of Wind

Wind influences plant life, both physiologically and mechanically. With the influence of strong winds, the normal form and position of shoots are permanently deformed. Another severe injury is lodging. Strong winds break twigs and shed fruits. Crops will shallow root often gets uprooted.

Conclusion

The demand for horticultural produce is increasing day by day due to rise in consumer demand. Climate change is global but its nature, extent and magnitude are variable in different regions and locations. Add ressing climate change through location specific climate smart horticulture intervention is the key in countering the negative effects from emission of green house gases. Horticulture centric farming has high potential for sequencing carbon for mitigation against climate change. Nation seeks a necessity to have an integrated approach which improves production under stress conditions while coping with this burning issue. Strategies like development of cultivars tolerant to fluctuations in temperature, moisture stress, pests and disease resistant, short duration and high yielding, as well as technologies like precision horticulture will help in addressing all these challenges.

Volume: 03 Issue No: 11

ARTIFICIAL BEE NESTS SERVE AS RESIDING PLACES FOR STEM NESTING BEES

Article ID: AG-VO3-I11-59

K. Vanitha*, Veena, G.L., Babli Mog, Aswathy Chandrakumar and Bhagya, H.P.

ICAR-Directorate of Cashew Research, Puttur - 574 202, Karnataka

*Corresponding Author Email ID: vanis102@gmail.com

Introduction

Pollination is an essential part of reproduction. Among the different pollinating agents, insects play a crucial role like bees, wasps, flies, beetles, moths, butterflies, ants etc. Among all, bees are considered as important pollinating agents for numerous crops and plant species throughout the ecosystems. They play essential ecosystem services and provide life sustenance. World-wide, there are around 25,000 species of bees, that belong to seven families under super family, Apoidea (Michener, 2007). In India, nearly 1000 bee species are known to occur under six families *viz.*, Apidae, Megachilidae, Andrenidae, Colletidae, Melittidae and Halictidae. Honey bees are commonly used for pollination of crops but, they could not provide satisfactory pollination service to many crops. In fact, native (wild) bees also provide good pollination services and nearly two third of the pollination service is provided by the wild pollinators. Native bees have wide array of sizes, shapes, and colors. They have different life styles, nesting behaviour (*viz.*, soil nesting, stem nesting, cavity nesting etc.,), bee flora, and their season of activity. Wild bees can also supplement honey bees, thus conserving them and their integrated management with honey bees will help to enhance the crop productivity as evidenced in some crop species.

Stem nesting bees

Most bee species build their nests in soil, wood, hollow stems, pithy stems or pre-existing cavities and tunnels abandoned by other wood-boring insects. Nesting resources have an important role in structuring of the bee communities. Many hollow or pithy plant stems and branches provide excellent places for cavity-nesting insects including bee species. For example, small carpenter bees (*Ceratina* spp.), leaf-cutter bees (*Megachile* spp.), bigger carpenter bees (*Xylocopa* spp.), reed bees (*Braunsapis* spp.), *Exoneura* sp. etc are the common tunnel / stem nesting bees. *These bees* utilize old, pithy stems as nesting habitats. They search for dead twigs and stems with pithy centers so that they can carve out for their nests. Thus, crop pruning strategies could focus on preserving suitable stems for nesting (Coates et al., 2022). While pruning back the shrubs or trees that have pithy stems, it is recommended to leave a few pruned stems (of 6-25 cm) to harden so that native bees can make their nesting sites by tunnelling inside them during the next season. Some examples for such plants are raspberries, elderberries, hydrangea, mussanda, tree like cashew, or even flowers with thick-stemmed structures like lantana, ixora, coneflowers, sunflowers, asters etc.

Leaving the dead branches from trees and shrubs, and leaving some piles of twigs and branches in the fields help the tunnel nesting bees to make nest in them. Few stem nesting bee species also occupy different types of artificial nests or trap nests successfully. Small wooden pieces with drilled holes of varying sizes, a bundle of hollow canes, paper straws, sticks could easily make a home for certain solitary bees. Nowadays, such bee houses are also available to buy in online markets, which can help the gardeners.

This article gives brief information about the artificial bee nests for stem nesting bee species and their management.

Making artificial nests for bees

A. Wooden blocks with drilled holes/ tunnels

Artificial nests consisting of wood blocks drilled with a large number of dead-end tunnels have been promoted as a way to attract bees and boost their local populations. Nest blocks with a greater diversity of hole sizes and depths are necessary to attract a variety of bees that are active throughout the year. During 1960s, bee nests were initially developed by alfalfa seed producers in United States to attract non-native alfalfa leafcutter bees (*Megachile rotundata*) (Mader et al., 2009). Bees occupy these types of artificial nests as long as the tunnels are of appropriate depth and diameters, as bigger bees prefer the tunnels of bigger size, while smaller ones prefer thin holes. For eg., drilled hole size of 3.0 mm diameter was highly preferred by *Braunsapis* spp. followed by 2.5 and 3.5 mm diameter compared to 4.00 mm diameter (Vanitha and Raviprasad, 2021). These nests kept in an appropriate location with proper shelter from the sunlight and rain, and protected from ants and other predators like spiders by periodical cleaning. But, direct sunshine in the early morning will help the bees warm themselves up to flight temperature, thus placing the nests facing east is advisable. However, direct sunlight later in the day can be detrimental, thus must be avoided to prevent death of brood.

Artificial bee nests for *Braunsapis* spp. (Developed by K. Vanitha and T.N. Raviprasad, ICAR-DCR, Puttur, Karnataka)	Mason Bee House available online, Source: Amazon

B. Stem Bundles

In addition to wooden blocks, artificial nests can also be made using the bundles of sticks of reed, teasel, cup plant, bamboo, etc so that a natural node forms the inner wall of the tunnel. Strap the tubes together into a tight bundle using a wire, string, or tape, and tightly pack them into a tin can, paper milk carton, plastic buckets, short sections of PVC pipe etc, by keeping their open ends out. The bundles should be placed in a sheltered location with the stems horizontal to the ground.

Artificial bee nests Vs bee species: Few Examples

- In Brazil, bamboo stem sections and cardboard tubes which were inserted into drilled wooden blocks were occupied by many bee species including *Megachile* spp., *Tetrapedia* spp., *Centris* spp., *Colletes* sp., *Eufriesea* spp. and *Euglossa* sp.,

- In Europe and South America, bees like *Osmia* sp., *Anthidium* sp., *Heriades* sp., *Megachile* sp. and *Duckeanthidium* sp. were found to successfully occupy reed stems, followed by wooden blocks with drilled holes and bamboo stems.
- *Braunsapis mixta* and *B. picitarsis* highly preferred to occupy bamboo sticks with cavity length even up to 25.6 cm followed by the sticks of Johnson's grass, lantana and cashew sticks when all were kept together but in separate bundles.

Importance of bee flora in conservation of bees

In addition to the bee nests, providing the preferred bee flora helps in supporting the bees during the lean period and off-season. Keeping flowering plants surrounding the artificial bee nests are helpful for the bees. Besides, maintaining a strip of land along the edge of an agricultural or horticultural lands and hedgerows of closely spaced shrubs and/or tree species along the field boundaries help in increasing habitat diversity, the number and type of weed species, insect species feeding on them, their natural enemies including parastioids and predatory insects and also different pollinators including native wild bee species. These conservation strips should be left unsprayed without fertilizer application and unharvested.

Advantages of artificial bee nests

a. They are economically cheap and eco-friendly.
b. With minimum inputs, they can be customized to suit for different bee species.
c. They help in conservation of bee species by serving as nesting sites for several number of bees in a small place. Besides, many species of wasps may also nest in them, which are in general, predators of pests.
d. These nests can be easily managed and with regular cleaning they can be maintained for several years.
e. These nests help in documentation of the bee behaviours and their seasonal activities.
f. These nests are helpful in documenting the life history of bees and also its natural enemies.
g. These nests can be shifted to crop fields like honey bee hives during the flowering season for providing pollination services. For eg., *Osmia* bee nests are used in orchards, where it was determined that 740 - 750 bees / ha and 530 – 625 bees/ ha is found adequate for almond and apple pollination, respectively (Bosch and Kemp, 2002).
h. They can also serve as educational tools for students, and can be a hobby for children and interested public.

Problems with the artificial bee nests and their management

Regardless of type, the artificial bee nests will need routine management and regular replacement to prevent the build-up of parasitoids/ parasites and diseases that affect the developing brood. With appropriate management, the parasitoids and disease problems can be minimized or avoided by,

a. Using paper straws to line the holes of wood nest blocks, which facilitate removal and storage during the offseason or the end of nesting season (if bees are present), and prevent excess drying of the pollen provision. When the old straws are empty, they are disposed of.
b. Replacement of nest blocks and stem bundles once in every two to three years, disposing the old ones.

References

Bosch, J., Kemp, W.P. (2002) Developing and establishing bee species as crop pollinators: the example of *Osmia* spp. (Hymenoptera: Megachilidae) and fruit trees. *Bull. Entomol. Res.* 92, 3–16.

Coates, J.M., Julian Brown and Saul A. Cunningham. 2022. Wild bees nest in the stems of cultivated Rubus plants and act as effective crop pollinators. *Agriculture, Ecosystems & Environment*. 325, 107741, ISSN 0167-8809, https://doi.org/10.1016/j.agee.2021.107741.

Mader, E., Matthew, Shepherd, Mace Vaughan, and Jessa Guisse. 2009. Tunnel Nests for Native Bees Nest Construction and Management. Invertebrate conservation fact sheet. Published by The Xerces Society for Invertebrate Conservation. Portland. 6p.

Michener, C.D. 2007. The bees of the world. Second Edition, John Hopkins University Press, Baltimore, MD.

Vanitha,K and Raviprasad, T.N. 2021. Artificial nests conserve important native bees, *Braunsapis* spp. pollinating cashew. *Current Science*, 121 (1): 127- 132.

Volume: 03 Issue No: 11

AUTOPHAGY - EVOLUTIONARY CONSERVED RECYCLING PROCESS

Article ID: AG-VO3-I11-60

Dr.A.Thanga Hemavathy[1], Dr.R.Vinoth[2] and Dr.S.Kavitha[3]

1- Associate Professor, Department of Pulses, TNAU, Coimbatore

2- Teaching Assistant, IOA, TNAU ,Kumulur, Trichy, Tamil nadu

3- Associate professor, Dept. of Seed Science and Technology ,TNAU, Coimbatore

*Corresponding Author Email ID: hemavathy.tnau@gmail.com

Introduction

Autophagy (from Greek, ‘‘self-eating’’) is a highly regulated cellular process that mediates the degradation of intracellular components single macromolecules and organelles inside lysosomes. Autophagy is also essential for cellular adaptation to environmental changes and in the cellular response to extracellular and intracellular stresses. This explains the involvement of autophagy in processes such as cellular growth, differentiation, development, and pathogen-to-host defense.

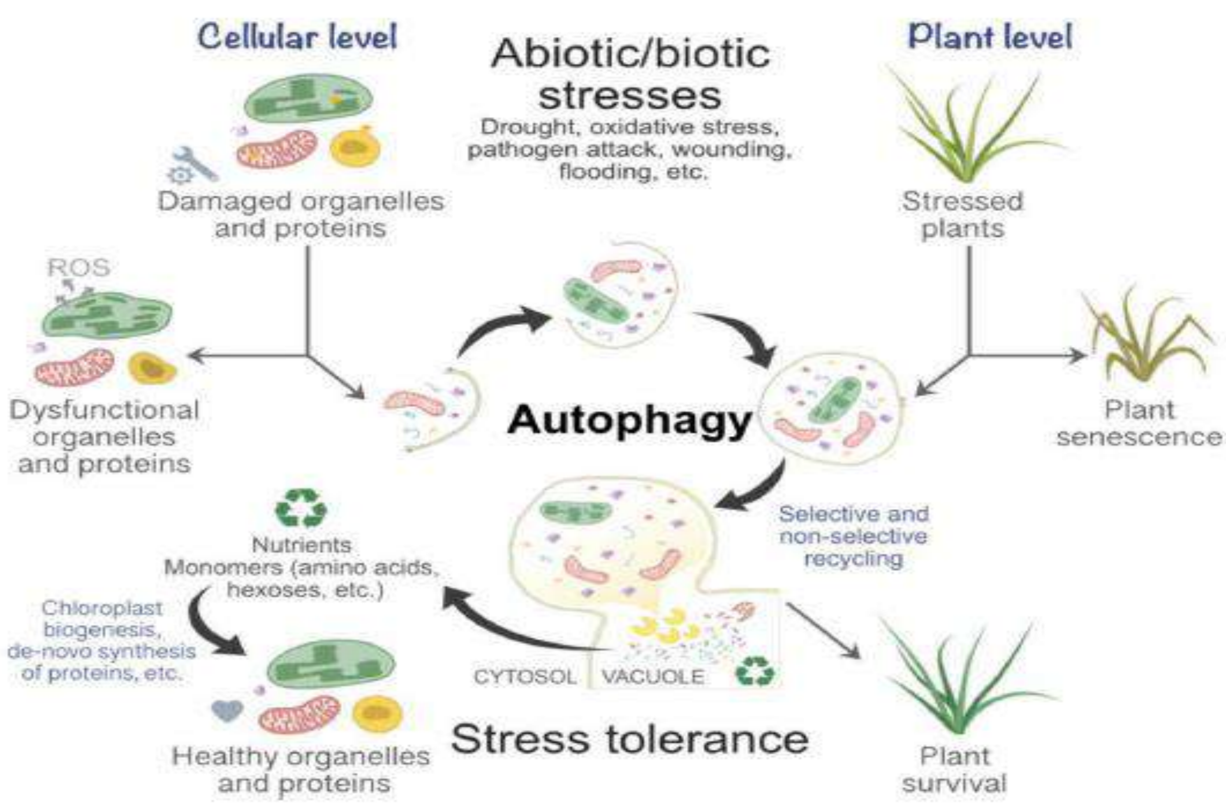
Autophagy is a highly regulated cellular degradation and recycling process, conserved from yeast to more complex eukaryotes” .It is an evolutionarily conserved intracellular process for the vacuolar/lysosomal degradation and recycle of cytoplasmic components”

The three main autophagic pathways are 1.Macroautophagy, 2.Microautophagy and 3.CMA, all contribute to lysosomal degradation, but differ in their regulation, the type of cargo preferentially degraded, and the mechanisms that contribute to targeting the cargo to the lysosomal compartment. Among them, macroautophagy is the best-characterized autophagic process, and probably the one that contributes to the highest percentage of lysosomal degradation inside cells. Based on recent studies, Autophagy plays significant role under nutrient starvation conditions and stress condition to proceed bulk degradation of cytoplasmic components which used for energy supply and the synthesis of components essential for survival in nutrient starvation and stress condition and also maintenance of cellular energetic balance and quality control

Domicile of Autophagy

Lysosomes are also responsible for autophagy, the gradual turnover of the cell's own components. The first step of autophagy appears to be the enclosure of an organelle (e.g., a mitochondrion) in membrane derived from the ER. The resulting vesicle (an autophagosome) then fuses with a lysosome, and its contents are digested.Autophagy is responsible for the gradual turnover of cytoplasmic organelles.

Autophagy is a general term for the degradation of cytoplasmic components within lysosomes. Autophagy is an evolutionary conserved recycling process in eukaryotes whereby intracellular components are engulfed by autophagosomes, which are subsequently transferred to the vacuoles for further degradation and reuse.



Role of autophagy

- Self-renewal function of each cell is needed for long lived cells
- Cell remodeling during development will helpful in cellular defense systems
- Plays a significant role during nutrient starvation conditions. Bulk degradation of cytoplasmic components used for energy supply and the synthesis of components essential for survival in nutrient starvation
- Maintenance of cellular energetic balance and quality control.

Recycled products are used for the de novo synthesis of molecules and organelle biogenesis, thus promoting stress tolerance at both cellular and whole plant levels

References

Jia-Jian Cao, Chen-Xu Liu, Shu-Jun Shao, and Jie Zhou (2021) Molecular Mechanisms of Autophagy Regulation in Plants and Their Applications in Agriculture Frontiers in Plant Science

Pingping Wang†, Tongtong Wang†, Jingyi Han, Ming Li, Yanxiu Zhao, Tong Su* andChangle Ma (2021) Plant Autophagy: An Intricate Process Controlled by Various Signaling Pathways- Frontiers in Plant Science

Volume: 03 Issue No: 11

FROM HUMBLE BEGINNING TO AGRICULTURAL MARVEL-THE SUCCESS STORY OF A FARMER

Article ID: AG-V03-I11-61

***Nandini Sharma and DD Sharma**

MS Swaminathan School Of Agriculture, Shoolini University of Biotechnology And Management Sciences, Solan(H.P.)173229, India

*Corresponding Author Email ID: nandinisharma.2306@gmail.com

Introduction

Located among the green valleys and rolling mountains of Himachal Pradesh is an inspirational story about a farmer who overcame all obstacles to become a symbol of dedication and success. After leasing in 10 bighas of land from a farmer, Pandit Bala Ram, a non-native of Himachal Pradesh, started on a journey that changed not only his own life but also the lives of other farmers of his region. The story starts from his cultivation of beans, tomatoes and capsicums. With an innovative and scientific mind, he understood the value of seed production particularly of capsicum locally called Shimla Mirach. He approached the scientist of Dr YS Parmar university of Horticulture And Forestry , Nauni(Solan)and extension functionaries of state department of agriculture for seeking technical guidance in scientific cultivation of capsicum crop .As a result ,he was not only capable to minimize cost of cultivation but also improve the quality of capsicum. In addition to cultivation and production of capsicum seeds, he also initiated the cultivation of tomato. He applied drip irrigation and organic fertilizers in tomato crop. He sold the produce in distant market(ludhiana market) as well as local market and earned his profit because there was a great demand of organically produced tomato in the market.

This journey from “FARSH TO ARSH” was not easy for him as he had to face a lot of challenges like unprecedented weather conditions like hail storms, unexpected rainfall particularly at the critical stages of crop growth, fluctuation of prices in the market, attract of insect pest and diseases etc. But he did not lose courage and moved on with his persistent courage and zeal in his endeavour. With the passage of time, he initiated dairy farming also and reared exotic breeds of cows particularly jersey.



Bala Ram ji has further expanded his farming activities to increase his revenue even more. He experimented with cultivating beans on the remaining land which was otherwise not being used. His success can be attributed to his flexibility and capacity to embrace the new agricultural technologies with his unwavering spirit and scientific bent of mind. He utilized the most recent farming innovations on his field and is always curious to learn new things. His impressive rise from an agricultural immigrant to an innovative agricultural marvel is living proof of the value of perseverance, hard effort, and acceptance for change. He has not only raised his socio- economic status in the society but also a source of motivation and inspiration for other the farmers of social system.

Volume: 03 Issue No: 11

BIOFOLIAR FERTILIZERS: BRIDGING SUSTAINABLE AGRICULTURE AND ADVANCED PLANT NUTRITION

Article ID: AG-VO3-I11-62

Dr. P.Reddypriya[*1], Dr. B. Deepak Reddy[2], P. Laxman Rao[3], Smt.D.Sravanthi[4], G. Amuktamalyada[5], Dr. M. Ramprasad[6], Dr. R. Ramesh[7]and Dr.J.Hemantha kumar[8]

[1234567] Assistant professor, Professor Jayashankar Telangana State Agricultural University, Telangana, India.

[8]Professor, Professor Jayashankar Telangana State Agricultural University, Telangana, India.

*Corresponding author. Department of Agricultural Microbiology and bioenergy

*Corresponding Author Email ID: drreddypriya@gmail.com

Abstract

Biofoliar fertilizers offer a sustainable approach to plant nutrition by providing an alternative to conventional soil-applied fertilizers. These fertilizers, derived from biological sources and intended for foliar application exhibits several advantages. This article provides an in-depth overview of biofoliar fertilizers detailing their composition, benefits and modes of action. Emphasizing rapid nutrient uptake, environmental benefits and optimized crop yields, biofoliar fertilizers present as resource-efficient solutions. Different types including microbial-based, seaweed-based and plant extract-based fertilizers cater to diverse agricultural needs. Proper application timing and equipment are crucial for maximizing their benefits. Despite challenges like limited research and cost considerations, biofoliar fertilizers have the potential to revolutionize sustainable farming practices, addressing the pressing demands of the agricultural sector amidst global challenges.

Introduction

Biofoliar fertilizers, an innovative segment in the field of agriculture, represent an amalgamation of modern scientific practices with eco-friendly approaches. These fertilizers are not only essential for fulfilling the nutrient requirements of plants but are also critical for sustainable agriculture. Unlike the conventional fertilizers that are applied to the soil, biofoliar fertilizers are sprayed onto the leaves of plants. Derived from biological sources, they provide a unique combination of macro and micronutrients, ensuring optimal plant growth and increased crop yield. Biofoliar fertilizers have gained attraction because of their environmentally-friendly nature and efficiency.

Understanding Biofoliar Fertilizers

Biofoliar fertilizers, as the name suggests, consist of two primary components viz., Bio represents the biological origin of these fertilizers. They are often derived from organic matter like plant extracts, seaweed, or beneficial microorganisms and Foliar indicates that these fertilizers are meant for application on plant leaves.

Benefits of Biofoliar Fertilizers

- **Rapid Nutrient Uptake:** As they are applied directly to leaves, plants can absorb nutrients much faster than through root uptake. This immediacy can be particularly useful in conditions where quick remedial action is needed.
- **Environmentally Friendly:** Being primarily organic, these fertilizers are biodegradable, reducing the ecological footprint. They do not contribute to soil pollution or water contamination.
- **Enhanced Crop Yield:** Regular use can lead to increased resistance to pests and diseases, ultimately leading to better crop yield. They are also used to address specific nutrient deficiencies during particular growth stages, leading to healthier plants and increased yields.
- **Cost-Effective:** They often require less product per acre than granular or liquid soil fertilizers, resulting in cost savings for farmers.
- **Versatility:** Suitable for a wide range of plants and crops from grains and vegetables to ornamental plants.

How Biofoliar Fertilizers Work

When plants face stress or a deficiency in certain nutrients, their growth is hindered. Spraying biofoliar fertilizers provides an instant boost of required nutrients, helping the plant to overcome the deficiency faster. Moreover, the nutrients in biofoliar fertilizers are often chelated, which means they are easier for plants to absorb and utilize.

Components of Biofoliar Fertilizers

Biofoliar fertilizers primarily consists concentrated forms of beneficial microorganisms including photosynthetic and lactic acid bacteria, yeast, and actinomycetes, protozoa, Rhizobacteria, seaweed extracts from kelp providing micronutrients and growth hormones, amino acids for protein synthesis and stress tolerance, vitamins as growth promoters and natural chelating agents to enhance micronutrient absorption.

Application Methods

The effectiveness of biofoliar fertilizers depends significantly on their proper application. Some best practices include:

- **Timing:** The best time to apply is during the early morning or late afternoon when the stomata are open.
- Avoid foliar spraying when
    - When the temperature above 80F.
    - When the weather is hot and dry and water vapor is leaving the cells.
- It should be done when
    - The temperature is 72F or below.
    - Early in the morning when the cells of the leaf are full of water and dew has collected on the foliage.
    - When air temperatures and humidity both equal 135 or less.
    - When air temperature is cooler than soil surface temperature.
- **Consistency:** A fine mist is ideal for ensuring even distribution. The pH of a foliar spray should be between 6.2 to 7.0.
- **Frequency:** Depending on the crop and its stage of growth, applications can vary from weekly to bi-monthly.
- **Leaf Surface Condition:** The condition of the leaf surface, in particular the waxy cuticle. The cuticle is only partially permeable to water and dissolved nutrients and, as a result, it can limit nutrient uptake.
- **Solution Retention:** The duration of time the nutrient remains dissolved on the leaf's surface affects its effectiveness.
- **Diffusion Dynamics:** Effective nutrient absorption requires proper diffusion, relying on the nutrient's dissolved state.

- **Formulation Impact:** Water-soluble formulations generally work better for foliar applications as they are more easily absorbed when compared to insoluble solutions. Water insoluble formulations are generally slow acting because they must dissolve before they can be absorbed and are more applicable for soil applications.

Limitations and Considerations

While biofoliar fertilizers have several benefits, there are a few considerations:

- **Over-reliance:** Relying solely on foliar application might ignore the essential nutrients needed in the soil. A balanced approach, combining both foliar and soil fertilization, is often best.
- **Burn Risk:** If not applied correctly, there's a risk of 'burning' the leaves, especially in high temperatures.
- **Runoff:** While they are environmentally friendly, excessive application can still lead to runoff, which can be wasteful.

The Future of Biofoliar Fertilizers

The future for biofoliar fertilizers seems promising. As the global population increases, the pressure to produce more food without causing harm to our environment rises. In this context, biofoliar fertilizers represent a middle path, where we can enhance agricultural productivity without sacrificing ecological sustainability. Research into more effective strains of beneficial microorganisms, combined with advancements in biotechnology, will likely lead to the development of even more efficient biofoliar fertilizers. Furthermore, as awareness about sustainable farming practices grows, so will the adoption of these fertilizers.

Conclusion

Biofoliar fertilizers are a testament to the power of integrating modern science with natural, sustainable practices. They are not just products but represent a philosophy of farming that is in tune with nature. Thus it can also be formulated from organic waste to enhance the quality of plant yields which will improve the income of the hard core poor in rural areas. By harnessing the potential of these fertilizers, we can ensure a more abundant, healthier, and sustainable future for global agriculture.

Volume: 03 Issue No: 11

BIOFORTIFICATION IN HORTICULTURAL CROPS

Article ID: AG-VO3-I11-63

A. Bharathi[1*], R. Saranya[1], K.S.Vijay Selvaraj[2], M. Chitra[1], D. Amirtham[3], M. Pandiyan[1], P. Sivakumar[1] and A. Velayutham[1]

1 Dr MS Swaminathan Agricultural College and Research Institute, Eachangkottai, Thanjavur, Tamil Nadu

2 Vegetable Research Station, Palur, Cuddalore, Tamil Nadu

3. Agricultural College and Research Institute, Eachangkottai, Thanjavur, Tamil Nadu, Kudimiyanmalai, Pudukkottai, Tamil Nadu

*Corresponding Author Email ID: ayyarappab@gmail.com

Introduction

In recent days, micronutrient malnutrition has become a major problem for humans. The reason for this malnutrition mainly lies in the quality of the food, rather than their quantity. Another main reason is that in many under developed countries people mostly eat low-protein staple food crops. This is because micronutrient rich foods are vegetables, fruits, meats and dairy which are expensive, so poor people depend mainly on few starchy foods rich in energy, not on micronutrients. In order to overcome this micronutrient malnutrition, agriculture needs to adopt new method that will improve the nutritional quality of food. Only the partial nutritional content of food can be improved in Traditional agriculture, however biofortification is a practice in which the nutrients are fortified into crops using agronomic practices, conventional breeding and biotechnology based applications like genetic engineering and genome editing. Transgenic approaches are advantageous when nutrient does not naturally exist in the crop. Recently ,there are several reports on the development of transgenic crops to enhance levels of provitamin A content in crops like potato, tomato, sweet potato, cassava, beans and other vegetable crops,

Keywords: Biofortification, Malnutrition, Transgenic approaches, Vegetables.

Introduction

Around 30-40% of pregnant women and preschool children in developed countries suffer from iron deficiency due to their imbalanced and improper diet. The most prevalent condition caused by iron deficiency is Anemia which results in complications such as fatigue, hair loss and restless leg syndrome. Several untreated deficiencies due to iron leads to morbidity and death. Two billion people are malnourished worldwide. Micronutrients play an important role in nutrition, in the prevention and treatment of various diseases, as well as promoting mental and physical health (Sharma 2017).Vitamin A deficiency (VAD) is predominant in developing countries among children and women which leads to more than 600,000 deaths each year globally among children less than 5 years of age. Among the micronutrient malnutrition of population about 60% of iron, 30% of zinc, 30% of iodine and 15% of selenium are predominant. Inadequate availability of these vitamins and micronutrients resulted in many health and physical disorders n human beings.

Therefore nutrients can be enriched in crops by 1) fortification, that is, by adding vitamins and minerals to commonly consumed foods during processing to increase their nutritional value 2) Supplementation is the use of vitamin and mineral supplements 3) Biofortification outperforms other methods in which nutrients are added to crop or plant (Gomathi *et al.*, 2019).Thus, biofortification capitalizes on the daily intake of large amount of food staples by family members. Because, staple foods predominate the diet of poor, this method mainly targets the low income households to improve their vitamin and micronutrient uptake in their daily diet which ultimately prevents the micronutrient malnutrition.

Most horticultural crops such as banana, cassava, sweet potato, tomato, pumpkin, beans and others are benefited from biofortification. A number of different varieties have been released in many crops. It is a promising technique to tackle micronutrient malnutrition by increasing the availability of essential nutrients through traditional plant breeding and genetic engineering. By following this strategy balanced nutritional status can be maintained by all the people in the world.

Importance of biofortification:

- To overcome malnutrition in human beings
- Prevention or reduction of the occurrence of micronutrient deficiency
- To improve the micronutrient and vitamin uptake in daily food intake of human

- Introduction of biofortified crops will provide sustainable and low cost way of reaching people with poor access to formal markets or healthcare systems
- It is highly cost effective method and the process can be easily replicated and scaled
- To improve plant or crop quality and increment of variability in germplasm

Methods Of Biofortification:

Generally there are three methods to improve the nutrient content in edible crops,

1. Agronomic biofortification
2. Conventional plant breeding
3. Genetic engineering

Agronomic biofortification:

One of the most important and primary strategy is agronomic biofortification, which employs the application of fertilizer either by spray on the leaves or the soil application. The use of foliar application to enhance these nutrients in plant tissue and edible parts was stated to be effective in micronutrients such as Fe and Zn (Saltzman *et al*., 2013). Selenium as selenite (*Rahim et al., 2010*), iodine (soil application as iodide or iodate), and Zinc (foliar application as $ZnSo_4$) are the most important micronutrients for agronomic biofortification. Various studies found that mycorrhizal associations increase Fe, Se, Zn and Cu concentration in crop plants. Sulphur oxidising bacteria increase the sulphur content in onions.

Tomato:

These plants can tolerate high level of iodine, stored in vegetative tissues and fruit in ample amount for human diet and thus tomato is an excellent crop for iodine biofortification. The use of organic fertilizer "Riverm" is environmentally safe to enrich the Zinc content in Solanaceous crops such as tomato, chilli and brinjal.

Amaranthus:

Spirulina platensis,is a microbial inoculant was used a biofortiying agent to enhance the level of iron in crops in Amaranthus gangeticus.

Potato:

Foliar application of Zinc improves the Zn concentration in potato (White *et al*., 2012)

Broccoli and Carrots:

Se-enriched *S. pinnata* is used as a soil modification to provide organic Selenium to broccoli and carrots by foliar application of a solution of 77Se (IV).

Conventional plant breeding:

Conventional breeding involves changing of traits in plants in order to produce desired characteristics. For the past four decades, conventional breeding focused primarily on enhancing yield traits and producing resistant cultivars. This approach of breeders on crop finally leads to reduction in the nutritional value of existing crop varieties. In order to increase the nutritional content of crop conventional breeding involves many techniques such as Introduction, Selection, Mutation breeding and Hybridization.

Table:1 Biofortified varieties developed through conventional breeding

Crop	Variety	Content rich in
Carrot	Ooty-1	Carotene
	Pusa Rudhira	Carotene nd Phenol
Sweet potato	Bhu Sona and Bhu Krishna	Carotene and Anthocyanin
Radish	Pusa Gulabi	Carotene, Anthocyanin and Ascorbic acid.
Potato	Kufri Neelkanth	Anthocyanin
Tomato	Pusa Rohini	Vitamin C
Cowpea	Pant Lobia-1 and Pant Lobia-2	Fe and Zn
Cauliflower	Pusa Beta Kesari-1	Carotene
Pumpkin	Arka Chandan	Beta carotene
Brinjal	Punjab Sadabar	Anthocyanin

Genetic engineering:

This is the most effective biofortification technique that is being used all over the world to overcome the mineral and vitamin efficiency. This method involves transfer of desirable characters from one organism to others, to develop new cultivars. Vegetable cultivars are nowadays encouraged to use gene transfer technique to enhance the deficient mineral or vitamins in particular. It provides opportunities to improve food quality and health benefits. In vegetable crops, gene transfer is used to improve characters such as nutritional value, flavour, slow ripening and anti-nutritional factors.

Genes are transferred through two methods:

1. Vector gene transfer
2. Direct gene transfer

Table-2 Biofortified Varieties developed through genetic engineering

Crop	Gene	Content
Carrot	*CAX-1*	Calcium
Lettuce	*Ferritin*	Iron
Cauliflower	*Or*	Beta-carotene
Sweet Potato	*IbOr-Ins*	Lutein and Carotenoids
Cassava	*PSY*	Carotene
Potato	*AmA1*	Protein
Tomato	*pGAntho*	Anthocyanin

Conclusion

To overcome, hunger and malnutrition all overall the world, biofortification is best approach to enhance the minerals and nutrients in crops either by agronomical practice, conventional breeding or genetic engineering. It is an environmentally safe and economically viable method. In recent days, many biofortified crop varieties have been released in vegetables and fruits which benefits poor people in the under developed country. Biofortified crops provide nutritionally balanced diet in daily food consumption of all humans.

References

Gomathi, M. Irene Vethamoni, P.; Vethamoni, I. and Gopinath, P. 2017. Biofortification in Vegetable Crops: A Review. Chemical Science Review and Letters, 6(22): 1227-1237.

Rahim FP, Rocio CG, Adalberto BM, Rosaura SCL, Maginot NH. 2020. Agronomic biofortification with selenium in tomato crops (*Solanum Lycopersicum* L. Mill). Agriculture. 21;10 (10): 486-495.

Saltzman A, Birol E, Bouis HE. 2013. Biofortification: progress toward a more nourishing future. Glob Food Sec. 2:9–17.

Sharma P, Aggrwal P, Kaur A.2017. Biofortification: A new approach to eradicate hidden hunger. Food Reviews International. 2; 33(1):1-21

White P. J., Broadley M. R., Hammond J. P., Ramsay G., Subramanian N. K., Thompson J. and Wright G. 2012. Bio-fortification of potato tubers using foliar zinc-fertiliser. J. Hort. Sci Biotech. 87: 123-129

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

WOMEN FRIENDLY IMPROVED FARM TOOLS TO REDUCE DRUDGERY

Article ID: AG-V03-I11-64

[1*] **Bindeshwari Pandro and [2]Pooja Jaisani**

1,2 M.Sc Department of Agriculture Extension, COA JNKVV, Jabalpur,

Madhya Pradesh, India

*Corresponding author Email Id: bindeshwaripandro190@gmail.com

Introduction

According to M.S. Swaminathan, the famous agricultural scientist, women were pioneers who domesticated crop plants and laid the foundation of agriculture as a means to satiate the hunger. Women gathered seeds from the native flora and begun cultivating them in their surroundings. Since then women continue to play important role in agriculture and allied activities. Women comprise 33% of agriculture labor force and 48% of the self-employed farmers in India. Women are also engaged in allied fields including livestock rearing, horticulture, post-harvesting operations, agro/social forestry, fishing etc. Most labor-intensive manual operations in agriculture such as cattle management, milking, threshing, winnowing etc., are performed by women.

Some women friendly improved farm tools

There are some women friendly farm equipments and tools to reduce drudgery and increase work efficiency.

1. Hand ridger

It consist of a ridger and a pulling beam with a T-type handle. It is used for making ridges and two workers were required for itsoperation,i.e., one for pulling and another for pushing cum guiding the hand ridger.

Benefits –

- It avoids bending posture, which is generally adopted in traditional method with short handled tools for making ridges.

- Productivity of worker double with the equipment than traditional practice.

2.Seed Treatment Drum

It consist of a frame , a handle and a cylindrical drum.

Benefits –

- Uniform mixing of chemical is done.
- It also avoid bending/squatting posture as done in traditional method of treating the seed.
- Provides safety to workers as direct contact with chemical is avoided due to the use of a safety kit.

3.FertilizerBroadcastor

It consist of a hopper with agitator, spreading disk, gear, crank with handl , lid over hopper and straps for mounting the unit.

Benefits – it scatters the fertilizer at a uniform rate in the field and also covers a large area. It also saves workers from being exposed to the dust of granular fertilizer at the time of its application in the field.

4.Improved sickle

The improved sickle consist of a serrated blade, ferrule and a wooden handle.

5.Tubular Maize sheller

Four tapered fins are provided in the octagonal maize sheller, which helps in shelling the maize grain from dehusked cobs. A cob is inserted into the shelling is achieved by the twisting action.

Benefits- The chances of injury to fingers are eliminates thus making the operation safer for workers.

6.Sitting type groundnut decorticator

It consist of a frame, handle, oscillating arm, sieve with oblong hole, wooden plateform and stool.

7.Hanging type cleaner

It consist of a main frame, grading screen, draper rod, rubber grip over handle and shutter.

Benefits- The chances of injury to palm and fingers are eliminates thus making the operation safer for workers.

8.sugarcane stripper

It is a hand tool for stripping of leaves and detopping of cane after harvest. The stripper works by separating and pushing the leaf sheath away from stalk. A knife is welded on the stem of the stripper for detopping of canes and for cleaning roots etc.

Benefits- it helps to reduce the drudgery involved and chances of injury to workers in sugarcane stripping operation.

9.Conoweeder

Uprooting and buying of weeds in weeds in between standing rows of rice crop in wetlands.

Benefits- Bending Posture is avoided thus reducing drudgery of workers in weeding operation in wetlands.

10.Four row rice transplanter

For transplanting og 20-25 days old mat type rice seedling at 3-4 leaves stage in four rows simultaneously under puddled conditions.

Benefits- it avoids bending postures which is adopted in traditional method.

Line sowing helps in promoting the use of mechanical weeders thereby reducing drudgery and cost during weeding operation.

11.Twin wheel hoe

For weeding and interculture in up land row crops in black soil region.

Benefits- productivity of worker increased more than thre times with the equipment than traditional method.

12. **Ground nut stripper**

For stripping groundnut pods from crop vines.

Benefits- Squatting posture is avoided which minimizes stress at knee.

Higher output

13. Standing type groundnut decorticator

For separating kernels from groundnut pods

Benefits- the productivity of workers increased tremendously than traditional practice apart from safety of workers.

14. Naveen dibbler

Naveen dibbler consist of a jaw type seed placement device, cell type metering mechanism, lever type power transmission system for roller and jaws and seed box with delivery system.

Benefits- besides avoiding the bending posture that is genrerally in the traditional method and covering a larger area , time , sowing is done with it which promotes the use of mechanical weeders for weeding thereby reducing drudgery of farm women.

15. Hanging type cleaner with sack holder

Consist of main frame, grading screen, draper rod, rubber grip over handle, shutter etc.

Benefits- output with the equipment is many times more as compared to the traditional method. The work is also performed standing.

The health of farm women is one of the important resources for agriculture development. Therefore, drudgery reduction measures need to be initiated to avoid occurrence of health hazard among farmwomen. Hence, there is an urgent need to make women aware about latest drudgery reducing tools and motivate them to adopt the same as felt. If appropriate drudgery reduction technologies are made available to the farm women, it would definitely contribute in reducing their drudgery, increasing their working capability, increasing farm production resulting in improved quality of life.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

IMPORTANCE OF DRONE IN AGRICULTURE

Article ID: AG-V03-I11-65

Rishav Singh[1] and D.D. Sharma[2]

[1]PG scholars, [2]Professor (Agricultural Extension and Communication)

MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan (H.P.), 173229, India

*Corresponding Author Email ID: singhrishav647@gmail.com

Introduction

India is primarily an agrarian economy and our country reigns the world in the production of pulses, milk, rice, wheat, sugarcane, spices, etc. The Indian agriculture is considered the prime source of livelihood for approximately 58 per cent of the country's population, mainly for rural areas and contributes 18.80 per cent to country's Gross Domestic Product (GDP) (anonymous, 2021). Despite manifold increase in agriculture production our country is yet to enhance productivity and efficiency in the sector to reach the highest potential. Several dimensions and concerns need to be identified, supported, and equipped with resolutions. Improper methods for monitoring crops, irrigation, pesticide application and many other necessary farming activities are currently in use by the farmers. Besides, inadequate resources and those are also either not allotted according to weather conditions or have not been fully exploited to their maximum potential resulting decline in the Return on Investment (ROI).

Drone technology is gaining more popularity because of its diversified uses and considered as a boon for the future of our agrarian community. Though the drone technology has been initially used by the army yet other sectors have also quickly embraced this unmanned aerial vehicle (UAV) due to its widespread applications. In recent times, the government of India has emphasised on promoting the application of drones in the agricultural sector. As per the Indian federal budget of 2022-23, the government is keen to use ‘Kisan Drones’ to boost the agricultural sector in the country which will be further promoted for crop assessment, digitization of land records and spraying of insecticides and nutrients. Kisan Drones as high capacity drones in the times to come can be used to carry vegetables, fruits, fishes to the market directly from the farmers' fields. The above items can be supplied directly to the market with minimum damage/risk, consuming lesser time and resulting in more profits to the farmers and fishermen."

Drones in support of Indian Agriculture:

Drones don't merely enhance overall performance but also encourage the farmers in solving complex barriers and obtaining plenty of benefits through precision farming. This unmanned aerial vehicle fills the gap of human error and inefficiency caused by traditional farming methods/techniques. Hence, the purpose of adopting drone technology is to exclude any type of guesswork or ambiguity and instead to focus on accurate and reliable information. We know that external factors like weather, soil conditions and temperature play a critical role in farming, therefore, Agriculture drone empowers the farmers to adapt themselves as per the existing environments and make mindful choices accordingly. But sometimes the question is asked how drone technology works? Typically drones include a navigation system, GPS, multiple sensors, high-quality cameras, programmable controllers and tools for autonomous drones. Most farmers currently use satellite imagery as an introductory guide for farm management. Furnished with modern technology, Unmanned Aerial Vehicles (UAVs) can get more precise data than satellites for precision agriculture. The data captured are then processed into Agri-tech software to produce beneficial knowledge for the farmers. The capturing data from agriculture drone takes place in the following stages:

Analysing the area: Here the identified territory is tested and the first step includes establishing a boundary and analysis of the area and then finally the uploading of the technical GPS information is done into the drone's navigation system.

Using Autonomous Drones: Since Unmanned aerial vehicles (UAVs) are independent, they enter flight patterns into their already established system to collect the required data.

Uploading the data: After capturing all the required data through sensors such as the multispectral sensor/RGB sensor, it is processed through numerous software for further analysis and interpretation.

<u>Output</u>: After collecting the data, the same is formatted so that the farmers can understand the data with no hassle and bringing the farmers a step closer to precision farming.

Let's now discuss the fields/areas in which drone technology is used

<u>Monitoring of irrigation:</u>

Drones along with hyperspectral, thermal or multispectral sensors recognize the areas which are too dry or need improvement by the farmer. The drone survey helps in improving water efficiency and discloses potential pooling/leaks in irrigation. By providing irrigation monitoring, yield calculations of the vegetation index, it helps to realize the health of crops and emitted heat/energy

Let's now discuss the fields/areas in which drone technology is used

<u>Monitoring of irrigation:</u>

Drones along with hyperspectral, thermal or multispectral sensors recognize the areas which are too dry or need improvement by the farmer. The drone survey helps in improving water efficiency and discloses potential pooling/leaks in irrigation. By providin irrigation monitoring, yield calculations of the vegetation index, it helps to realize the health of crops and emitted heat/energy.

<u>Crop Health Monitoring and Surveillance</u>

It is crucial to track the health of the vegetation and spot bacterial/fungal plagues in the early stages. Agriculture drones can see which plants reflect different amounts of green light and Near-Infrared Spectroscopy (NIRS) light. This data helps produce multispectral images to track crop health. Quick monitoring and discoveries of any defect can help save crops. In case of crop failure, the farmer can also document the damages for accurate insurance claims

<u>Crop Damage Assessment</u>

Agricultural drones fitted along with multispectral sensors and RGB sensors also detect field areas infested by weeds, infections, and pests. According to this data, the exact amounts of chemicals needed to fight these infestations are known which helps in diminishing the costs borne by the farmer

Field Soil Analysis

The drone survey allows farmers to obtain information about their soil conditions. Multispectral sensors allow capturing the data useful for seed planting patterns, thorough field soil analysis, irrigation and nitrogen-level management.

PlantingDrone start-ups in India have invented drone-planting systems that allow drones to shoot pods, their seeds and crucial nutrients into the soil. This technology not only reduces costs by almost 85 per cent but also increases consistency and efficiency.

Agricultural spraying Through drone spraying, human contact with the harmful chemicals/pesticides get limited to a large extent. Agri-drones can carry out this task much quicker than other spraying tools. Further, the drones with RGB sensors and multispectral sensors can precisely identify and treat problematic ares.

Livestock tracking The drone survey allows the farmers not only to keep track of their crops but also in monitoring the movements of their cattle. Thermal sensor technology helps to lost animals and detect an injury or sickness in them and they can carry out this function favourably

Some other benefits of drone technology

With the invention/introduction of new farm technologies, the commercial use of drone technology is increasing day by day. Hence,the government has been easing restrictions for drone usage and supporting the start-ups to come up with novel ideas. As drone surveys become more common, they also become more cost-effective. In agriculture, they have a plethora of advantages which are given bellow

Enhanced Production - The farmer can improve production capabilities through comprehensive irrigation planning, adequate monitoring of crop health, increased knowledge about soil health, and adaptation to environmental changes

Effective and Adaptive Techniques - Drone usage results in regular updates to farmers about their crops and helps develop strengthened farming techniques. They can adapt to weather conditions and allocate resources without any wastage

Greater safety of farmers - It is safer and more convenient for farmers to use drones to spray pesticides in terrains challenging to reach infected areas, taller crops and power lines. It also helps farmers prevent spraying the crops which leads to less pollution and chemicals in the soil

Faster data for quick decision-making - Drone surveys back farmers with accurate data processing that encourages them to make quick and mindful decisions, allowing farmers to save the time invested in crop scouting. Various sensors of the drone enable capturing and analyzing data from the entire field. The data can focus on problematic areas such as infected crops/unhealthy crops, different colored crops, moisture levels, etc. For this purpose, the drone can be fixed with several sensors for other crops, allowing a more accurate and diverse crop management system.

Less wastage of resources - Agri-drones enables optimum usage of all resources such as fertilizer, water, seeds, and pesticides.

Accuracy rate - The drone survey helps farmers calculate the precise land size, segment the various crops and indulge in soil mapping

Useful for Insurance claims - Farmers can use the data captured through drones to claim crop insurance in case of any damages. They even calculate risks/losses associated with the land while being insured.

Evidence for insurance companies - Agricultural insurance sectors use Agri-drones for efficient and trustworthy data. They capture the damages that have occurred for the right estimation of monetary payback to the farmers.

LOCUST SWARM:

Locust swarms are known to feed on crops, trees and other types of plants. This feeding can destroy crops planted, causing famine and deprivation in societies that solely dependent on these crops for survival. In recent times, swarms of locusts have invaded several areas in India, especially Rajasthan. Most nations battling locust swarms rely significantly on organophosphate chemicals. These are utilized in little concentrated lots by vehicle-mounted and aerial sprayers. For example the state of Rajasthan has stationed drones to carry out the spraying efficiently which can diffuse pesticides on approximately 2.5-acres in merely 15 minutes. Thus, using drones to combat the locust swarms is an immediate, secure and practical approach.

Limitations of agri-drones:

Despite a lot of benefits of drone technology, there are certain limitations also which are discussed as under:

Connectivity issue

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

Highly dependent on weather

Drones are heavily dependent on good weather conditions. Hence, under rainy or windy weather conditions, it is not advisable to fly drones.

Knowledge and skill

Using new technology is a welcoming change but using it daily requires the right skillset and adequate knowledge. An average farmer may struggle to understand drone functions. As a result, either he must acquire the knowledge of drone technology or he might have to depend on an experienced/skilled person.

Keeping the importance of drone application in agriculture, the government of India has taken certain initiatives. On 16th November 2020, the Indian government granted the International Crops Research Institute (ICRISAT), to use agri-drones for agricultural research activities. With this move, the government hopes to encourage budding researchers and entrepreneurs to look at budget-friendly drone solutions for more than 6.6 lakh Indian villages. To make drones affordable to the farmers and different stakeholders and further promoting drone use, the Government of India has announced a number of subsidies on the purchase of drones.

Similarly, for promoting the use of Kisan Drones, the Indian Agriculture Ministry is providing 50 per cent or maximum Rs. 5 lakh subsidy to the SC/ST small and marginal farmers to buy drones. For other farmers, financial assistance is given upto 40 per cent or maximum Rs. 4 lakh. Moreover, 100 per cent of the cost of drone is extended to the Farm Machinery Training & Testing Institutes, Institutions of Indian Council of Agricultural Research, Krishi Vigyan Kendra (KVK) and State Agricultural Universities (SAUs) for drones for demonstration on the farmers' fields.

Farmers Producers Organizations (FPOs) are also provided grants @ 75 per cent for purchase of drones for its demonstration on the farmers' fields. Financial assistance of 40 per cent of total cost of drone upto Rs. 4 Lakh is provided for drone purchase by existing and new Custom Hiring Centres (CHCs) under Cooperative Society of Farmers, Farmers Producer Organizations (FPOs) and Rural entrepreneurs. Moreover, agriculture graduates establishing CHCs are eligible to receive financial assistance @ 50 per cent of the cost of drone up to a maximum Rs. 5 Lakh. Thus, with these subsidies in place, drones are free for agri-training and research institutes. Besides, implementing agencies are eligible for subsidies per hectare if they want to hire drones for demonstrations rather than buying them.

In fact, as an outreach activity to showcase and promote drones, Bharat Drone Mahotsav 2022- India's biggest drone festival was held on May 27-28, 2022 in New Delhi which was inaugurated by the Prime Minister of India who interacted with Kisan drone pilots, start-ups and witnessed open-air drone demonstrations. The presence of the Prime Minister in different events related to drones makes amply clear the priorities that the government attaches to the development of the drone sector in India, particularly Kisan drones.

Prospective challenges with drone sprays and the way forward

It is common knowledge that cost of labour of manually spraying an acre of land is Rs. 350-400 or more and hardly a farmer can spray about 2 acres in a day. Though, the spray cost in case of renting drones presently is slightly higher i.e. approx. Rs. 700 per acre yet it is worth the cost. However, the time and labour savings while using drones for spray is substantial. Farmers are willing to experiment with drone use in their farms to test both economics as well as efficacy of its use. But the requirement of trained manpower for their operations and maintenance/services present both a challenge as well as an opportunity. The need is to create a pool of well trained personnel in the rural areas particularly near the farms, who can operate and deliver the drone services at an economic price to the farmers.

Given the huge number of farms in India, there is also an employment opportunity for aspirational youths. Possibility can be further explored for other advanced uses which can lead to more efficient resource utilisation in Indian agriculture.

Some start-ups in the Indian drone sector:

Some startups (along with their websites) active in the Indian drone sector are listed below:

Asteria Aerospace Limited: https://asteria.co.in/

AUS-Aarav Unmanned Systems: http://www.aus.co.in/

Garuda Aerospace Pvt Ltd: https://www.garudaaerospace.com/

General Aeronautics Pvt Ltd: https://www.generalaeronautics.com/

ideaForge: https://www.ideaforge.co.in/

Indrones: https://www.indrones.com/

IoTechWorld Avigation: https://www.iotechworld.com/

Conclusion

As mentioned before, agricultural drone technology is undoubtedly the future of the Indian agrarian community. It can transform traditional farming methods in uncountable ways. Even though this technology is more complex to be familiar with, it will yield its results in no time once learned. Looking further into the future, drone technology is going to change the agriculture sector. Many Indian startups are also showing interest in the industry and aiming to invest in low-cost drones, which can help farmers and simultaneously create employment opportunities for the rural youth and enhance the knowledge of farmers as well. However, the industry needs mature reforms, keeping in mind the growing population, the needs of the farmers, operational policies, and the shrinking farmlands. Overall, it would be interesting to see how things go ahead, and how useful the applications of drones turn out to be in the long run.

References

https://www.indiabudget.gov.in/economicsurvey/ebook_es2022/ files/basic-html/page262.html#:~:text=The%20share%20of%20the%20agri culture,per%20cent%20in%202021%2D22.

https://www.indiabudget.gov.in/doc/Budget_Speech.pdf

Patel, Sohangkumar & Mujmer, Pranjal & Rank, Harshil & Malaviya, Darshankumar & Sutariya, Ashishkumar & Pipaliya, Malay & Gajera, Ankitkumar. (2022). Case study on Agricultural Autonomous Drones. 10.13140/RG.2.2.31964.46724.

https://pib.gov.in/PressReleseDetailm.aspx?PRID=1822070

https://pib.gov.in/PressReleasePage.aspx?PRID=1806231

https://www.hindustantimes.com/india-news/indias-biggest-drone-festival-inaugurated-by-pm-huge-enthusiasm-for-tech-101653630409251.html

https://www.facebook.com/iffcokisan/videos/533186745002351

Volume: 03 Issue No: 11

IMPORTANCE OF HONEY BEES IN CROP PRODUCTION

Article ID: AG-VO3-I11-66

[1]Aparna, FS., [2*]V. Krishnan, [1]S. Lakshmipriya, [1]J. Arathi, [1]R. Praveen, [1]K. Preetha and [2]T. Anandhan

[1]PG Scholar & [2]Faculty,Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal 609603, U. T. of Puducherry

*Corresponding Author Email ID: anurathakrishnan66@gmail.com

ABSTRACT

Pollination plays a significant role in the agriculture sector and serves as a basic pillar for Crop Production. There is a rising demand for food security in the face of threats posed by a growing human population. Bees as an insect play a crucial role in crop pollination alongside other animal pollinators such as bats, birds, beetles, moths, hoverflies, wasps, thrips, and butterflies and other vectors such as wind and water. Bees contribute to the global food supply via pollinating a wide range of crops, including fruits, vegetables, oilseeds, legumes, etc. Bee pollination improves the quality and quantity of fruits, nuts, and oils. Plants depend on vectors to move pollen, which can include water, wind, and animal pollinators like bats, moths, hoverflies, birds, bees, butterflies, wasps, thrips, and beetles. Cultivated plants are typically pollinated by bees. Animal-based pollination contributes to 30% of global food production, and bee-pollinated crops contribute to approximately one-third of the total human dietary supply. Bees are considered significant pollinators due to their effectiveness and wide availability. Bee pollination provides excellent value to crop quality and quantity, improving global economic and dietary outcomes.

INTRODUCTION:

Pollinators are the key players of the crop yield process since plants completely rely on vectors to transfer their pollen in cross-pollination. Pollination plays a vital role in maintaining the natural balance of ecosystems and is the cornerstone of Crop Production, providing a link between agriculture and the cycle of life. In agriculture, comparable to any other input such as fertilizer, labor or pesticides Pollination is an important input of crop production. Insect pollinators are very important in determining the mate opportunity of plants and they are a key stone process in Crop Production. From the six known types of pollination agents (insects, birds, wind, gravity, water and mammals) insects are by far the most important in pollination. Bees as an insect play a crucial role in crop pollination.Insects are considered to be responsible for 80-85% of all pollination, and of this 75-80% are attributable to honeybees. The biggest groups of insects for pollination are solitary bees, bumblebees and honeybees this is because of their sufficient body hair and their behaviour patterns . Honeybee pollinators are required for producing up to 30 % of the human food supply directly or indirectly and the farmers rely on managed honeybees throughout the world for crop production. The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production (Shrestha, 2004).Honeybees must be considered the major pollinator of cultivated crops for the following reasons.

HONEY BEES IN CROP PRODUCTION:

Mellitophily is the method of cross pollination in which the pollination is carried by bees as the pollinating agents. Entomophily is a group of plant pollination where by pollen is distributed by the respective insects, particularly bees. Note that honey bees will pollinate many plant species that are not native to areas where honey bees occur, and are often inefficient pollinators of such plants. For the animal-pollinated agricultural crops, bees are the most important pollinators worldwide because of their foraging behaviour and floral constancy (ability to visit flowers of only one plant species on every foraging bout). But, only about 15% of the world's crops are pollinated by a few managed bee species. A bee visits same species of plant for pollen/nectar collection until the source is exhausted. This is known as Royal fidelity. Bees travel 2-3 km distance to collect pollen/nectar.

6. Bees do not injure the plants.

THE MUTUALISTIC RELATION BETWEEN FLORAL AND POLLINATOR:

Pollination is the term used to elucidate the transfer of pollen from the male part of the flower, the stamen, to the female part of the flower, the pistil. The mutualistic relationship between plants and honey bees results from the exchange of nectar and pollen. It is one of the most important processes when it comes to reproduction and is a crucial part of the ecosystem. The mutualistic relation between floral and pollinator creatures has shown a beneficial outcome for both these life forms .The evolution of angiosperms was shaped by the pollinators and *vice versa* by co-evolution. From way back, the relation between flowers and insects that deliver pollen grains to the female parts of plants, bespeak that they are key for the productivity of seeds and fruits. They perform the role of dispersing pollens, spores, and seeds of many species of plants. Contrarily, most of the plants are dependent upon insects for their reproductive cycle by pollination to continue their race in enriching the biodiversity and a better yield .The efficacy of pollination markedly hinged on some allocations and idiosyncrasies of pollinators such as sight, behaviour, and learning ability etc. The evolutions of the behavior of pollinators and flowering plants have become species specific in some cases that the elimination of one will drastically affect the survival of the other. The pollinators contribute enormous productive and ecological aid to flowering plants and mankind. The alliance between flowering angiosperms and their pollinators emerged about 225 years ago. Among 240,000 species of flowering plants, approximately 91 per cent require the assistance of pollinators for the completion of their reproductive cycle. About 35% crops around the globe are depending on pollinators and entomophily is regarded as the key for pollination of around 70 to 108 major crops around the world.

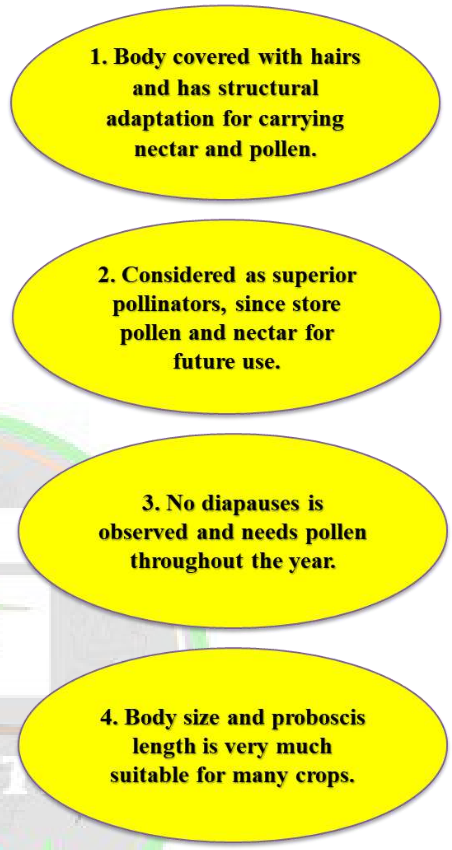


Fig. 1. Adaptations of Honey bees for pollination

MANAGEMENT OF BEE HIVES FOR BETTER POLLINATION:

1. Place hives very near to field source to save bee's energy
2. Mitigate colonies near field at 10 per cent flowering
3. Allow sufficient space for pollen and honey storage
4. Place colonies at 5/h for Italian bees and 3/ha for Indian bees
5. Colonies should have 5 to 6 frame strength of bees

Fig. 2. Management of Bee hives for better pollination

EFFECT OF BEE POLLINATION IN CROPS

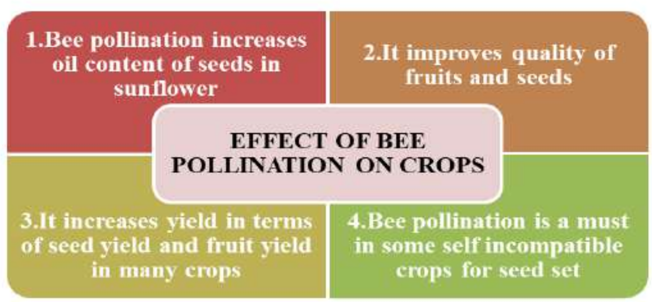


Fig. 3. Effect of bee pollination on crops

WHAT'S THEIR (BEES) ACTUAL ROLE IN CROP PRODUCTION?

Sunflower:

- ✓ It is a cross-pollinated crop. The pollen of the plant cannot fertilize ovary of same plant. Pollen source should be from different plant. Hence, honey bees' acts as important agents for pollination in sunflower.
- ✓ In sunflower, yield increases even up to 600 per cent due to bee pollination.

CROP	PERCENT YIELD INCREASE
Mustard	43
Sunflower	32 - 48
Cotton	17-19
Lucerne	112
Onion	93
Apple	44

Fig. 4. Per cent increase in yield of different crops due to Honey bee pollination

- ✓ It improves quality and quantity of seeds. Oil content also increases by 6.5 per cent in seeds.
- ✓ To achieve this it requires five strong *C. indica* colonies or three *A. mellifera* colonies. Mostly irrigated crop is preferred by bees.

Cucurbitaceous vegetables:

- ✓ Cucurbits are monoecious with staminate and pistillate flowers in same plant.
- ✓ Due to bee pollination fruit set increases up to 30 to 100 per cent.

Alfalfa or lucerne:

- ✓ These plants have tubular flowers with 5 petals joined at base. They posses one large standard petal, 2 smaller petals on sides and 2 keel petals holding staminal column.
- ✓ When bee sits on a keel petal, stamina column strikes against standard petal resulting in shattering of pollen. This is called *tripping*. Seed set occurs only if bee sits to trips the flowers.

Coriander:

- ✓ In coriander yield increases up to 187 per cent due to pollination.

Cardamom:

- ✓ It is an important commercial crop depending on bees for pollination.
- ✓ Here yield increases up to 21 to 37 per cent.

Gingelly:

- ✓ Another oilseed crop where bee pollination causes 25 per cent increase in yield.

Apple:

- ✓ In apple seed set occurs only if it is pollinated by bees.
- ✓ Fruit is formed only around the seeds. If improper seed set occurs fruit shape is lopsided resulting in decreased market value.

Conclusion

It is now apparent that most of the pulses and oilseeds, fruits and orchard crops including vegetables heavily depend on bees for their pollination. The number of colonies of honeybees required per hectare very much depends on the strength of foraging bees in the colony, the crops and prevailing weather conditions. The optimum number of colonies of average strength may range from 3 to 9 colonies per hectare, since the bees usually forage within a radius of about 1 to 2 km to harvest their nectar and pollen loads, and then return to their own hive. This is also true for seed production of vegetables like onion, cabbage, cauliflower, tobacco, sun hemp, alfaalfa and clovers. The number of colonies of honeybees required per hectare very much depends on the strength of foraging bees in the colony, the crops and prevailing weather conditions. Pollination is an important input in crop production to improve crop quantity and quality and it a valuable ecosystem service, on condition that a variety of benefits including food and fiber, plant-derived medicines, ornamentals and other aesthetics, genetic diversity, and overall ecosystem resilience. But, only about 15% of the world's crops are pollinated by a few managed bee species, while the rest are pollinated by un-managed solitary bees and other wildlife.

References

Kewanit Alemberhe, Kidu Gebremeskel, A Review on: Role of Honey Bee Pollination in Improving Crop Productivity and Seed Quality in the Northern Ethiopia, Food Science and Quality Management, 2016; Vol.47:7-13.

Breeze, T.D.; Bailey, A.P.; Balcombe, K.G.; Potts, S.G. Pollination services in the UK: How important are honeybees? Agric. Ecosyst. Environ. 2011; 142, 137–143.

Stanley, D.A.; Msweli, S.M.; Johnson, S.D. Native honeybees as flower visitors and pollinators in wild plant communities in a biodiversity hotspot. Ecosphere 2020; 11, e02957.

P.G. Kevan, H.G. Baker, "Insects as flower visitors and pollinators", Ann. Rev. Entomol. 28,407- 453, 1983.

Volume: 03 Issue No: 11

INDUCTION OF MUTATION IN FLOWER CROPS

Article ID: AG-V03-I11-67

Rishika Choudhary[1] and Anuj Kumar[2]

[1]Research Scholar, Department of Floriculture and Landscape Architecture, College of Agriculture (MPUAT), Udaipur, Rajasthan

[2]Assistant Professor & Head, Department of Floriculture and Landscape Architecture KNK College of Horticulture (RVSKVV, Gwalior), Mandsaur, M.P. India

*Corresponding Author Email ID: rishikatetarwal@gmail.com

Introduction

Mutation is the process by which a gene or chromosome differs from the wild type. It is the result of a sudden heritable alteration in an organism. Ornamental plants with a wide range of flower colours and shapes are highly valued in the commercial flower industry, thus mutant cultivars that produce a variety of blooms while keeping their growth patterns are in high demand. Furthermore, mutation breeding is ideally suited for ornamental plants due to the ease with which many species can be vegetatively propagated, allowing the development of spontaneous and induced mutations. The genetic system for expressing significant features, which will most likely result in the development of more efficient decorative plant mutant breeding procedures. With over 3,200 mutant cultivars created worldwide (FAO/IAEA Mutant Variety Database), mutation breeding is an important strategy for agricultural improvement. Mutation can occur naturally or through deliberate induction, and the resulting mutant has a change in the gene or chromosomes. Induced mutagenesis techniques have created and commercialised a huge number of new promising types

in many crops around the world, including ornamental plants. Amaryllis, Asiatic hybrid lily, bougainvillaea, chrysanthemum, dahlia, gladiolus, hibiscus, Lantana depressa, marigold, rose, tuberose, gerbera, narcissus, and other flower and ornamental crops have been improved with both physical and chemical mutagens. In ornamental crops, induced mutagenesis has been most successful. In ornamental crops, mutation breeding has resulted in compact growth, appealing variegated leaves, and new blossom colours and shapes.

Effective mutagenic treatment techniques for different species are of tremendous interest due to the exciting potential of mutation breeding in ornamental plants. There are other nontargeted mutagenesis techniques that can be used, such as chemical treatment with alkylating chemicals or different dosages of X-ray, gamma, or neutron or heavy ion beam radiation. All of these are reasonably priced and have been shown to be efficient mutagens across a wide range of species. However, due to the high cost and lack of understanding required to efficiently transform and regenerate attractive crops, genetic engineering is still generally impracticable for many ornamental breeding operations. Irradiation with gamma rays is still the most widely used nontargeted mutagen. When compared to chemical mutagens, it has a higher consistency, albeit at a lower mutagenic efficiency. Changes in radiation dose rate may improve efficiency, but chronic irradiation over a longer period results in fewer deleterious mutations than commonly used acute irradiation protocols. Because of the high particle energy associated with these treatments, heavy ion beam irradiation may also provide highly consistent mutation induction at higher efficiencies. Additionally, there are opportunities to improve chemical mutagenesis.

Combining mutagenesis with ethyl methane sulfontate with genetic screening in a process known as TILLING (Targeting Induced Local Lesions IN Genomes) may eventually result in a potent mutation breeding tool, even though the necessary knowledge of specific gene functions in many ornamentals is still lacking. It is still very beneficial to use mutation breeding, and there are plenty of chances to make the current techniques better.

The following are some instances of how mutations have been induced in flower crops:

Table.1 Gamma ray dosages adopted for different flower crops

Ornamentals	Propogation	Mutagen	Dose
Amaryllis	Bulb	Gamma rays	250 rads – 5 Krad
Bougainvillea	Stem cuttings	Gamma rays	250 rad to 1.25 kR
Canna	Rhizome	Gamma rays	2 and 4 Krad
Chrysanthemum	Rooted cuttings/ suckers	Gamma rays	1 to 3.5 Krad
Gerbera	Rooted plantlet	Gamma rays	1 and 2 Krad
Gladiolus	Bulb	Gamma rays	250 rads to 5 Krad
Hibiscus	Stem cutting	Gamma rays	1 to 4 Krad
Narcissus tazetta	Bulb	Gamma rays	0.25, 0.50 and 0.75 kR
Perennial portulaca	Stem cutting	Gamma rays	250 rad to 1.25 Krad
Polianthes tuberosa	Bulb	Gamma rays	250 rad to 8 Krad
Rose	Stem with budding eyes	Gamma rays	2 to 6 Krad
Tagetes erecta	Rooted cuttings	Gamma rays	500 rad to 2 Krad
Lantana depressa	Stem cutting	Gamma rays	1 to 4 Krad

Table.2 Improved attributes of mutant cultivars in different flower crops.

Scientific name	Common name	Name of cultivar	Parent cultivar	Main improved attribute of mutant cultivar
Catharanthus roseus (L.) G. Don	Madagascar periwinkle	Setofuku CAP	Setofuku CAMR	Altered flower color and petal shape
Catharanthus roseus (L.) G. Don	Madagascar periwinkle	Setofuku GPN	Kamihon BPN	Altered flower color

Chrysanthemum × *morifolium* Ramat.	Chrysanthemum	Aladdin	Jimba	Few lateral buds
Chrysanthemum × *morifolium* Ramat.	Chrysanthemum	Imajin	Jimba	Few lateral buds
Chrysanthemum × *morifolium* Ramat.	Chrysanthemum	Aladdin 2	Aladdin	Early flowering at a low temperature
Chrysanthemum × *morifolium* Ramat.	Chrysanthemum	Ion-no-Kouki	Taihei	Altered flower color (Complex with light yellow and pink)
Chrysanthemum × *morifolium* Ramat.	Chrysanthemum	Ion-no-Mahou	Taihei	Altered flower color (Light orange on adaxial, dark yellow orange on abaxial side)
Chrysanthemum × *morifolium* Ramat.	Chrysanthemum	Ion-no-Koumyou	Taihei	Altered flower color (Complex with light yellow and light pink)
Cyclamen L.	Cyclamen	Tennyo-no-Mai	Uruwashi-no-Kaori	Altered flower color (salmon pink)
Dianthus caryophyllus L.	Carnation	Misty Pink Vital Ion	Vital	Altered flower color (bi-colored) and petal shape

Volume: 03 Issue No: 11

PROMOTING PRODUCTIVITY AND SUSTAINING SOIL HEALTH

Article ID: AG-VO3-I11-68

Dr. M. Paramasivan[1] Dr. N. Senthilkumar[2] and Dr. L. Allwin[3]

[1]Agricultural College and Research Institute,

Tamil Nadu Agricultural University, Killikulam, Vallanad – 628 252, Tuticorin, Tamil Nadu.

[2]Coconut Research Station, Veppankulam – 614 906, Tanjure – Dt, Tamil Nadu,

[3]Rice Research Station, Ambasamudram – 627 401, Tirunelveli – Dt, Tamil Nadu

*Corresponding Author Email ID: paramusoil@gail.com

Introduction

Soil degradation is a global phenomenon. Of the world's total land area of 13.5 billion hectares, only 3.03 billion hectares (22 per cent) is actually cultivable and about 2 billion hectares is degraded. Soil degradation in India is estimated to be occurring on 147 million hectares (Mha) of land, including 94 Mha from water erosion, 16 Mha from acidification, 14 Mha from flooding, 9 Mha from wind erosion, 6 Mha from salinity, and 7 Mha from a combination of factors.

Causes of soil degradation are both natural and human-induced. Natural causes include earthquakes, tsunamis, droughts, avalanches, landslides, volcanic eruptions, floods, tornadoes, and wildfires. Human-induced soil degradation results from inappropriate agricultural practices, improper management of industrial effluents and wastes, over-grazing, careless management of forests, surface mining, urban sprawl, and commercial/industrial development. Inappropriate agricultural practices include excessive tillage and use of heavy machinery, excessive and unbalanced use of inorganic fertilizers, poor irrigation and water management techniques, pesticide overuse, inadequate crop residue and/or organic carbon inputs, and poor crop rotation.

In India, low and imbalanced fertilization to crops have virtually mined nutrients from the soil. The already imbalanced consumption ratio of 6.2:4:1 (N:P:K) in 2000–2001 has widened to 7:2.7:1 in 2010–2011 and 5:2:1 in 2020–2021 compared with a target ratio of 4:2:1. The nutrients deficient in Indian soils increased from one (N) in 1950 to nine (N, P, K, S, B, Cu, Fe, Mn, and Zn) in 2020–2021. Wide spread Zn deficiency, followed by S, Fe, Cu, Mn and B in are common throughout the country. In addition soil erosion is another reason for soil fertility depletion, accounting for an annual loss of 8 Mt of plant nutrients through 5.3 billion tons of soil loss.

Declining soil health is a major constraint on crop production in the arid and semi-arid region of southern Tamil Nadu. Particularly, land shortage and land fragmentation have increasingly forced farmers to abandon soil fertility management practices such as fallowing, manuring, terracing, and using crop residues. Unless farmers use other sources of nutrients, the disappearance of these traditional practices will have a considerable impact on soil fertility.

Indigenous technical knowledge (ITK)

Indigenous technical knowledge (ITK) is the local knowledge that people have gained through inheritance from their ancestors. It is a people derived science and represents people's creativity, innovations and skills. Indigenous technological knowledge pertains to natural resource conservation, especially soil and water. This knowledge has backgrounds of hundreds and sometimes thousands of years of adoption.

We have many indigenous techniques for promoting productivity and sustaining soil health. These have been in practice for number of years. Therefore there is a need to enmesh these practices along with conventional soil and water conservation measures for promoting sustainable development of agriculture. Some of these traditional practices are in the fields of agriculture such as crop residue application, relay cropping, green leaf manure and green manure cropping, tank silt application, sheep penning etc,.

Crop residue application

Crop residue application to field surface is an age old practice followed by farmers in southern Tamil Nadu. The crop residues are left in field after harvesting. Left over residue are ploughed and

incorporated to the soils which supplied all nutrients to subsequent crops. In rainfed crops, after threshing and collection of seeds and grains of crops, the stalks and forage are spread on the surface of the field till next crops are grown. This will also be used as fodder for animals. The residue act as mulch and barrier to conserve the physical and biological properties of soil such as reducing erosion, improve the soil structure and texture, and conserve soil moisture. This practice also improve organic matter and fertility status of the soil through decomposition of residue during the rainy season in irrigated and low land river basin tract.

Relay cropping

Relay cropping is a common indigenous practice in river basin and lowland rice field. In the practice the pulse crops such as black gram and green gram are sown 15 days before harvesting of paddy crop. The seeds of the above mentioned crops are broad casted. The manual harvesting of the paddy crop do not affect the germination of pulse seeds. This practice is a cost effective and time saving by reduce the cost and time for land preparation. Relay cropping with pulses is important agronomic management tool by providing nutrients, reducing the attack of pest and diseases and weed break for the subsequent crops. Broad crop rotation within farm land maintain the physico-chemical and biological properties of the soil and lead to sustaining soil health.

Green Leaf Manure / Green trees on field boundary

Growing trees such as Neem (*Azadiracta indica)*, Poovarasu (Thespesia populnea), Glyricidia, Karanji *(Pongamia glabra)*, *Sesbania grandiflora*, Subabul, are important species useful in green leaf manure are grown in the boundary of field. This is an age old practice in field act as life fencing and wind breaker to standing crops. Also act as habitat for birds and honeybees. The birds involved in biological control of insects and honeybees act as a natural cross pollinator for fertilization and seed set of cultivated crops.

Application to the field, green leaves and twigs of trees, shrubs and herbs collected form elsewhere is known as green-leaf manuring. The important plant species useful for green-leaf manure are neem, mahua, wild indigo, glyricidia, Karanji *(Pongamia glabra)* calotropis. avise *(Sesbens grandiflora)*, subadul and other shrubs. This practice helps in improving the soil fertility and sustaining the soil health.

Nutrient content of Green Leaf Manure trees and shrubs

S. No	Name of the species	N	P	K
	Tephrosila purpurea	2.4	0.3	0.8
	Phaseolus trilobus	2.1	0.7	3.6
	Gliricidia	2.9	0.5	2.8
	Pungam	3.2	0.4	2.2
	Erukkan (calotrpis)	2.1	0.7	3.6
	Virali (Dodanca viscose)	2.0	0.8	2.8
	Malaipuvarasu	2.2	0.5	2.3

Growing Green Manure

Green manures are the natural gift, being a suitable alternative to increase the organic matter content of the soil. Several advantages accrue due to the addition of green manures. Undecomposed plant material used as manure is called green manure. It is obtained in to ways: growing green manure crops or by collecting green leaf (along with twigs) from plants grown in wastelands, field bunds and forest. Green manuring is frown in the field plants usually belonging to leguminous family and incorporating into the soil after sufficient growth. The most important green manure crops are sunhemp, dhaincha, pillipesara, clusterbeans and Sesbania rostrana.

In situ growing of legumes such as sunhemp, daincha, sesbania, pillipesara, cluster bean conserve the soil and improved fertility status of the soil through fixation of atmospheric nitrogen with the help of microorganism like rhizobium. Incorporation of these species before flowering (30-45 days after sowing) provide a substantial amount of green leaf materials and can decompose easily in the soil. A

green manure crop will benefit the soil by providing cover to suppress weeds, will store soluble nutrients preventing them from being washed out by rain. Legume family green manure crops fix the atmospheric nitrogen by beneficial bacteria living in root nodules in the plants roots, when the plant is cut the roots break down in the soil and release the nitrogen.

Nutrient content of Green Manure Crops

S. No	Name of the species	N	P	K
	Sesbania aculeata	3.3	0.7	1.3
	Crotalaria juncea	2.6	0.6	2.0
	Sesbania speciosa	2.7	0.5	2.2
	Clusterbean	1.9	0.4	0.9
	Pillipesara	2.9	0.6	1.1

Recommended stage green manure crop to incorporate to thesoil

S.No.	Name of the crop	To be incorporated into soil (DAS)	Biomass \ Drymatter (t\ha)	N accumulation (kg\ha)
1.	Azolla	35	1.8 – 3.0	52
2.	cowpea	40 - 60	3 - 4	140 - 150
3.	lablab	45 - 60	5 - 7	220
4.	*Sesbania aculeata*	50	23.2(F)	133
5.	*S. rostrata*	50	22.8(F)	182
6.	*Sunhemp*	50	5 – 6.0	117
7.	*Mungbean*	30-60	1.1-4.7	35-135
8.	*Clusterbean*	60	3.8	87

Sheep penning

Sheep penning is an important traditional practice, where the sheeps are allowed to bed in the particular fenced area of the field during the night hours after the regular grazing by the shepherd. This practice is being familiar in southern districts of Tamil Nadu *viz,.* Tuticorin, Tirunelveli, Ramanad, Sivagangai, Viruthunagar and some parts of Madurai Dindugal, Coimbatore and Karur. More than 50 % of the farmers of these region follow this practice at least once in 2 years. Nellore, Madras red, Vembur, Ramnad white, Trichy black are the important sheep breeds and suitable for the arid zone areas. In rainfed and garden, the penning practice is followed after the harvest and before onset of the monsoon or whenever the field is kept free. The main purpose is to collect the dung and urine of the sheep to maintain the soil health. The manure contains 0.9, 0.6 and 1.0 per cent of nitrogen, phosphorus and potassium. The urine of sheep have more nutrients than dung which containing 1.7 per cent nitrogen and 2.0 per cent potassium.

Sheep penning practice

For penning, the shepherds pool their animals into a flock that numbers about 250 – 1000 sheeps. Farmers who want to manure their lands make arrangements with the shepherd to pen the flock overnight on their land. During day times the animals are carried to surrounding field for grazing. The location of the penning is changed every day. This practice helps to uniform distribution of manures in the field.

The sheeps are allowed to stay during night hours in the field itself after the regular grazing. The penning area of about 100 to 200 m^2 (10 X 10 or 10 X 20 m) is fenced with wooden reapers or nylon nets and about 300 – 500 animals are accommodated inside the selected area. The shepherds or the contractors are doing this practice as an additional income. The charges for penning is collected based on the numbers of animals. Normally 50 paise per animal is collected for single night. Usually, penning is performed for 7-15 days depending upon the number of animals and when excreta deposition on the fields is considered adequate, then the camp is shifted to other place. Around 5000 animals are sufficient for one hectare of land. From this, the field is enriched with 10 tonnes of fresh dung along with 10,000 litres of urine (2 litre \ sheep in single night). The top soil of the field drenched with the urine mineralize

the nutrients rapidly available to the first season crop. The 30 per cent of dung obtained from the sheep is utilized by the first crop and remaining 70 per cent is utilized by the next season crop.

In terms of nutrients, about 170 kg of nitrogen and 200 kg of potassium which is equal to 370 kg of urea and 333 kg of potassium chloride fertilizers. Both the dung and urine can be incorporated into the soil efficiently by the ploughing.

Tank silt application

Removal of tank silt and its application on agricultural lands is a traditional activity done by farmers for sustainability and productivity. Application of tank silt as an amendments to the sandy soil is economically viable for improving the soil physical and chemical properties of soil.

Characteristics of tank silt

Soil parameters	**Values**
Texture	Clay
Clay (per cent)	71.8
Silt (per cent)	19.3
Fine sand (per cent)	6.8
Coarse sand (per cent)	1.4
Organic carbon (per cent)	1.6
pH	7.4
EC (dS m^{-1})	0.22
Available nitrogen (kg ha^{-1})	360
Available phosphorus (kg ha^{-1})	28
Available potassium (kg ha^{-1})	210
Available Sulphur (mg kg^{-1})	28.3
Available Zinc (mg kg^{-1})	1.4
Available Copper (mg kg^{-1})	2.8
Available Manganese (mg kg^{-1})	14.6
Available Iron (mg kg^{-1})	22.0

(Paramasivan *et al* ., 2015)

Application of tank silt to rainfed and irrigated agricultural lands is an age old traditional practice of South Indian farmers to sustain the productivity of their lands. In Southern districts of Tamil Nadu, until the recent past, it was very common that farmers maintained an open compost pit of their own. Such a mixture of decomposed farm yard waste with tank silt was applied to their dry lands once in two years. Some farmers used to transport tank silt and farm yard manure separately to their fields for spreading before

the onset of monsoon. Such practices not only replenished the soil nutrients, but also improved the moisture retention capacity of the soil conducive for enhanced crop production, without the need for applying chemical fertilizers.

Indigenous Technical Knowledge (ITK) is the cost effective technology to enhance crop productivity and to sustain the soil health. The small and marginal farmers of the southern Tamil Nadu can follow these practices without much risk. These practices lead to improved soil structure and promotes a healthy, fertile soil. Indigenous Technical Knowledge (ITK) relating to soil and water conservation suitable for different agro-climatic conditions of the state. Conservation of land and water not only controls land degradation but also can lead to sustain soil health to achieve the productivity.

Volume: 03 Issue No: 11

JASMINE BLOSSOM MIDGE, *Contarinia maculipennis* AND ITS MANAGEMENT

Article ID: AG-V03-I11-69

***Dr. I. Merlin K. Davidson**
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India
*Corresponding Author Email ID: merlinkdavidson@gmail.com

Introduction

- The adult midges lay eggs at the tip of the flower buds, when they are immature and green in colour.
- The emerging maggots moved down, reached the base of corollas and suck the sap, resulting in swelling at the base of the buds and pink discolouration of buds.
- The maggots fed on the corolla, anthers and stigma of the developing buds.
- The infestation leads to premature drying of buds, stunted growth and ultimately drying of plants.
- The external damage symptom is characterized by the pinkish violet colouration of flowers and subsequent drying and final dropping off.

Bionomics

- Freshly laid eggs of blossom midge eggs are elongate and cylindrical.
- Eggs are placed on the inner whorls of the petals in groups of 10-13 during night times. Eggs hatched in one to two days.
- The larval stages of midges are called maggots. There were totally four larval instars. The maggots are narrow with pointed anterior and posterior end.
- The maggots on eclosion were dull white in colour and turns yellow as the development progressed.
- The maggots scrap the petals, stamen and stigma and suck sap from the flower buds. The maggot period lasted for 4 to 5 days.

Pink discoloured buds

Pre-mature drying of buds

Adult midge

Shriveled bud stalk

Maggot inside the shriveled bud stalk

- The maggots turned orangish yellow before pupation. Pupation occurs in the top superficial layer of soil in a thin white case. The pupal period lasts for 7 – 8 days.

- The adults were minute and delicate flies. The females had a black head and yellowish-brown body and were characterized by a distinct long ovipositor. The males were brownish and shorter than females.
- The moniliform antennal segments adorned with hairs in whorls were short and cylindrical in males, long and spherical in females.
- Adults usually lived for one to two days and for three days in rare cases.
- The total duration taken to complete egg to adult stage was 15 to 16 days

Host Plants

- The blossom midge has a wide host range spanning at least six plant families, including the flower buds of orchids, plumeria, hibiscus, white mustard, cabbage, tomato, eggplant, pepper, potato, bittermelon, and other vegetables and ornamentals apart from *Jasminum* cultivars.

Management Measures:

- Regular field scouting for early diagnosis of infestation.
- Plant pruning should be done to regulate the shade in order to facilitate proper penetration of sunlight and maintenance of hygienic bushes.
- Rake the soil during the off season to expose the pupae.
- Maintain sanitation of the jasmine field with good drainage.
- Avoid planting of alternate host plants such as tomato, brinjal and bitter gourd around the main cropped area.
- Collect the damaged pinkish flowers once in a week and destroy to arrest further multiplication.
- The fallen dried pink flowers should be discarded away from field to avoid further infestation.
- Install sprinkler irrigation for minimizing sucking pests' damage.
- Spray one of the following insecticides when infestation occurs with surfactant thoroughly covering foliage and stem during early morning or late evening hours
    - Thiochloprid (Alanto) 240SC @1ml/litre
    - Spinosad (Tracer) @0.5 ml/lit

  - Profenophos 25EC @ 2 ml/lit
  - Lambda-cyhalothrin (Kungfu 2.5 EC) @ 20 g a.i/ha.
  - Monocrotophos @ 2 ml/lit
  - Chlorpyriphos 20 per cent EC @ 1.5 lit in 500 lit of water/ha
  - Chlorantraniliprole 18.5 SC @ 0.3ml/lit.
  - Neem seed kernel extract-5 percent
  - Neem oil – 3 percent
- Add one ml Teepol or Sandovit/litre as surfactant.
- Neem seed kernel extract or Neem oil can be repeatedly sprayed at fortnightly intervals.
- Avoid repeated application of same chemical.
- Conserve the natural hemipteran predator, *Systasis dasyneurae* in jasmine ecosystem to check blossom midge menace.
- Ensure the natural occurrence of predators such as spiders, chrysopids, coccinellids, reduviid bugs etc for natural check of pests.

Volume: 03 Issue No: 11

KINETIC PARAMETERS DURING THERMAL MILK PROCESSING

Article ID: AG-VO3-I11-70

***Subhash Prasad**

Assistant Professor, College of Dairy Science, KU, Amreli, India

*Corresponding Author Email ID: Subhashprasad85@gmail.com

Introduction

The heat tolerance of microorganisms varies greatly between species and forms. Thermophiles have more resistance than mesophiles, whereas psychrophiles have the lowest resistance. Non-spore formers (vegetative cells) are less heat resistant than spore formers. Cocci are often more durable than rods. Bacteria that clump or form capasules are more heat resistant than those that do not. Cells with a high lipid content are more difficult to destroy than cells with a low lipid content. Organisms that can withstand pasteurisation temperature fall into two categories: thermodurics and thermophiles. Thermoduric creatures can endure high temperatures but do not always develop or reproduce at those temperatures. Thermophiles are creatures that can thrive and reproduce in extremely hot environments. Keep in mind psychrotrophs and psychrophiles.

Thermal death point: Thermal death point is the lowest temperature at which all microorganism in a liquid suspension are killed in 10 minutes.

Thermal Death Time (TDT): The length of time required to kill a certain quantity of microorganisms at a specific temperature is referred to as thermal death time. This figure is produced by holding the temperature constant and measuring the time required to kill the specific number of cells. It is a key aspect in regulating microorganisms by heat treatment or determining a microorganism's heat resistance. In the canning business, a simple glass-tube process is utilised.

Decimal Reduction Time (D-value): It is defined as the time required to heat to a temperature that causes a 90% drop in the number of viable cells or spores. The D value (Decimal reduction time) is also known as the 'time at given temperature for the surviving population' to be decreased by one log cycle.

It is frequently more practical to use the D-value as a metric of microbial inactivation rate. The Dvalue is the exposure time necessary to modify the number of survivors by a factor of ten, or the time required to lower the survivor curve by one log cycle.

The D-value and K are unique to each microorganism and sterilisation technique. Thus with data for heat inactivation of microbes the temp is shown D121°. For radiation inactivation the D-value is stated in the terms absorbed dose (kGy).

Thermal Death Time Curve (TDT Curve: The D value falls as the temperature rises. It indicates that if we heat the sample at a high temperature, the microorganisms in a specific food sample will be killed in less time. We obtain a straight line if we plot log D values versus temperature. We may deduce another crucial metric in heat processing from this, Z, which is the temperature change that results in a tenfold (1 log) change in D.

Reaction kinetic (K) aspects of thermal processing:

The heating process can be considered as a chemical reactor in which the microbial inactivation, as well as chemical changes in nutrients and other components have to be balanced. Of all the major changes in milk, the important one is heat denaturation of proteins in milk. Denaturation leads to unfolding of polypeptide chains exposing reactive side groups which may undergo irreversible reactions. Denaturation, as well as the microbial inactivation is modelled as per rate kinetics study.

D=LOG(10)/K ------------------(1)

The Z-value: The Z-value is the temperature change necessary to reduce or increase the decimal reduction time by one decimal. It is a measure of how the death rate changes when the temperature changes.The number of degrees Fahrenheit or Celsius necessary for a thermal death time curve to complete one log cycle. This is the temperature rise needed to cut thermal death time by a factor of ten. The z-value indicates how different temperatures affect a microorganism, with smaller values suggesting higher susceptibility to increased heat.

$Z = (T_2 - T_1)/(\log D_1 - \log D_2)$ ---(2)

Where T = temperature and

D = D-value

If we are interested to process the food item so that it may be free from any spore or microorganisms, first we have to calculate D, Z and F values.

12-D Concept : Canned foods are vulnerable to the spores of the microbe Clostridium botulinum, which is responsible for botulism. The canning industry uses the 12D heat treatment for low acid foods as a safety precaution. In this technique, enough heat is applied to decrease 10^{12} C. botulinum spores to 1 spore per millilitre. It is easy to understand.

F-value: The F value for a process is the number of minutes required to kill a known population of microorganisms in a given food under specified conditions. This F value is usually set at 12 D values to give a theoretical 12 log cycle reduction of the most heat-resistant species of mesophilic spores in a can of food.

When F is used without a subscript indicating temperature, 250°F (121.1°C) is assumed. When the symbol F is used, a z value of 18°F (10°C) is assumed with an exposure temperature of 250°F (121.1°C). The actual processing time a can of food is given in a retort is always greater than the F value due to heat penetration requirements. Two different processes are considered equivalent when the processes are equally effective with respect to destruction of a given microorganism.

Equivalent Killing Power at Other Temperature = **$F \times 10^{(121-T)/z}$ -----------------------(3)**

This implies that the sterilization process is complete, that the necessary fraction of the bacteria/spores have been destroyed, when the integral is equal to F. In this way, the factors *F* and *z* can be combined with the time-temperature curve and integrated to evaluate a sterilizing process.

Q10 –Value: It refers to an increase in the kinetics of reaction (faster reaction takes places) when the temperature is increased by 10°C. Chemical reactions: 2 – 4. Inactivation of microorganisms: 10 and 30. Spores of Bacillus subtilis and Bacillus stearothermophilus are most common and the most resistant mesophilic and thermophilic species in milk likely to survive processing. In the 110-125°C range, the rate of spore destruction of Bacillus stearothermophilus increases about 11 times for each 10°C rise in temperature, i.e. Q_{10} = 11. Other Bacillus spores, such as Bacillus subtilis are more sensitive (Q_{10}=30). In the range of 95 - 120°C, the Q_{10} browning is 3.

Sterilizing effect or lethality: The sterilizing effect, which is also called lethality or death rate, indicates the effect of a heat treatment, expressed as the number of decimal reductions in the number of microorganisms.

Lethality calculations: In the sterilization of low-acid foods, process lethality is expressed as equivalent minutes at a reference temperature of 121.1°C, and is commonly expressed as Fo value.

Pasteurization:

Milk is a product that most people know is pasteurized. There are many different time/temperature combinations that can be used in the pasteurization of milk. The LTLT (low-temperature/long-time) process involves brining the milk to a temperature of 145°F (63°C) for 30 minutes. Conversely, the HTST (high-temperature/short-time) method brings the milk to a temperature of 161°F (72°C) for 15 seconds. Both of these processes accomplish the same thing: the destruction of *Mycobacterium tuberculosis* and *Coxiellaburnetii*. So, you can see that not only is temperature important, but the time at that temperature is also important. The color of this product is similar to that of HTST milk. Likewise these values for enzymes, nutrients and food quality are much smaller compared to that required for bactericidal effect.

Sterilization:

Any physical or chemical technique that kills all living things, particularly microorganisms (including bacteria and sporogenous forms) and inactivates viruses. A logarithmic progression is used to describe the annihilation of a microbial population during a sterilisation process. As a result, only an infinite-duration therapy gives perfect confidence that the whole microbial population has been eliminated and the system is sterile. Making the sterilisation treatment features harsher (i.e. increasing time and/or temperature) frequently results in a degradation of the product's quality and undoubtedly raises process costs.

UHT (Ultra High Temperature) process:

The ratio of bactericidal (sporicidal) impact to browning effect vs temperature does not alter significantly until the temperature reaches around 135°C. Bactericidal actions are between 1,500 and 5,000 times stronger at 140 and 150°C, respectively. As a result, if milk is processed for a few seconds in the UHT range of 135 - 150°C, it is feasible to achieve a product almost devoid of spores and with minor browning.

Conclusions

Due to its perishable nature, it is required to carry out heat treatment of milk to destroy the microorganisms as soon as it is received in the dairies. However, heat treatment of milk also brings about some chemical changes which may be desirable or undesirable. Undesirable changes may include alterations in the sensory properties and depletion of nutrition value of milk. So careful optimization of thermal processes is needed to maximize microbial inactivation and minimize the undesirable ones. Terms are used to denote heat resistance micro-organism and kinetics parameter of chemical reaction, viz. D-value, Z-value, F-value, Q_{10}-value, k-value, sterilizing effect, etc. The heating process may be thought of as a chemical reactor in which microbial inactivation and chemical changes in nutrients and other components must be balanced.

Volume: 03 Issue No: 11

KUNAPAJALA – AN INDIAN ANTIQUITY

Article ID: AG-VO3-I11-71

[1]Someshwari, S. and [2]Dr. N. Elakiya*

[1] B.Sc., (Hons.) Agriculture Student

[2] Assistant Professor (Soil Science & Agricultural Chemistry), JKK Munirajah College of Agricultural Science, Gobichettipalayam, Erode, Tamil Nadu

*Corresponding Author Email ID: elakiya.nandu@gmail.com

Introduction

India witnessed the world's worst food disaster in 1943 which affected 4 million lives in Eastern India alone. Achieving food self-sufficiency was not successful during a major part of post-independence era. However, chemical agriculture made adverse effect and use of synthetic fertilizers in late 1960s led India to become self-sufficient. Excessive and unscientific use of chemical inputs in today's intensive agriculture creates poor soil health through hampering soil physico-chemical properties as well as depleting soil fertility, hampering micro-organisms' activities, keeping toxic footprints in the environment for a long time, which altogether resulting in poor crop growth, yield and quality. Hence, there is a need to adopt eco-friendly agricultural practices for sustainable agriculture and to adapt alternative approaches for the replenishment of soil fertility.

Annals

In India, organic farming was a well-developed and systematized agricultural practice and this 'ancient wisdom' obtained through Indian knowledge systems such as Vedas specify the use of organic products for improving soil and plants health and protective measure against plant diseases, thus for improving agricultural productivity in an eco-friendly manner.

The main aim of Vedic organic agriculture is to re-enliven natural law in agriculture, bringing the farmer, the process of farming and the environment in complete harmony with each other. Earliest written record of liquid organic manure by Vedic literature mentioned kunapajala and their applications in ancient India. It is derived from Sanskrit words 'kunapa' means corpse and 'Jala'means water. Documents regarding kunapajala were found in two possibly contemporary documents, Vrikshayurveda by Surapala, who possibly lived around 1,000 A.D in eastern India and Lokopakara complied by a poet Chavundaraya around 1,025 AD in Karnataka of southern India. The existence and use of kunapajala was forgotten until the Asian Agri-history Foundation published the English translation of Vrikshayurveda (Biswas and Das, 2022).

Nutritional properties of Kunapajala

Kunapajala is rich in carbohydrates, proteins and alkaloids obtained from milk, sesame and black gram. Further, animal and fish body parts supply ample amount of phosphorus, triacyl glycerides, esters, sterol ester, phospholipids, vitamins A, D and E. This liquid organic concoction contains macro and micro nutrients, vitamins, growth regulators like IAA and GA_3, essential amino acids and beneficial microbes like *Rhizobium*, *Azotobacter*, *Azospirillum*, phosphorus solubilizing bacteria, *Trichoderma* and *Pseudomonas* (Biswas and Das, 2022).

Kunapajala preparation and its history

According to Vrikshayurveda, the flesh, bone marrow, brain, blood and excreta of a dead boar are collected as and when available and mixed with water for further storage under the ground to avoid foul odour. Before storage, all the animal and fish excreta or body parts should be boiled in water and kept in earthen pot with sufficient addition of paddy husk. During the time of use, this mixture is cooked after adding sesame oilcake, honey and water soaked black gram. A little ghee can also be poured into the mixture.

According to Sarangadhara (a scholar in the court of King Hammira of Sakambhari-desa i.e. Bundelkhand), in order to prepare Kunapajala, flesh, fat, bone marrow of animals (deer, pig, sheep, goat, rhinoceros etc.) and fishes are boiled in water and compound milk, sesame oilcake powder, blackgram (boiled in honey), pulse decoction, ghee and hot water were added into the earthen pot containing the boiled substances. Afterwards, the pot was kept in a warm place for about two weeks to incubate boiled Kunapajala before use (Sharath Chandra et al., 2019).

Kunapajala water

The flesh, fat, marrow of deer, sheep, goat, pig and rhinoceros in water, all of them were properly boiled in an earthen pot. Compound milk, powders of sesame and oil cake, black gram boiled in honey, the decoction of pulses, ghee, and hot water were added. These are put in a warm place for a fortnight, which is known as kunapa water. It is better for nourishing for plants.

Materials used for preparation of Kunapajala

Animal flesh/Fish waste

Sesame oil cake

Fresh cow urine

Honey

Cow Milk

Cow Ghee

Rice husk

Molasses

Table 1. Physico-chemical properties of Kunapajala after different days of incubation

Physico-chemical parameters	Livestock based Kunapajala				Fish based Kunapajala			
	0 days	**30 days**	**60 days**	**90 days**	**0 days**	**30 days**	**60 days**	**90 days**
Organic carbon (%)	1.95	1.81	1.72	1.68	1.79	1.71	1.68	1.61
TSP (g/L)	3.58	3.00	2.74	2.38	3.98	3.47	3.03	2.96
pH	4.70	5.79	7.01	7.17	4.47	5.96	7.25	6.87
EC (d S/m)	0.31	0.42	1.21	0.42	0.41	0.46	1.29	0.36
Available N (g/L)	0.88	2.35	2.69	2.91	0.77	2.58	2.73	3.25
Available P (g/L)	247.24	500.99	613.88	489.62	109.63	263.60	367.00	414.93
Available K (g/L)	265.44	219.90	222.50	190.08	329.77	265.16	319.69	178.74

(Source : Mukherjee et al., 2023)

Applications and Dosage per acre

Kunapajala can be foliar spray and in drip irrigation and sprinkler and in canal water as fertigation. Dosage per acre for small plants (Vegetables, tomato, chili, etc.) is 5%, for medium sized plants (Banana, moringa etc.) it is 7% and for trees (Mango, palm, coconut, teak, etc.) it can be applied at 10%. Recommended dilution: 10% (10 litres of tonic in 100 litres of water).

Minimum dilution: 5% (5 litres of tonic in 100 litres of water)

Maximum dilution: 20% (20 litres of tonic in 100 litres of water)

Effect of Kunapajala on growth and yield parameters

In mustard, nettle based herbal kunapajala 2000 l/ha gave higher chlorophyll content. In chick pea, 10% herbal kunapajala priming enhanced germination and enzymatic activity significantly. Panchgavya (3%) and kunapajala (1%) when treated on seedlings of tomato, chili and cowpea induced defense mechanism in terms of polyphenol oxidase content in plants. Gas Chromatography-Mass Spectrometer analysis of fermented liquid organic formulation kunapajala at 20th, 40th and 60th days of fermentation period expressed a variety of phytochemical compounds possessing to possess various biological activities such as antifungal, antibacterial, antimicrobial, antioxidant, nematicidal, pesticidal, insecticidal irritant and herbicidal activities. Addition of paddy husk in Kunapajala makes the formulation rich in silica which helps the plants to become robust against pest and disease attacks (Revathi et al., 2023).

Benefits of Kunapajala

- Improving chlorophyll content of the leaves, providing more nourishment to the plant
- More flowering and consequently more yield
- Provides amino acids, sugars, fatty acids, keratins, macro-and all micronutrients in available form
- All essential nutrients including NPK enhancing flowering and fruiting
- More effective for early flowering, enhancing fruiting period, size, fresh weight and shelf life of fruits
- Antioxidant value of the yield is much higher compared to other inorganic products

Conclusion

India is now on the verge of introducing chemical-free natural farming based on on-farm resource recycling and dairy excreta-based microbial formulations. Surely, Kunapajala technology would get wider acceptance as a regenerative input under the new Indian agricultural policy. The use of chemical fertilizers left higher amount of residues in the soil causing loss of soil fertility. This will lead to increase in the consumption of organic manure leads to increase in soil fertility and soil health. Careful animal waste utilization generated from animal farms into recycled animal manure will be far more effective for environment-friendly, sustainable agriculture.

Reference

Mukherjee S, Basak A, Chakraborty A, Goswami R, Ray K, Ali MN, Santra S, Hazra AK, Tripathi S, Banerjee H, Layek J, Panwar AS, Ravisankar N, Ansari MA and Chatterjee G. 2023. Revisiting the oldest manure of India, Kunapajala: Assessment of its animal waste recycling potential as a source of plant biostimulant. Front. Sustain. Food Syst. 6:1073010. DOI: 10.3389/fsufs.2022.1073010

Biswas S. and Das R. 2023. Kunapajala: A Traditional Organic Formulation for Improving Agricultural Productivity: A Review. Agricultural Reviews. DOI: 10.18805/ag.R-2570.

Sharath Chandra M, RK Naresh, N Lavanya, N Varsha, Shaikh Wasim Chand, Pebbeti Chandana, Shivangi, B Naveen Kumar, Rajendra Kumar and Rahul Indar Navsare. 2019. Production and potential of ancient liquid organics panchagavya and kunapajala to improve soil health and crop productivity: A review. Journal of Pharmacognosy and Phytochemistry 2019; 8(6): 702-713.

Revathi M, V. Vasuki, E. Parameswari, P. Janaki and R. Krishnan. 2023. Biocharacterization Study on Fermented Liquid Organic Manure (Kunapajala) Using Analytical Technique: Gas Chromatography –Mass Spectrometry (GC-MS). International Journal of Environment and Climate Change. 13 (9): 1001-1010.

Volume: 03 Issue No: 11

MACHINE LEARNING IN AGRICULTURE

Article ID: AG-VO3-I11-72

V. Arunkumar*, K. Ananthi and M. Yuvaraj

Agricultural College and Research Institute, Tamil Nadu Agricultural University,

Vazhavachanur - 606 753, Tiruvannamalai, Tamil Nadu

*Corresponding Author Email ID: arunkumarv@tnau.ac.in

Introduction

Machine learning is a branch of artificial intelligence in which the computer, referred to as a machine, learns to perform various tasks automatically. Machine learning focuses on aiding the computers in learning the underlying relationship between inputs and outputs from the given data and make accurate predictions. Machine learning combines mathematical modeling and complex algorithms to perform tasks by learning from existing data.

Machine learning algorithms employ statistical methods to learn from the exposed data without any explicit programming instructions. The workflow of a typical machine learning model is as depicted in Fig. 1 and consists of the following phases:

Data acquisition – gathering data (open-source datasets, sensors, etc.)

Data pre-processing – involves cleaning the data, making the data suitable to be used by the model

Dataset creation – involves splitting the data into training, validation, and testing sets

Model training – the training set is used to train the model and the model learns appropriate input-output relationships

Model testing and performance evaluation– the trained model is employed on the testing set and performance metrics are used to quantify the model's accuracy

Model deployment – making the model available to the users via web/software application

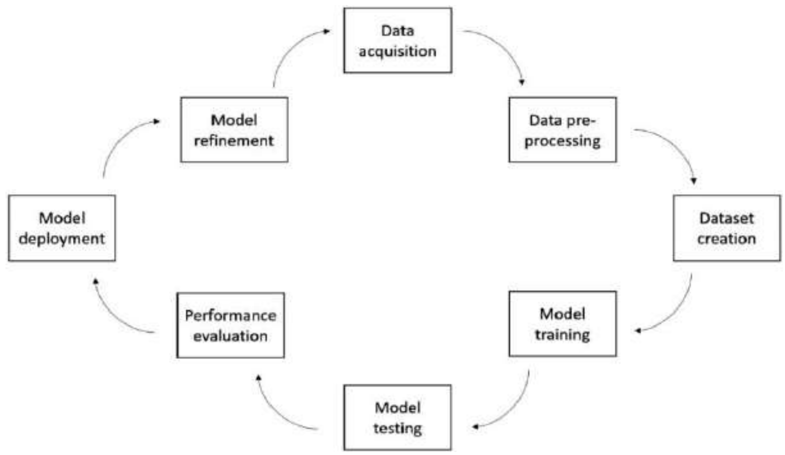


Fig. 1. Workflow of Machine Learning models

Machine learning is split into three main categories depending on the sort of learning response accessible to a learning system

1. Supervised learning,
2. Unsupervised learning and
3. Reinforcement learning

Supervised learning: Supervised learning includes training the machine learning algorithms with labeled data to perform tasks like classification or regression. Labeled datasets contain both the causal factors (input features) and their target responses or outcomes (output variables). The causal factors are the input features, and the target responses are the output variables. The objective of supervised learning is to identify the underlying relationship between input features and output variables so that they can predict the target responses for future unforeseen input features.

Unsupervised learning: Unsupervised Machine learning algorithms are trained on an unlabeled dataset to identify patterns and structures in the given data. They are mainly used for tasks such as clustering and features association. *K*-means clustering, Principal Component Analysis (PCA) and Gaussian Mixture Models are popular unsupervised learning algorithms.

Reinforcement learning: Reinforcement learning is a paradigm of machine learning which involves a sequential decision-making process to achieve the end goal. In reinforcement learning, a computer agent learns to reach a defined goal optimally by navigating through the environment by choosing actions that yield higher rewards. SARSA, and Deep Q networks are some of the widely used algorithms for reinforcement learning.

Machine learning algorithms

Regression is a part of supervised learning that provides a prediction of an output variable as a function of input variables that are usually known and available in these subcategories. There are many algorithms used in almost all fields, e.g., linear regression (LR), least absolute shrinkage and selection operator (lasso), logistic regression, and stepwise regression.

Classification is another important type of supervised learning that uses models to predict a discrete label instead of a continuous output.

- Support Vector Machine (SVM) is an algorithm that classifies data instances by constructing a linear separation hyperplane. Classification, regression, and grouping have all been performed with SVMs. Support Vector Regression, Least Squares Support Vector Machine and Successive Projection Algorithm Support Vector Machine are the most commonly used SVM algorithms
- Decision tree (DT) based algorithms use trees to gradually group the dataset into smaller homogeneous subsets (sub populations) while creating an associated tree graph.
- The Random Forest algorithm (RF) is also widely used and consists of a sequence of decision trees.
- Artificial neural networks (ANNs) are also supervised models commonly used for regression and classification. Deep ANNs, also called deep learning (DL) or deep neural networks (DNNs), are a relatively new branch of machine learning research that enables computer models to represent complex data at multiple levels of abstraction by using numerous processing operations. The Convolutional Neural Network (CNN) is also a well known Deep Learning algorithm that was first used to classify images. CNN creates an artificial neural network that can autonomously learn and make intelligent decisions by automatically extracting the most appropriate features from input sequences and layering techniques.

Applications in agriculture

Machine learning has been successfully applied in many fields that require classification, prediction, and recommendations. Machine learning uses features extracted from known experimental input data to develop models capable of predicting the desired outcome from new data. For example, it provides farmers with soil quality monitoring tools and personalized recommendations based on experimental and field data.

Yield Prediction

In general, yield prediction is one of the most important and challenging topics in modern agriculture. Yield prediction can be determined by several factors such as environment, management practices, crop genotypic and phenotypic characteristics, and their interactions. Hence, it necessitates a fundamental comprehension of the relationship between these interactive factors and yield. In turn, identifying such kinds of relationships mandates comprehensive datasets along with powerful algorithms such as ML techniques.

Pest and Disease Detection

SVM, RF ML techniques has made a remarkable progress in disease and pest classification, detection, and prediction. Detection and classification of pests and diseases can be performed using computer vision and deep-learning algorithms based on CNN models. SVMs are robust and useful in high dimensional spaces due to their use of kernel trick. RF can avoid overfitting due to the high number of trees trained in different subsets of data. Deep learning usually achieves the best classification results due to its ability to create and extract hierarchical features from the inputs. Deep learning beats other ML models, particularly in image classification domains, especially when using pre-existing CNN architectures such as Inception and ResNet. RNNs are capable of establishing relationships between weather data and pest occurrence, surpassing other models such as RF and SVM

Weed identification

Three ML approaches were used namely, SVM, Neural Networks and Miscellaneous (Bayesian networks, Decision Trees, Genetic Algorithms etc.). The most popular type of data that was used by these approaches was colour data (images and videos). spectral data (hyperspectral data, reflectance spectra, fluorescence spectra etc.) was also used.

Nitrogen management based systems

The implementation of Machine learning techniques for N management can be divided into different approaches such as Economic Optimum Nitrogen Rate (EONR) and (N-nutrient index) NNI determination, remote sensing and spectroscopy Wang et al. (2021a) used five input variables (nitrogen rate, seed rate, elevation map, soil electrical conductivity, and the NDVI index) to estimate corn yield production using a deep-learning approach, and the results were compared with other machine learning approaches (Fully connected neural network (FNN), multiple linear regression (MLR), SVM, and RF regression models).

Yu et al. (2018) used a deep learning-based regression model with a fully connected neural network (FNN) and stacked auto encoders (SAE) to quantify nitrogen concentration in canola leaves. SAE was used to infer deep spectral features in the visible and near-infrared regions from a hyperspectral image of a canola leaf, which in turn were used as input data for the FNN to predict N content. The results showed that with a combination of hyperspectral imaging and deep learning it is possible to quickly and non-destructively detect N concentration in canola leaves to provide better fertilizer recommendations.

NPK management based systems

The development of NPK management based systems follows two general approaches based on the type of input, namely field data (soil tests, fertilization trials, etc.) or RGB and hyperspectral images. A fertilizer model was created using the ensemble method for neural networks. In this model, soil nutrient content and fertilizer rate are used as inputs to the neural network, while yield is considered as an output. With this approach, the calculation of fertilizer rates becomes a programming problem and can be used to determine the fertilizer rate with the highest yield and profit and to predict the yield. This fertilizer model was also validated using data on the effect of fertilizers. The results show that using an ensemble of neural networks to predict yield is more accurate than using individual neural networks.

Yu et al. (2010) developed a fertilizer model with data points from 10experimental fields with 4 fertilizer rates and 14 treatments. A neural network ensemble was presented to calculate the fertilizer rate more accurately. The authors used K-means clustering to select the best networks individually and then combined the models using a Lagrange multiplier.

Conclusion

Machine learning (ML) has recently been increasingly used to develop decision support tools for modern agricultural systems, including nutrient management, to improve yields while reducing expenses and environmental impact. ML based systems require huge amounts of data from different platforms to handle non-linear tasks and build predictive models that can improve agricultural productivity. ML algorithms show great potential when properly used for support or decision-making. The rapid improvements in machine learning and sensor technology can provide cost-effective and thorough nutrient assessment, pest and disease detection, weed identification and decision-making solutions.

References

O.Ennaji O., L.Vergütz L., Allali S.EL. 2023. Machine learning in nutrient management: A review Artificial Intelligence in Agriculture 9 : 1–11

Venkataraju A., Arumugam D., Stepan C., Kiran R., Peters T. 2023. A review of machine learning techniques for identifying weeds in corn Smart Agricultural Technology 3 : 100102

Wang S., Guan K., Wang Z., Ainsworth E.A., Zheng T., Townsend P.A., Liu N., Nafziger E., Masters, M.D., Li K., et al., 2021a. Airborne hyperspectral imaging of nitrogen deficiency on crop traits and yield of maize by machine learning and radiative transfer modeling. Int. J. Appl. Earth Obs. Geoinf. 105, 102617.

Yu X., Lu H., Liu Q. 2018. Deep-learning-based regression model and hyperspectral imaging for rapid detection of nitrogen concentration in oilseed rape (Brassica napus L.) leaf. Chemom. Intell. Lab. Syst. 172: 188–193.

Yu H., Liu D., Chen G., Wan B., Wang S., Yang B., 2010. A neural network ensemble method for precision fertilization modeling. Math. Comput. Model. 51, 1375–1382.

Volume: 03 Issue No: 11

AN ECONOMIC ANALYSIS OF COST OF PRODUCTION OF MAIZE IN DINDIGUL DISTRICT

Article ID: AG-V03-I11-73

***A.Narmatha[1] and R. Ananth[2]**

[1]Assistant Professor Department of Social science and Humanities, College of Agricultural Technology, Theni, Tamil Nadu, India

[2] UG Students, College of Agricultural Technology, Theni

*Corresponding Author Email ID: narmiagri@gmail.com

ABSTRACT

The present study on Economics of Production of maize in Dindigul district, Among the cereals it ranks fifth in area, fourth in production and third in productivity. The productivity of maize has shown an impressive increase from 627 Kg/ha in 1951- 52 to 1721 Kg/ha in 1997-98. It accounted for 28.23 per cent and 42.76 per cent of the area and production respectively followed by Dindigul district. The productivity was maximum in Thiruvarur District (3592 Kg/ha) followed by Thanjavur district (2674 Kg/ha) and Nagapattinam district (2605 Kg / ha). The yield per hectare was found to be same in all the farms. The cost of production per quintal decreased slightly with size groups.

Keywords: Production of Maize, Cost of Production

Introduction

In India, maize is one of the emerging crop. Among the cereals it ranks fifth in area, fourth in production and third in productivity. The productivity of maize has shown an impressive increase from 627 Kg/ha in 1951- 52 to 1721 Kg/ha in 1997-98. This has led to a phenomenal increase in production. Area under maize in India expanded at an average annual growth rate of 2.9 per cent, increasing from 3 million hectares in 1950 to 6 million hectares in 1970. However, there had been virtually very little growth in area after 1970. A significant shift from area planted with maize to rice and other high – value crops like sugarcane and groundnut was the major reasons for stagnation. Additionally, maize cultivation had shifted to marginal lands of relatively low production potential, as farmers reserved their productive lands for more profitable crops.

Table 1.1. Area, production, productivity of maize in major districts of Tamil Nadu (2009 – 2010)

S.No.	District	Area (ha)	Production (tonnes)	*Yield* (Kg /ha)
1.	Dindigul	23,002 (28.23)	46,311 (42.76)	1982
2.	Coimbatore	17,272 (21.20)	19,397 (17.91)	1125
3.	Theni	7,306 (8.97)	10,049 (9.28)	2006
4.	Salem	6,290 (7.72)	4,684 (4.32)	1860
5.	Virudhunagar	6,245 (7.67)	7,984 (7.37)	2027
6.	Thirunelveli	5,408 (6.64)	3,119 (2.88)	1545
7.	Thoothukudi	5,204 (6.39)	2,576 (2.38)	1449
8.	Erode	5,019 (6.16)	8,235 (7.61)	2287
9.	Perambalur	1,979 (2.43)	886 (0.82)	1187
10.	Dharmapuri	903 (1.11)	576 (0.53)	1106
11.	Vellore	796 (0.98)	930 (0.86)	1660
12.	Namakkal	581 (0.71)	1130 (1.04)	1862
13.	Madurai	393 (0.48)	764 (0.71)	2005
14.	Thiruvannamalai	323 (0.90)	450 (0.42)	1545
15.	Thanjavur	230 (0.28)	533 (0.49)	2674
16.	Pudukottai	222 (0.27)	334 (0.31)	2002
17.	Ramanathapuram	96 (0.12)	59 (0.05)	390

18.	Cuddalore	89 (0.11)	63 (0.06)	1783
19.	Thiruchirapalli	56 (0.07)	35 (0.03)	1364
20	Villupuram	40 (0.05)	61 (0.06)	1318
21.	Nagapattinam	8 (0.0098)	56 (0.05)	2605
22.	Thiruvarur	3 (0.0057)	56 (0.05)	3592
23.	Karur	2 (0.0045)	7 (0.006)	1737
	State	81467 (100.00)	1,08,295 (100.00)	1717

(Source: Season and crop report of Tamil Nadu, 2018 – 2019)

(Figures in Parentheses indicates percentage to the total)

During the period from 2005 to 2015 –16 the area under maize in Tamil Nadu was increasing positively with a compound growth rate of 12.85 per cent. But the productivity of maize during the same period decreased at a compound growth rate of 0.032 per cent. The production of maize during the same period has increased at a compound growth rate of 10.31 per cent. The present area and production of maize in Tamil Nadu (2015-16) was 8.15 lakh hectares and 1.08 lakh tonnes respectively.

Among the various districts of Tamil Nadu, the area and production under maize was maximum in Perambalur district followed by Dindigul district. It accounted for 28.23 per cent and 42.76 per cent of the area and production respectively followed by Dindigul district. The productivity was maximum in Thiruvarur District (3592 Kg/ha) followed by Thanjavur district (2674 Kg/ha) and Nagapattinam district (2605 Kg / ha).

MATERIALS AND METHODS

Selection of study area

Dindigul district comprises of seven taluks and 13 blocks. Since the present study is on production and marketing of maize, two blocks namely Oddanchatram which had 44 per cent of area under maize and Palani which came next with a share of 41 per cent were selected for the study.

Selection of farmers

The primary data of two villages from Oddanchatram block viz., Chatrapatti and

Virupatchi and two villages from Palani block viz., Eramanayakanpatti and Kanakanpatti were selected randomly. The total size of the sample farms was fixed as 60, 30 from Oddanchatram block and 30 from Palani block taking into considerations the time and other facilities at the disposal of the researcher for the production status and the other for the constrains . The schedule for the production status covered aspects such as family size, educational status, asset position, cropping pattern, availability of land, both irrigated and rainfed, labour availability, machine and animal power, cost of cultivation, etc., In the constrains schedule covered the aspects of the problems faced by the farmers were covered. To understand the basic characteristics of agricultural system in the study area, data on soil conditions, land utilization, cropping pattern, agro-climatic features and other available facilities were collected from published and unpublished records available in various government departments.

Cost concepts

All the cost concepts used in farm management studies viz., Cost A_1, Cost A_2, Cost $B_{1,}$ Cost $B_{2,}$ Cost C_1 and Cost C_2were used in the present study. The details of cost concepts are as follows:

Cost A_1

1. Value of human labour
2. Value of manures and fertilizers
3. Cost of seeds
4. Plant protection chemicals
5. Irrigation charges
6. Land revenue, less and other taxes
7. Depreciation (on implements, machinery, buildings, irrigation structures etc.,)
8. Interest on working capital and
9. Miscellaneous expenses

Cost A_2:

Cost A_1 plus rent paid for leased in land

Cost B_1:

Cost A_2 plus imputed rental value of owned land plus interest on fixed capital (excluding land)

Cost B_2:

Cost B_1 plus rental value of owned land.

Cost C_1:

Cost B_1 plus imputed value of family labour.

Cost C_2:

Cost B_2 plus imputed value of family labour.

Income measures in relation to different cost concepts

1. Gross income = Value of main product plus value of by-product
2. Net income = Gross income – cost C_2.
3. Farm business income = Gross income – Cost A_1
4. Owned farm business income = Gross income - Cost A_2
5. Family labour income = Gross income - Cost B_2
6. Family investment income = Net income plus rental value of owned land plus interest on fixed capital

RESULTS AND DISCUSSION

ECONOMICS OF PRODUCTION OF MAIZE

To know the economics of maize production the cost of production for irrigated maize conditions and various income measures were derived and discussed in this section.

Cost of cultivation

An analysis of cost would enable the farmers to re-examine the utilization of farm resources effectively. Various cost concepts such as Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1 and Cost C_2 were estimated and discussed.

Irrigated maize

The details regarding cost of cultivation of irrigated maize for small farm, medium farm and large farm is presented in Table 1.2

It could be noted from the table 1.2 that Cost A_1 represents the actual cash expenses of cultivation. It included cost of seeds, labour charges, manures and fertilizer cost, plant protection chemicals cost, interest on working capital and depreciation cost. Among the cost component of A1, expenditure towards labour charges was maximum in all size groups. Maize being labour intensive short duration crop and the wages prevailed in the study area was also high comparatively with Rs.350 per men per day and Rs.200 per women per day. This might have contributed for higher labour charges. This is followed by costs of manures and fertilizers and seed costs. The Cost A_1 for small, medium and large farms was Rs.8925.15, Rs.9013.39 and Rs.9124.30 respectively. Since the entire sample farmers were owner operators, Cost A_2 was the same as that of Cost A_1.

By adding the interest on fixed capital excluding land, to Cost A_2, Cost B_1 was arrived and they were found to be Rs.9115.30, Rs.9220.89 and Rs.9338.03 for small, medium and large farms respectively. It accounted for 54.45 per cent for small farm, 54.81 per cent for medium and 55.30 per cent for large farms. By adding the rental value of owned land to Cost B_1, Cost B_2 was arrived. The estimated costs for different size groups were Rs.15, 971.30, Rs.16, 1273.19 and Rs.16, 293.53 for small, medium and large farms respectively. It accounted for about 96 per cent of the total cost in all the size groups.

Cost C1 was arrived at by adding the imputed value of family labour to Cost B_1. The estimated cost for different size groups were Rs.9885.30, Rs.9920.89 and 9931.73 for small medium and large farm respectively. The cost C_2 for the small farm is Rs.16, 741.30 it is obtained by adding the imputed value of family labour to Cost B_2. So, for the medium and large farms the Cost C_2 is Rs.16, 823.19 and Rs.16, 887.23 respectively.

Among the yield per hectare for different size groups, it was same in all the farms viz., 46.88quintals in small farms, 47.50 quintals in medium farms and 47.63 quintals in large farms. Cost of production per quintals of maize decreased slightly with size groups. It varies from Rs.357.11 in small farms to Rs.354.55 in large farms

Table 1.2 Cost of production for irrigated maize (Rs. /ha)

S.No.	Cost components	Small farm	Medium farm	Large farm
1.	Cost of seed	700.00 (4.18)	710.00 (4.22)	710.00 (4.20)
2.	Labour charges	3710.00 (22.16)	3820.00 (22.71)	3885.00 (23.01)
3.	Manures and fertilizers	2982.00 (17.81)	2924.50 (17.38)	2936.00 (17.39)
4.	Plant protection chemicals	456.00 (2.72)	468.00 (2.78)	471.00 (2.79)
5.	Interest on working capital (12.5%)	483.55 (2.89)	491.35 (2.92)	504.77 (2.99)
6.	Depreciation on buildings (5%) and implements (10%)	593.60 (3.55)	599.54 (3.56)	617.53 (3.66)
	Cost A_1	8925.15 (53.31)	9013.39 (53.58)	9124.30 (54.03)
7.	Rental value of leased in land	0.00	0.00	0.00
	Cost A_2	8925.15 (53.31)	9013.39 (53.58)	9124.30 (54.03)
8.	Interest on fixed capital other than land	190.15 (1.14)	207.50 (1.23)	213.73 (1.27)
	Cost B_1	9115.30 (54.45)	9220.89 (54.81)	9338.03 (55.30)
9.	Rental value of owned land	6856.00 (40.95)	6902.30 (41.03)	6955.50 (41.19)
	Cost B_2	15971.30 (95.40)	16123.19 (95.84)	16293.53 (96.48)
10.	Imputed value of family labour	770.00 (4.60)	700.00 (4.16)	593.70 (3.52)
11.	Cost B_1 + Imputed value of family labour = Cost C_1	9885.30 (59.05)	9920.89 (58.97)	9931.73 (58.81)
12.	Cost B_2 + Imputed value of family labour = Cost C_2,	16,741.30 (100.00)	16,823.19 (100.00)	16,887.23 (100.00)
13.	Yield per hectare (quintals)	46.88	47.50	47.63
14.	Cost of production / quintal	357.11	354.17	354.55

(Figures in parentheses indicates percentage to the total)

Summary and Conclusion

Cost of cultivation of maize was estimated under different cost concepts.

Irrigated maize

The cost A_1 represents the actual cash expenses of cultivation. Cost A_1 accounted for nearly 54 per cent of the cost of cultivation. Since the entire sample farmers were owner operators, Cost A_2 was the same as that of Cost A_1.

Cost B_1 and B_2 accounted for 55 per cent and 96 per cent of the total cost of cultivation respectively in all size groups.

Cost C_1 accounted for 59 per cent of the total cost of cultivation, while the value of Cost C_2 found to be more or less equal in all size groups.

The yield per hectare was found to be same in all the farms. The cost of production per quintal decreased slightly with size groups.

References

Acharya and N.K. Nair, "Empirical Issues in Total Productivity - An Experiment with Cement Industry in India", Productivity, 19(3):365-374, 1978.

Aigner,D.J.,Lovel,C.A.K. and Schimidt,P. "Formation and estimation of Stochastic frontier production function models", Journal of Econometrics,6(4):21-37,1977.

Akbar, M.A. and M.L. Rahaaman, "Marketing of Banana by Farmers in some selected Areas of Bangladesh", Bangladesh Journal of Training and Development, 4(1):88-97, 1991.

Banik,Arindam, "Technical efficiency of irrigated farms in a village of Bangladesh", Indian Journal of Agricultural Economics, 49(1):70-77,1994.

Srivastava, P.S. and M.N. Srivastava, "Increasing Rice production in Eastern Uttar Pradesh", Indian Farming, 40(2):13-16, 1987.

Thakur, P.S., "Pricing Efficiency of Indian Apple Market", Indian Journal of Agricultural Economics, 33(1):160, 1975.

Volume: 03 Issue No: 11

MASS MEDIA- A BOON TO AGRICULTURE

Article ID: AG-VO3-I11-74

[1]*Pooja Jaisani and [2]Bindeshwari Pandro

[1,2] M.Sc Department of Agriculture Extesion, COA, JNKVV,

Jabalpur, Madhya Pradesh, 482001, India

*Corresponding Author Email Id: tanuayushpooja@gmail.com

Introduction

The role of mass media in every sector, including agriculture, is of great significance. It is, however, unfortunate that only a small number of individuals are cognizant of the impact of media in this field. In India, a significant portion of the population is engaged in farming, and due to a lack of access to education, farmers have traditionally relied on the knowledge passed down from generation. Consequently, they have not been able to keep up with the latest scientific and technological advancements in farming. Nevertheless, in modern times, various media platforms have been able to bridge this gap and make farmers aware of the latest technologies. It is undisputed that mass media remains an essential element in the effective transfer of knowledge and skills aimed at enhancing agricultural production.

Mass Media

The success of agricultural development schemes in developing countries like India largely depends on the nature and extent of the use of mass media. The planners in developing countries realize that the development of agriculture could only be hastened with the effective use of media. Electronic media, such as television and radio, and print media, such as newspapers and magazines, have been the traditional mediums for spreading information. However, with the rise of the internet and technology, digital media has emerged as a powerful tool for information dissemination. Digital media includes online news portals, social media platforms, blogs, and podcasts. These platforms have made it easier for individuals to access information from anywhere in the world, at any time. The convenience, speed, and accessibility of digital media have made it an indispensable part of our lives. Both electronic and print media are essential for information dissemination, but digital media is gaining prominence.

Electronic Media

Electronic Media includes Radio, Television, and mobile. They play an important role in educating the farmers, especially the illiterate ones through infotainment i.e. education and entertainment at the same time.

Television

Messages can be sent over long distances at a low cost. It can transmit motion pictures, recordings, slides, and photographs, making it better than radio.

Dr. Vikram Sarabhai initiated the 1st program on agriculture named "Krishi Darshan" in 1967, for communicating agricultural information to the farmers on an experimental basis in 80 villages of the union territory of Delhi.

DD Kisan is another Indian agriculture 24-hour television channel launched by PM Narendra Modi, which is owned by Doordarshan and was launched on 26 May 2015. The channel is dedicated to agriculture and related sectors and disseminates real-time inputs to farmers on new farming techniques, water conservation, and organic farming among other information.

Radio

It is an important communication tool for transferring information, education, and entertainment, especially in areas where there is an erratic power supply. For example, All India Radio (AIR), a public broadcaster that informs, educates, and entertains, has been actively playing a unique role in supporting agricultural extension programs in India. On February 15, 2004, All India Radio started a new project called narrowcasting to turn its hard-core agriculture program into ‘The Voice of Farmers’, or ‘Kisvanvani’.

Presently Kisanvani is being broadcast from identified 96 AIR stations across the country. There are several shows like "KISANVANI, SAMRUDDHI, KRISHI JAGAT & SUNO KISAN"

Most significantly, radio allows listeners to make the experience their own by challenging them to use their imagination while trying to make sense of what’s happening. “TV gives everyone an image, but radio gives birth to a million images in a million brains,” wrote American author Margaret ‘Peggy’ Noonan.

Mobile

Mobile Technology today is present in all parts of our lives, and it is widely available to almost everyone. At present, the main form of technology in the industry, farming, and household is mobile technology.

At present, there are many mobile-based applications initiated by the government. Examples of few are -

1) Kisan Suvidha mobile application to facilitate dissemination of information to farmers on the critical parameters viz., Weather; Market Prices; Plant Protection; Input Dealers (Seed, Pesticide, Fertilizer), Farm Machinery; Soil Health Card; Cold Storages and godowns, Veterinary Centres and Diagnostic Labs.

2) IFFCO Kisan agriculture- It provides personalized information to farmers based on their specific requirements.

3) RML Farmer- Krishi Mitr

It provides them with prevailing mandi rates, weather updates, fertilizer, pesticide application time, various input rates, various government schemes, etc.

4) Pusa Krishi- App released by the union ministry to disseminate technology designed by IARI.

Like this, there are over a hundred mobile apps designed to aid farmers by providing them with real-time information on every aspect of farming.

Print Media

Print media plays an indispensable role in the agriculture sector and mass media. Farmers rely heavily on it to stay informed about updates related to their farming, which includes articles about farming, monsoons, crops, agricultural marketing, and accurate pricing information. There is the publishing of such farm magazines particularly through government organisations and farmers associations. Some of the popular magazines published in India are Indian Horticulture, Indian Farming, Krishi Jagran, Phal Phool, Kheti, Ishika, Horticulture Today, Agriculture Today, Agro India, Modern Kheti, Liesa India, Farm Food, Agriculture World, Kurukshetra etc.

Social Media

Social media platforms such as YouTube, Instagram, and Facebook are used by governments and organizations to educate farmers. It refers to user-generated information, opinion, Video, audio, and multimedia that are shared and Discussed on digital networks.

More Initiatives are taken by the government to foster the use of mass media in agriculture i.e to digitalize agriculture:

1. e-NAM is an electronic trading portal that unifies the Agricultural Produce Market Committee (APMC) mandis across India into a national market for agricultural commodities. It offers digital services to traders, farmers, and FPOs via various modules such as the FPO trading module and warehouse-based trading module.
2. The PM KISAN Scheme is now accessible through the PM-KISAN Mobile App for farmers to view their application status, update their UID details, and check their credit history.
3. Under the National e-Governance Plan in Agriculture (NeGP-A), funds are provided to States/UTs for projects that involve modern technologies such as Artificial Intelligence (AI), Machine Learning (ML), Robotics, Drones, Data Analytics, and Blockchain.
4. The Central Institute of Agricultural Engineering, Bhopal (ICAR-CIAE) under the Indian Council of Agricultural Research(ICAR) has developed the Krishi Yantra App to augment research, operations, and technology dissemination process in the field of agricultural engineering.
5. Farm Mech and Farm Safety are some of the mobile apps released by ICAR-CIAE.
6. **Digital Green: B**rilliant initiative that accomplishes the task of dissemination of agricultural information using videos.

Conclusion

The promotion of mass media for the development of agriculture is absolutely crucial. Mass media plays an indispensable role in providing farmers with timely, accurate, and location-specific information, which is vital for their success. The government is continuously implementing various media-based schemes and programs to encourage the use of media in agriculture. Agriculture digitalization is one of the initiatives taken by the government to enhance the use of media in the farming sector, making it clear that the use of mass media in agriculture is not just important, but essential for the growth and development of the farming community.

Volume: 03 Issue No: 11

MEDICAL MARIGOLD: AYURVEDIC TREASURE

Article ID: AG-V03-I11-75

Piyush Singh* and Amit Maurya

*P.hD Scholar, Department of Floriculture & Landscape Architecture, BUAT, Banda -210001

PG Scholar, Department of Floriculture & Landscape Architecture, BUAT, Banda -210001

*Corresponding Author Email ID: ps397948@gmail.com

Introduction

Marigold, scientifically known as Tagetes, holds a significant place in the history of horticulture and cultural traditions across the world. Its name is believed to be derived from the old English word "marien gold," which means "Mary's gold," indicating its association with the Virgin Mary and its common use in religious ceremonies. The robust annual plant known as marigold, which is native to Southern Europe, also grows in most temperate parts of the world. They can reach a height of 50 to 80 cm, and their lance-shaped, mid-green leaves range in size from 5 to 17 cm. small hairs cover the leaves and stems, and the leaf edges might be serrated or waved sparsely.

A. Species/Varieties of Marigold

Marigolds belong to the Tagetes genus and are divided into several species, with various varieties known for their unique characteristics. Some common varieties include:

- **African Marigold (*Tagetes erecta*):** Known for its tall, erect stems and large, showy flowers. African marigolds come in various colors, including orange, yellow, and gold. **Example:** Pusa Narangi Gainda, Pusa Basanti Gainda, Crackers Jack, Crown of Gold.
- **French Marigold *(Tagetes patula):*** Compact plants with smaller, delicate flowers. They are available in a wide range of colors and are often used as border plants. **Example**: Arka Honey, Arka Pari, Pusa Arpita, Red Brocade, Rusty Red, Spray, Spun Gold.
- **Signet Marigold *(Tagetes tenuifolia)*:** These marigolds have finely divided, lacy leaves and small, single flowers.

They are edible and are sometimes used in salads. Example: Red gem, Starfire, Lemon gem.

- **Mexican Marigold *(Tagetes lucida):*** Unlike other marigold species, Mexican marigold is primarily grown for its culinary and medicinal uses. It has a strong, anise-like flavour and is used in Mexican cuisine.
- **Pot Marigold *(Calendula officinalis):*** Although not a true marigold, it is often called "pot marigold." It is known for its bright orange or yellow flowers and is valued for its medicinal properties.

C. Tips for Growing Marigolds at Home

1. **Sunlight:** Marigolds thrive in full sun. Plant them in a location that receives at least 6-8 hours of direct sunlight per day.
2. **Soil:** Marigolds are not picky about soil and can grow in various soil types. However, well-draining soil with good organic content is ideal.
3. **Watering:** Keep the soil consistently moist but not waterlogged. Water at the base of the plant to prevent fungal issues and avoid overhead watering.
4. **Spacing:** Plant marigold seeds or seedlings at the recommended spacing for the specific variety you're growing. Adequate spacing allows for good air circulation and prevents overcrowding.
5. **Deadheading:** Regularly remove faded flowers (deadhead) to encourage continuous blooming. This also helps the plant redirect its energy into producing new flowers.
6. **Fertilization:** Marigolds typically don't require heavy fertilization. A balanced, all-purpose fertilizer applied once a month during the growing season is usually sufficient.
7. **Pest Control:** Marigolds are known to repel some garden pests, but they can still be susceptible to aphids and spider mites. Monitor your plants for signs of infestations and address them promptly with organic pest control methods if needed.
8. **Disease Prevention:** Good air circulation, proper spacing, and avoiding overhead watering can help prevent fungal diseases.
9. **Harvesting Seeds:** If you want to save marigold seeds for the next season, allow the flowers to fully mature and dry on the plant. Collect the dried seed heads, remove the seeds, and store them in a cool, dry place.

D. Medicinal Properties of Marigold

The flower is helpful for liver problems, scabies, astringent, carminative, stomachic, fevers, and epileptic fits (according to Ayurveda). used in ocular illnesses (Ampai *et al*., 2013) The best cosmetic remedy for minor skin issues like sunburn or subdermal broken capillaries is marigold (Rahman *et al*., 2016). In India, marigold flowers are frequently used as loose flowers, and their flower petals are also used in the production of xanthophyll, a major carotenoid component that makes up 80-90 % of the overall xanthophyll content (Singh *et al*., 2019). French marigolds' bicolor pattern, commonly known as the French sort, is suitable for mass planting. These can also be grown in pots and window boxes. Over 50 years ago, nematode-fighting abilities of marigolds were discovered. In addition to being insecticidal, Tagetes has been demonstrated to have fungicidal activity against *Helminthosporium oryzae*, according to Nahak *et al*., Tagetes oil is reported to suppress gram-positive bacteria and fungus.

1. Anti-inflammatory properties Marigold contains compounds like flavonoids and carotenoids, including lutein and zeaxanthin, which have anti-inflammatory properties. Marigold ointment can soothe skin inflammation.

2. Antioxidant effects. Marigold is rich in antioxidants such as carotenoids and vitamin-C. Marigold tea is rich in antioxidants. Antioxidants help neutralize harmful free radicals in the body, protecting cells from oxidative damage. Regular consumption of marigold may reduce the risk of chronic diseases associated with oxidative stress, such as heart disease and cancer.

3. Antimicrobial benefits Marigold possesses natural antimicrobial and antifungal properties. The plant produces antimicrobial compounds that can inhibit the growth of certain bacteria and fungi. Marigold extracts and preparations are sometimes used topically to treat minor skin infections and wounds. Marigold poultices can treat infected wounds.

4. Mosquitocidal activity Researchers have looked at the mosquitocidal effects of Tagetes erecta flower ethanolic extract and its chloroform and petroleum ether soluble fractions against Culex quinquefasciatus larvae. The larvicidal impact of ethanol extract and their solvent fractions was assessed against various C. Quinquefasciatus instars using the usual WHO approach (Nikkon *et al.*, 2011).

E. Here are some common Ayurvedic uses of marigold

1. Wound Healing: Marigold has antimicrobial and anti-inflammatory properties that make it useful for treating wounds, cuts, and minor skin injuries. Ayurvedic practitioners often use marigold-based ointments or poultices to promote faster healing and reduce the risk of infection.

2. Skin Disorders: Marigold can be beneficial for various skin conditions, such as acne, dermatitis, and eczema. Its anti-inflammatory properties can help soothe skin irritations, and its antimicrobial effects may assist in preventing infections.

3. Eye Health: Marigold extract, when used as eye wash or applied topically around the eyes, is believed to have a cooling and soothing effect. It is used to reduce eye fatigue and redness, especially after prolonged screen time or exposure to harsh environmental conditions.

4. Digestive Health: In Ayurveda, marigold flowers are sometimes used as a mild digestive aid. Consuming marigold tea or incorporating marigold petals into meals is believed to support digestion and alleviate digestive discomfort.

5. Menstrual Disorders: Some Ayurvedic remedies include marigold for managing menstrual irregularities and discomfort. It is believed to have properties that can help regulate menstrual cycles and reduce cramps.

6. Anti-Inflammatory Poultices: Marigold poultices are used for their anti-inflammatory properties. They are applied topically to inflamed joints or muscles to alleviate pain and swelling.

7. Calming Effects: Marigold is considered a calming herb in Ayurveda. It is sometimes used to reduce stress, anxiety, and restlessness. Marigold tea or the fragrance of marigold flowers is believed to have a calming effect on the mind. In Ayurveda, marigold (*Tagetes erecta*) is recognized for its medicinal properties and is used in various formulations to address specific health concerns. Here are some Ayurvedic recipes and tips for incorporating marigold into your daily life:

(I). Recipes for Ayurvedic formulations

1. **Marigold Skin Soothing Paste:**

Ingredients: Fresh marigold flowers, aloe vera gel.

Instructions: Crush fresh marigold flowers to make a paste and mix it with aloe vera gel. Apply this paste to irritated or sunburned skin for a cooling and soothing effect.

2. **Marigold Eye Wash:**

Ingredients: Marigold petals, distilled water.

Instructions: Steep marigold petals in distilled water overnight. Strain the liquid and use it as an eye wash to refresh tired or irritated eyes.

3. **Marigold Digestive Tea:**

Ingredients: Dried marigold petals, hot water, honey (optional).

Instructions: Steep dried marigold petals in hot water for 5-10 minutes. Add honey if desired. Drink this tea after meals to support digestion and relieve digestive discomfort.

4. **Marigold Hair Oil:**

Ingredients: Marigold-infused coconut oil, essential oils (e.g., lavender or rosemary). **Instructions:** Mix a few drops of essential oil with marigold-infused coconut oil and massage it into your scalp. Leave it on for at least an hour before washing for stronger and healthier hair.

(II). Tips for Incorporating Marigold into Daily Life

1. **Marigold Infused Oil:** Prepare marigold-infused oil by placing dried marigold petals in a carrier oil like coconut or sesame oil. Use this oil for daily self-massage (abhyanga) to promote relaxation and nourish the skin.

2. **Marigold Flower Garlands:** In Indian traditions, marigold flower garlands are commonly used for decorations during festivals and ceremonies. You can create your own marigold garlands to add colour and fragrance to your living space.

3. **Marigold in Cooking:** While not as common as other culinary herbs, marigold petals can be added to salads and garnishes for a touch of colour and flavour. Ensure that you use marigold varieties specifically meant for culinary use.

4. **Marigold in Skincare:** Look for skincare products that contain marigold extract or oil. These products can help soothe and nourish the skin.

5. **Marigold Aromatherapy:** Use marigold essential oil or marigold-scented candles for aromatherapy to create a calming and stress-relieving atmosphere at home.

6. **Marigold Teas:** Enjoy marigold tea regularly as a gentle way to incorporate its potential health benefits into your daily routine.

7. **Marigold in Herbal Formulations:** Explore Ayurvedic herbal formulations that contain marigold as one of the ingredients, often designed to address specific health issues. Consult an Ayurvedic practitioner for guidance on choosing the right formulation for your needs.

F. Marigold in Home Remedies

1. **Marigold Infused Oil:** To make marigold-infused oil, place dried marigold petals in a clean, dry jar and cover them with a carrier oil like coconut or olive oil. Seal the jar and place it in a sunny spot for about 2-4 weeks, shaking it gently every day.

Strain the oil and use it topically for massages or as a soothing balm for skin irritations.

2. **Marigold Poultice:** Create a marigold poultice by crushing fresh marigold flowers and mixing them with a small amount of warm water to form a paste. Apply this paste to minor cuts, bruises, or insect bites to promote healing and reduce inflammation.

3. **Marigold Tea:** Make marigold tea by steeping dried marigold petals in hot water. This tea can be consumed to aid digestion, alleviate menstrual discomfort, or simply as a calming beverage.

4. **Marigold Face Mask:** Mix marigold petal paste with honey and yogurt to create a nourishing face mask. Apply it to your face, leave it on for 15-20 minutes, and then rinse with warm water. This can help improve skin tone and reduce acne.

6. **Marigold Hair Rinse:** Infuse marigold petals in hot water, strain the liquid, and use it as a hair rinse after shampooing. It may help strengthen hair and add shine.

G. Safety Precautions

1. Allergy Test: Before using marigold-based remedies on your skin, perform a patch test. Apply a small amount to a small area of your skin and wait for 24- 48 hours to check for any adverse reactions, such as redness, itching, or irritation.

2. Avoid Ingestion: While marigold tea is generally safe when consumed in moderation, avoid ingesting large quantities of marigold or any plant material without proper guidance. Excessive consumption may cause stomach discomfort.

3. Use Organic Sources: If possible, source organic marigold petals to avoid exposure to pesticides or other chemical residues.

4. Medication Interactions: If you are taking medications or have underlying health conditions, consult with a healthcare provider before using marigold-based remedies, as they may interact with certain drugs or exacerbate certain conditions.

5. Dilution: When applying marigold-infused oil or paste topically, make sure to dilute it appropriately with a carrier oil or water to prevent skin irritation.

6.Storage: Store marigold-based products in a cool, dry place away from direct sunlight to maintain their potency.

H. Culinary Uses of Marigold

1. Salads: Marigold petals, with their bright colors and mild, slightly peppery flavour, can be added to salads to enhance their appearance and taste. They make salads more visually appealing and add a subtle tangy note.

2. Herbal Teas: Dried marigold petals can be used to make herbal teas. These teas are believed to have soothing properties and may help with digestive issues and stress relief.

3. Flavouring: Marigold petals can be used as a garnish or flavouring agent in various dishes, including soups, stews, rice, and pasta dishes. They can impart floral flavour to the food.

4. Baking: Marigold petals can be incorporated into baking recipes such as bread, muffins, and cakes. They add colour and a unique flavour to baked goods.

Conclusion

A significant source of chemicals with potential therapeutic significance may be found in the genus Tagetes. The majority of the Tagetes species, including *Tagetes tenuifolia* and *Tagetes patula*, are still unknown to physiochemists, researchers and pharmacologists. In several regions of the world, decorative plants are utilised in traditional medicine. In order to completely screen this genus for its phytoconstituents and biological activity, additional care must be taken.

References

Ampai P, Kiattisin K, Pensak J, Chansakaow S, Vejabhikul S, Leelapornpisid P (2013). Appraisal of biological activities and identification of phenolic compound of African marigold flower extract. *Pakistan Journal of Pharmaceutical Science*, 26, 1071-1076.

Nikkon F, Habib RH, Saud ZA, Rezaul KM (2011). Tagetes erecta Linn. and its Mosquitocidal potency against Culex quinquefasciatus. *Asian Pacific Journal of Tropical Biomedicine*, 1, 186-188.

P T Srinivas and TRajasekharam. Marigold Genotypes Characterization Using Morphological Characters. *Int. Arch. App. Sci. Technol*; Vol 11 [2] June 2020: 78-84.

Sai Y, Banafar KNS, Sahu T and Chandravanshi V (2018) Economic analysis of marigold in Surajpur distric of Chhattisgarh. *Journal of Pharmacognosy and Phytochemistry* 2018; 7(2) .

Singh Y, Gupta A, Kannojia P (2020). *Tagetes erecta* (Marigold) - A review on its phytochemical and medicinal properties. *Current Medical and Drug Research*, 4 (1), Article ID 201.

Vallisuta O, Nukoolkarn V, Mitrevej A, Sarisuta N,Pimporn L, Phrutivorapongkul P, Sinchaipanid N (2014). In vitro studies on the cytotoxicity, and elastase and tyrosinase inhibitory activities of marigold (*Tagetes erecta* L.) flower extracts. Experimental and Therapeutic Medicine, 7, 246–250.

Volume: 03 Issue No: 11

MEMORY BOOSTING WONDER CROP- CUMIN (*Cuminum cyminum Linn.*)

Article ID: AG-V03-I11-76

***Dr.A.Thanga Hemavathy[1] and Dr.R.Vinoth[2]**

1-Associate Professor (PBG), Department of Pulses, TNAU, Coimbatore, Tamil Nadu

2-Teaching Assistant (PBG), IOA, TNAU, Kumulur, Trichy, Tamil Nadu, India

*Corresponding Author Email ID: hemavathy.tnau@gmail.com

Introduction

Cumin (*Cuminum cyminum Linn.*) is an important seed spice and one of the earliest known minor spices used by mankind. The typical pleasant aroma of the seeds is due to their volatile oil content, the principal constituent of which is cuminol (cuminaldehyde). Tamil name: Seeragam Cumin (*Cuminum cyminum L*) is a leafy plant that grows low to the ground in China, India, the Middle East, and the Mediterranean region. The fruit of the plant is called the cumin seed, and it's popular all over the world as a spice. Cumin has become the subject of medical research, as anecdotal evidence claims it has all kinds of health benefits.Most of cumin's claimed benefits have to do with your digestion, immune system, and circulation. Some benefits of cumin can be demonstrated with clinical studies, while some remain hard to prove.

Origin and distribution

It is native of Egypt and Syria, Turkestan and the Eastern Mediterranean region. To date, cumin is widely cultivated also in Uzbekistan, Tajikistan, Turkey, Morocco, Egypt, India, Syria, Mexico and Chile.India is the largest producer (70% of world production), exporter and consumer of cumin seed in the world. Rajasthan and Gujarat accounts for 90% production.

Climate and season

Cumin needs dry and cool climate for its growth, with a temperature ranging between 25 to 30°C. India, cumin is sown from October until the beginning of December, and harvesting starts in February. The seeds are also sown in spring at the time June- July.

Types of Cumin

There are two main types of cumin:

→ **White cumin seeds** which are the most common type known as cumin

→ **Black cumin seeds or Bitter cumin** that are popular in Iran

White cumin

The most common cumin (*Cumin cyminum*) that we all use in our kitchen is the yellow-brown seeds. Bearing an oblong shape, and with a ridged cover, these standard cumin seeds. Available in seeds as well as powdered form, the cumin seeds have warming and slightly sweet flavor with a nutty note. You can sprinkle roasted and powder cumin over your salads and raita for a lovely earthy flavor or add it to your stews and soups for a nice depth. Loaded with nutrients, these cumin seeds are also known to be an effective ingredient for improving digestion. Main constituents: Cuminaldehyde



Common Cumin, **Black seed** **Bitter or Black cumin.**

Bitter Cumin or Black Cumin

Cuminum nigrum (occasionally referred to as *Buniumpersicum*; also known as kashmiri jeera), belonging to Apiaceae (parsley family), is a smaller variety of cumin with a different flavour, popularly used in North Indian, Pakistani, and Iranian foods. Until now, there is only very little scientific information on this spices.

Black seeds

Black seed (Commercially known as black cumin; *Nigella sativa*) is an annual flowering plant belonging to the family Ranunculaceae and is a native of Southern Europe, North Africa, and Southwest Asia. Main constituents: Thymoquinone. The seeds of *N. sativa* have a pungent bitter taste and aroma and are used as a spice in Indian and extensively in Middle Eastern cuisines. The dry-roasted *nigella* seeds flavour curries, vegetables, and pulses.

Black cumin IS NOT black seed and although plenty of products now erroneously label themselves as black cumin, the two should not be confused. Black cumin is actually from the plant *Bunium*, which is in the Apiaceae family.Black seed, which is sought after oil made from *Nigella sativa*and not related to cumin at all.

Common name of the spice	**Cumin / white cumin**	**Black seed (*Nigella*/kalonji)**	**Bitter cumin / Black cumin(Kashmiri jeera/ Shahi jeera)**
Scientific name	*Cuminum cyminum*	*Nigella sativa*	*Cuminum nigrum or Buniumpersicum*
Chromosome number	*2n=14*	*2n=12*	*2n=14*
Genus/family	*Cuminum/*Apiaceae (member of Parsley family)	*Nigella/*Ranunculaceae	*Cuminum/*Apiaceae
Native of countries growing	East Meditaranian to South Asia. Now mostly grown in Pakistan, India, Uzbekistan Iran, Turkey, Morocco, Egypt, Syria, Chile, Mexico, and China	South to Southwest Asia. Middle Eastern Mediterranean region, South Europe, Northern India, Pakistan, Syria, Turkey, Iran, and Saudi Arabia	Central Asia to Northern India. Mountainous regions of North India
Plant habit	The plant is about 20 to 60 cm tall and has pale blue and white flowers. Kala jeera	The plant grows nearly 20-40 cm height and has wispy foliage, small pale purple	Cumin is an annual herb which usually attains a height of 30 - 50 cm and the flowers

Common name of the spice	Cumin / white cumin	Black seed (*Nigella*/kalonji)	Bitter cumin / Black cumin(Kashmiri jeera/ Shahi jeera)
	looks similar to common cumin but it is slightly shorter and has a dull, dark gray hue.	flowers and fruit pods filled with seeds.	are white or pink in colour
Flowers and flavour	It has characteristic strong and heavy flavour and is slightly bitter	They have pungent, bitter taste and smell	Usually the flowers have a stronger flavour than the leafy parts, and the developing seed head even stronger flavour
Traditional uses	Both whole and ground seeds are used in the cuisines of many cultures for ages. It has also many uses in traditional medicine. They are used in chronic diarrhoea and dyspepsia	A spice in Indian and Middle Eastern cuisines. In the ancient Egypt, it was used as a preservative in mummification. Traditionally, it is used for asthma, diabetes, hypertension, fever, inflammation, bronchitis, eczema, and gastrointestinal disturbances	A spice in Northern Indian cookery, often the Moghul cooking

Common name of the spice	**Cumin / white cumin**	**Black seed (*Nigella*/kalonji)**	**Bitter cumin / Black cumin(Kashmiri jeera/ Shahi jeera)**
Main constituents	Cuminaldehyde	Thymoquinone	Cuminaldehyde, *p*-mentha-1,3-dien-7-al and *p*-mentha-1,4-dien-7-al

References

Kumar N. (2019). Introduction to Spices, plantation crops, medicinal and aromatic plants. Medtechpublishers.pp 47-63.

Nybe E. V. (2007). Spices. New india publishing agency. New Delhi

Ravindrababu Y and R. K. Jaiman. (2011). Recent advances in seed spices. Daya publishing house. New Delhi

Volume: 03 Issue No: 11

MICROPROPAGATION IN RED BANANA

Article ID: AG-VO3-I11-77

[1]Praveen, R., [2*]V. Krishnan, [1]K. Preetha, [1]FS. Aparna, [1]J. Arathi, [1]S. Lakshmipriya and [2]D. Umamaheswari

[1]PG Scholar & [2]Faculty,Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal 609603, U. T. of Puducherry, India

*Corresponding Author Email ID: anurathakrishnan66@gmail.com

Introduction

Red banana 'Red Dacca' possesses large amounts of calories and also more vitamins C and B6 than yellow banana. Many pests and diseases threaten banana production and have resulted in the application of high quantities of pesticides with serious consequences to the environment. Because of its high degree of sterility and polyploidy nature of the edible banana varieties, classical breeding is difficult. In order to argument conventional breeding and to avoid constraints imposed by some pests and pathogens, transgenic and in vitro approaches are being considered. Banana shoot-tip cultures were most suitable for micropropagation for large scale production. Bananas are propagated by means of young "sword sucker"– 50 to 60 cm tall, which bears only long, narrow leaves, or by rhizome pieces cut from old stools. This traditional technique produces a relatively good yield of plants, but cannot match the speed and quality of meristematic culture. Sword suckers are the preferred types of propagule since they produce fruit more quickly than small suckers or pieces of the corm. Consequently meristems are obtained and excised from suckers and rhizomes using the appropriate techniques.

Characteristics of Tissue Culture Banana Plant

The important factor affecting the efficiency of micropropagation system is the rate of multiplication. It has been observed that banana multiplication rate is genotypic dependent as well as variable behaviour has been observed among cultures initiated from same banana genotypes cultured in vitro condition. In vitro multiplication of banana is normally carried out in the presence of high cytokinin levels which inhibit root formation and elongation. Moreover, during in vitro multiplication shoots may lack roots and are growing in the form of bunches which cannot be transferred directly to field conditions. Importance of in-vitro propogation. Conventional propagation of red banana (*Musa accuunata*) generally done vegetatively through suckers as it is seedless. The vegetative production of suckers is low i.e. 5–10 suckers per plant per year and it leads to the transmission of soil borne diseases through rhizome and viral infection causing bunchy top, resulting in significant loss in productivity Besides, this vegetative method of propogation is slow and season bound. This all limitations can be reduced by propogation of banana through tissue culture technique i.e. micropropogation which is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants.

Through this biotechnological tool, it is possible to get plantlets free from bacteria and other micro-organisms.The process also produces genetically uniform plants. Micropropagation can be rewarding only if complete genetic fidelity of micropropagules is maintained.

Surface Sterilization of Explants

Surface Sterilization of Explant Microbial contaminations are the major hurdle to the initiation and maintenance of viability in in vitro culture. Field-grown plants are liable to be contaminated with microorganisms, which must be disinfected before explants are transferred to in vitro condition. Surface sterilization of underground modified stem is done by various method. Different sterilization procedure and chemical disinfectants are proposed by several in vitro experiments. Sodium hypochloride is the most commonly, used disinfectant for in vitro surface sterilization of banana explants.

Low concentration of mercuric chloride substituted for sodium hypochloride is give the highest percentage of contamination-free healthy culture. Double disinfection method has been adopted in which Clorox followed by mercuric chloride. Double sterilization with NaOCl (3.5%) and Tween 80- first time for 15 minutes and after five rinsing with water and second time for 5 minutes. Explants are treated with fungicide and antibiotics to minimize the contamination in in vitro cultures. Ethanol 70% has also been used for disinfection purposes

Initiation of Shoot Tip Culture

Initiation of Shoot Tip Culture Shoot apical meristem, covered by leaf primordia that are supported on a small base of rhizome tissue, is cultured on medium intact or after incision or fragmentation into pieces.(Murashige and Skoog 1962) basal medium is the most widely used for micropagation of banana. Different strength of MS medium, frequently transfer to similar fresh medium, antioxidants and activated charcoal are used to eliminate phenol oxidation in in vitro propagation of banana. Ascorbic acid combined with 1/2 MS or 1/3 MS reduced browning. Soaking of explants in an citric acid and ascorbic acid mixture prior to culture was effective in controlling the phenolic exudation.

Addition of ascorbic acid to the surface of culture medium not only prevented the development of lethal browning but also greatly increased the number of plantlet produced. Ascorbic acid was able to reduce the disease incidence by more than 60%.

Effects of Plant Growth Regulators on In Vitro Propagation of Banana

For Shoot tip culture Different plant growth regulators in various combination and concentrations are used for culture initiation. Low concentration of BAP 2.0 mg· L-1 with MS agar medium was used for initiation of shoot tip culture and then transferred to high concentration of BAP (5.0 mg· L-1) at multiplication of Red banana shoot tips.High multiplication rate (3.0) was observed at 5.0 mg· L-1 BAP with 20 mg· L-1 ascorbic acid in Red Banana (AAA).

In Vitro Rooting

The Concentration of cytokinin in the rooting medium should be lower than auxins concentration, so that cytokinin/auxin ratio becomes low,The most frequently incorporated auxins in rooting medium were NAA, IAA and IBA. Naphthalene acetic acid (NAA) was used frequently at lower concentrations for root induction of in vitro raised banana plants in that addition of charcoal at 2% concentration instead of hormones (IAA, IBA) showed 95% success rate in Red Banana (AAA).

Acclimatization of Micropropagated Plant

The process of acclimatization is not unique to micropropagation as clonally propagated cuttings are also often acclimatized prior to field transfer. However, in the case of in vitro raised plantlets, it becomes obligatory to acclimatize because they are not adapted to harsh in vivo conditions. Generally, in vitro conditions which promote rapid growth, shoot proliferation and plantlet development result in certain abnormal plant characteristics. In fact, ultimate success of micropropagation technology, either for academic or commercial purpose.

Explant Source for Banana Micropropagation Plant tissue cultures are initiated from tiny pieces, called explants, taken from any part of a plant.

Selection of healthy sword sucker

Trimming of sword sucker

Prepared Explant

Inoculation of Explant in Nutrient medium

First sub culture with cross cut after 35 days

Rooting of Shoots

Plant ready for hardening

Hardening of TC plants

Fig.1. Micropropagation in Red Banana

Practically all parts of a plant have been used successfully as a source of explants. Banana micropropagation has been induced from a range of explants, including meristems corm tissue, leaf bases immature zygotic embryos and immature male and female flowers. However, banana shoot tips are the most commonly-used explants for banana micropropagation. Shoot tips and meristem tips are perhaps the most popular source of explants to initiate tissue cultures. Shoot tips and dormant buds taken from independently growing plants survive at a higher frequency and show greater physical stability than shoot tips taken from in vitro cultures.

Hardening of In Vitro Raised Banana Plants

The transfer of rooted plantlets from aseptic culture conditions direct to the external environment resulted in significant losses of plants. When removed from the tissue culture environment, micropropagated plants must be allowed to adjust to the outside environment with its varying light levels, changing temperature, reduced humidity, lower nutrient availability and pathogen presence. Tissue-cultured plants are generally poor in cuticle; therefore lose water rapidly upon transfer to natural conditions.

The adapted plantlets were then transferred to a peat moss and sand (1: 1 v/v) potting mixture.

Conclusion

Tissue cultured plants perform better than suckers in most of parameters i.e. weight and size of the fingers, weight and number of hands (Faisal et al. 1998). For existing yield to be maintained, a cyclical process of replacement of old for new plants should be undertaken. Plants in a single-cycle plantation have strong vigour and high yield potential because of the juvenile nature of the material and their photosynthetic efficiency and disease free plants are obtained. Single cycle consists of the micropropagation of banana shoot tip tissues and the transfer of plantlets from in vitro culture to the nursery for acclimatization, and then they are grown out to field planting site. Micropropagation of bananas and nurseries are now present in most banana exporting countries (FAO 2003). In vitro multiplication of banana plantlets is an excellent alternative and a number of countries in the world,

References

Agustin, B. and J. Molina. 2002. Tissue culture in the banana industry. International training course on biotechnology for seed and seeding production, 2- December Los Bańos, Philippines.

Ahloowalia, B.S., J. Prakash, V. A. Savangikar, and C. Savangikar. 2004. PLANT TISSUE CULTURE. In: James, S.M. Low cost option for tissue culture technology for developing countries. Proceedings of a Technical Meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

Ahmed S, Sharma Akash, Singh AK, Wali VK, Kumari Preeti (2014) In vitro multiplication of banana (Musa sp.) cv Grand Nanine. Afr J Biotechnol 13 (27) : 2696—2703. Anonymous (2013) Healthy Food House. http://www.healthy foodhouse.com/redbananutrition-facts-health-benefits Chatterjee G, Prakash J (1996) Genetic stability in commercial tissue culture. In: Prakash J, Pierik RLM (eds).

Al-amin, M.D., M. R. Karim., M. R. Amin., S. Rahman and A. N. M. Mamun. 2009. In vitro micropropagation of banana (Musa spp.). Bangladesh J. Agri. Res. 34 (4): 645-659.

Kesar Kiran P., S. V. Sawardekar, N. B. Gokhale, S. S. Sawant, P. M. Randive, Y. R. Parulekar (2018).Standaradisation of in vitro regeneration techniques in Red banana and fidelity testing of tissue culture raised plantlets of Red banana.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

NANOTECHNOLOGY: PLANT DISEASE MANAGEMENT

Article ID: AG-V03-I11-78

R. L. Joshi[1]*, D. H. Tandel[1], Sunil Patel[2] and Sandhya G.[1]

[1]Department of Plant Pathology, [2]Department of Genetics and Plant Breeding

N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, India

*Corresponding Author Email ID: rahuljoshi7719@gmail.com

ABSTRACT

Ensuring food security in developing countries is challenging due to the low productivity of the agriculture sector, degradation of natural resources, high post-harvest losses, less or no value addition and high population growth. Researchers strive to adopt newer technologies to enhance supply and narrow the food demand gap. Nanotechnology is one of the promising technologies that could improve agricultural productivity via nanofertilizers, use of efficient herbicides and pesticides, soil feature regulation, wastewater management and pathogen detection. It is equally beneficial for industrial food processing with enhanced food production, excellent market value, elevated nutritional and sensing properties, improved safety and better antimicrobial protection. Nanotechnology can also reduce post-harvest losses by increasing the shelf life with the aid of nanoparticles. Each year, 20%–40% of crops are lost due to plant pests and pathogens. Existing plant disease management relies predominantly on toxic pesticides that are potentially harmful to humans and the environment. Nanotechnology can offer advantages to pesticides, like reducing toxicity, improving the shelf-life, and increasing the solubility of poorly water-soluble pesticides, all of which could have positive environmental impacts.

INTRODUCTION

The foremost universal challenge on our planet is the question of establishing food security for a rapidly increasing population in the world. Predictions show that food demand is likely to rise from 59 to 98% of the world population reaching 9 billion by 2050. Despite an increase of the world population particularly in developing countries, the global food supply is interrupted by the expenditure of bio-resources for energy production, manufacturing chemicals, high post-farming loss, less value addition, inefficient distribution and marketing systems, and other factors. Farmers throughout the world will focus on using new innovations and technologies to enhance the production of crops through intensive and extensive agriculture. The current efforts are further boosted using nano-modified stimulants and precision farming. Agricultural efficiency, soil improvement, secure water use, distribution of food in stores, and its quality are basic factors of securing food that may be improved via advances in nanotechnology research.

Nanotechnology can provide a path for producing foods with outstanding quality in highly improved workable form along with induction of nutrients bioavailability. Many research investigations are focusing on increasing the application of nanotechnology for the production of crop and food processes. Nanotechnology is one of the promising areas to boost the availability of food and to manufacture newer products for beneficial purposes in agriculture, food, water, the environment, medicine, energy, and electronics. It is a developing and quickly growing region with new and exclusive applications in agriculture and food research. Growing productivity and declining post-harvest expenditure via better outcomes with the support of newer technical investigations with the help of nanotechnology and biotechnology in foodstuffs might be the best answer. A few evolving areas regarding nanomaterials in agriculture are to reduce the number of spread chemicals, minimize nutrient losses in fertilization and increased yield through pest and nutrient management.

Nanotechnology-based applications have put forward the growing requirement of using nanoparticles in food biotechnology, science, food processing, food packaging, functional food development, food safety, detection of pathogens in food and extended shelf-life of food and food foodstuffs. Nanomaterials perform very well in enhancing food security to support the development of the food manufacturing industry. Depositing of food manufacturing equipment (via biofilm coating), nanofabricated filters, sieves and membranes, nanocomposite-based and Nano sized adsorbents and catalytic agents are utilization areas for the provision of assistance in the processing of food. Adding nanomaterials into food packing are supposed to modify the hindrance felt during materials packing and can help decrease the involvement of valued raw ingredients and waste production.

Approaches of nanotechnology

Nanotechnology can be applied via two opposite approaches that are “bottom-up” or “top-down” approach. The top-down approach can be employed via the physical method undertaken for food and agriculturally based materials. Production of nanomaterials at a commercial scale presently employs mainly the ‘‘top-down” approach, where nanoscale materials are synthesized by size decrease of bulk precursors, via milling technique, nanolithography, or using precision engineering. A dry milling protocol is employed to get grain flour with reduced size and hence more water-retaining ability. Another procedure called homogenization broadly used for dairy work regarding size reduction in case of globules, vaporization and laser application associated with cooling is also supposed to be top-down protocol. The functionality of food material for the required purpose is a surface area with better properties. Top-down and bottom-up approaches are exhibited and dependent upon size reduction as finer size material possesses bigger.

Agriculture nanotechnology

Agriculture is practiced for food production via the cultivation of varied crops and the raising of livestock. It is considered the backbone economy for most developing countries as a vital role in progress and development. The rising population in the world results in high demand for more food supply, need to practicing new methods to increase agricultural production. For the last several years, agriculture nanotechnology has focused on research and application to resolve agriculture and environmental issues sustainability, crop improvement and enhanced productivity.

Nanotechnology in Plant Disease Management

Nanotechnology, due to the unique properties of nanomaterials (NMs), offers a promising alternative in plant disease management and has many advantages over conventional products and approaches, which are associated with enhanced efficacy, reduced input and lower eco-toxicity. In the last decade, the toxicity to plants induced by NMs has been widely studied. Nonetheless, NMs at an appropriate dose exhibited the potential to suppress pathogen infection and improve plant growth. NMs, as nanofertilizers, can efficiently deliver micronutrients to plants and trigger plant immune responses for crop protection.

Nanomaterials used as antimicrobial agents

There are several uses of NMs in plant protection, but the most evident seem to be their use as antimicrobial agents for disease management to improve plant health. The most extensively examined NMs used as antimicrobial agents are nanoparticles (NPs) of metals such as silver (Ag), copper (Cu), and zinc (Zn); and carbon- and polymer-based NMs were also both explored for antimicrobial properties.

Table 1: Management of various plant diseases using different nanomaterials

Nanomaterials	Application dose	Target pathogen	Host and Disease
Ag-dsDNA-GO composite	100 ppm	*Xanthomonas perforans*	Tomato; bacterial spot
Ag NPs	3 mg l^{-1}	*Botrytis cinerea*, *Penicillium expansum*, *Aspergillus niger*, *Alternaria* sp., *Rhizopus* sp.	Multiple diseases in several crops
CuO, Cu_2O, Cu/ Cu_2O NPs	27.78–43.87 g hl^{-1}	*Phytophthora infestans*	Tomato; late light
CS-Cu, MV-Cu, FQ-Cu nanocomposite	100 µg ml^{-1}	*Xanthomonas perforans*	Tomato; bacterial spot
ZnO/nanocopper composite (ZnO-nCuSi)	0.22 kg ha^{-1} metallic Cu	*Xanthomonas citri* subsp. *Citri*	Citrus; canker disease
GO	500 µg ml^{-1}	*Pseudomonas syringae*, *Xanthomonas campestris* pv. *undulosa*, *Fusarium graminearum*, *Fusarium oxysporum*	Infection to many *Triticum* genera

C_{60}, MWCNTs, Fe_2O_3, TiO_2	50 mg l^{-1}	*Turnip mosaic virus*	Tobacco; *Turnip mosaic virus* infection
Chitosan NPs	0.0005% (w/v) for *in vitro*; 0.1% (w/v) for foliar application	*Fusarium oxysporum f.sp. lycopersici*	Tomato; Fusarium wilt

Abbreviations: GO, graphene oxide; CS-Cu, core-shell copper; MV-Cu, multivalent copper; FQ-Cu, fixed quaternary ammonium copper; MWCNTs, multi-wall carbon nanotubes.

The application of Ag NPs for controlling plant pathogens is the most investigated area given the historically known antimicrobial activity of Ag. The DNA-directed Ag NPs grown on graphene oxide (GO) and found that a low concentration of 16 ppm Ag-dsDNA-GO showed excellent antibacterial capability against *Xanthomonas perforans*. In a greenhouse experiment, foliar application of 100 ppm Ag-dsDNA-GO on tomato seedlings significantly reduced the disease severity of bacterial spot as compared with untreated plants, giving results similar to conventional bactericides (Kocide 3000+mancozeb) treatment. Meanwhile, no phytotoxicity on plant leaves was observed. These results highlight the nanoscale Ag in managing Cu-tolerant phytopathogens, given the comparable efficacy to the commercial products, and remarkably low dose and toxicity. The application of biosynthesized Ag NPs at 100 µg ml^{-1} can reduce chickpea Fusarium wilt incidence by 73.33%, compared with the commercial fungicide control (CuOCl) at 26.67%, with an improved efficacy of 46%. Also, Ag NPs showed non-toxic properties to chickpea seed germination and the soil microbial community. Nonetheless, concentrations as low as 3 ppm Ag NPs , produced by the culture supernatants of *Rhodotorula glutinis*, were significantly effective for inhibiting growth of the plant pathogenic fungi in potato dextrose agar (PDA). In particular, these biosynthesized Ag NPs were significantly more effective in inhibiting the fungi than their chemically synthesized counterpart. The bactericidal activity of Ag NPs from *Trichoderma viride* was higher than that of chemically synthesized Ag NPs, attributed to the surface coating of secondary antimicrobial metabolites of *T. viride*. Biosynthesis of NPs is generally recognized as more advantageous over chemical synthesis, such as higher production, lower costs, and biocompatibility. The employment of suitable biocontrol agents to biogenic synthesis of NMs may gain more efficient application in agro-ecosystems due to the integration of natural bioactive ingredients with nanoformulation, which is also an environmentally friendly approach that would be considered preferable in future.

Conclusion

The integration of nanotechnology into plant disease management represents a paradigm shift in agriculture, offering targeted and sustainable solutions to combat pathogens. Nanomaterials have demonstrated exceptional potential in enhancing plant defenses, enabling precise delivery of treatments, and providing real-time monitoring capabilities. While the field holds great promise for revolutionizing crop protection and ensuring global food security, it is imperative to address challenges related to environmental impact and regulatory frameworks. Continued research and responsible implementation will be key in harnessing the full benefits of nanotechnology, paving the way for a more resilient and sustainable agricultural future.

References

Fu, L., Wang, Z., Dhankher, O. P. and Xing, B. (2020). Nanotechnology as a new sustainable approach for controlling crop diseases and increasing agricultural production. *Journal of Experimental Botany*, **71**(2): 507-519.

Neme, K., Nafady, A., Uddin, S. and Tola, Y. B. (2021). Application of nanotechnology in agriculture, postharvest loss reduction and food processing: Food security implication and challenges. *Heliyon*, **7**(12).

Volume: 03 Issue No: 11

NON- CHEMICAL APPROACHES IN INTEGRATED PEST MANAGEMENT

Article ID: AG-VO3-I11-79

Shailendra Kumar Mishra[1], Ajit Pandey[1*], Brajrajsharan Tiwari[1] and Ankit Kumar Mishra[1]

[1] Research Scholar, Banda University of Agriculture &Technology (BUAT), Banda, U.P. 210001, India

*Corresponding Author Email ID: ent.ajit19@gmail.com

Abstract

Pesticides, crop protection systems, crop yields, and cropping practices may all be improved by employing pesticides. Insect resistance and a decreasing supply of active chemicals both represent future challenges to crop productivity. As a result, agricultural systems that rely less on synthetic pesticides must be developed. The environmental impact of pest management strategies must be reduced. Changes in plant protection practices against the harm caused by insect pests are also impacted by increased concerns about the potential health repercussions of pesticides, a loss in arable land per person, and the emergence of new pest complexes, which is expected to be accelerated by climate change. Although pesticides remain an important weapon in the fight against insect pests, their unregulated use has resulted in a number of negative consequences, including contamination of the environment, toxic residues, pest comeback, resistance to pesticides, disruption of natural enemies, and so on. This might be accomplished by combining a non-chemical, safer delivery system that is also more environmentally friendly, allowing the pest to be dealt with while causing the least amount of interruption to its natural adversaries. This situation enhances the necessity for alternative pest management approaches such as physical controls, mechanical controls, botanical controls, and bio-rational controls.

Keywords: Resurgence, Environment, Non-chemical, Botanical.

Introduction

Insecticides made from chemicals are mostly used to control insect pests in agriculture. Farmers frequently use chemical pesticides in big quantities on a regular basis to reduce crop loss due to pests. Despite the use of large amounts of insecticides, crop loss rises for a variety of reasons, including the emergence of pest resistance, pest revival, and pest replacement, in addition to having a detrimental impact on the environment and human health by leaving harmful residues. As a result, eco-friendly management techniques must be developed. The use of chemical pesticides in agriculture has been reduced in recent year’s thanks in large part to the increased interest in biological management of pests and diseases that harm farmed plants. Microbial control of pests is mediated by natural enemies like predators and parasitoids and microbial control is achieved utilizing beneficial microbes such as insect pathogenic bacteria, fungi, viruses, protozoa and nematodes. However, the demand for contaminant-free, high quality crops has led to a movement towards non-chemical pest management and sustainable crops cultivation. To restore the productivity and sustainability of soil as well as plants, efforts have been made to implement alternative, eco-friendly and cost effective pest and disease management strategies. CABI and TTRI are conducting a scientific study to evaluate the environmental and economic feasibility of applying biological or non-pesticide methods for plant protection. There is need to reduce the negative impacts of pest control methods on the environment. Increased concerns about the potential effects of pesticides on health, the reduction in arable land per capita **(Novartis, 1997)** and the evolution of pest complexes likely to be accelerated by climate changes also contribute to change in plant protection practices.

Components of Non- Chemical Approaches:

a) **Cultural Control:** Cultural control refers to the control of insects through the adoption, at the appropriate time, of conventional form practices in such a way that the insects are either destroyed or decreased in a population.

Tillage:

During the summer, deep ploughing exposes the pupa in the fields to solar heat and natural enemies, reducing the population **(Reddy D.S., 2018).**

Sowing time

Early sowing reduced gall midge and leaf folders in rice, shoot fly in sorghum, *Helicoverpa armigera* in chick pea, and aphid in mustard.

Cotton bollworm damage can be reduced by planting on time.

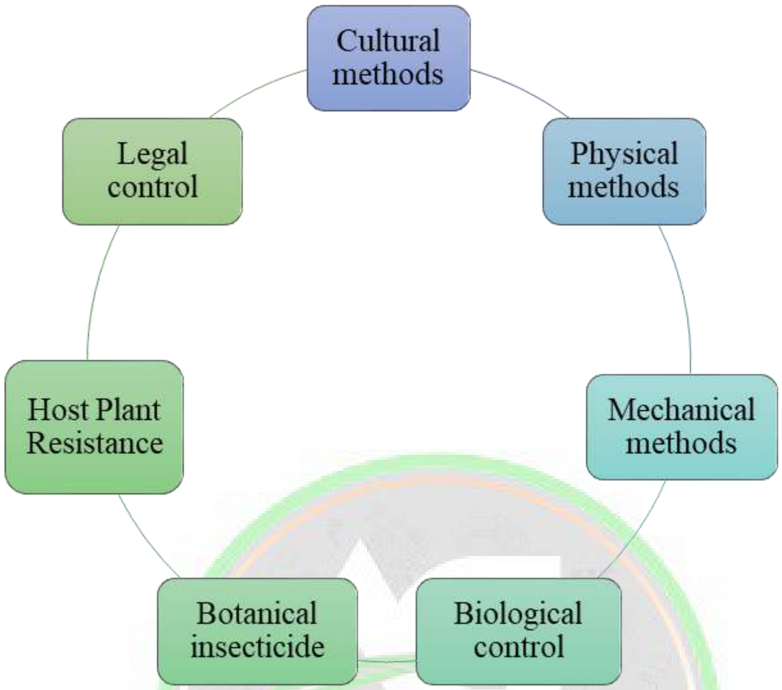


Fig: Components of Non- Chemical Approaches

Seed rate:

High seed rate use was proven to minimize termites in wheat and shoot flies in sorghum.

Plant spacing:

Closer spacing increases the likelihood of plant hoppers, whereas broader spacing increases the likelihood of leaf hoppers. The population of *Helicoverpa armigera* was four times higher in a closer-spaced chickpea crop.

Water management:

Crops grown in low-lying waterlogged environments suffer greatly from whitefly and termites. *Helicoverpa armigera* reduced as the frequency of irrigations increased.

Management of nutrients:

Most insect pests are substantially more prevalent when nitrogen fertilizer levels are high. Many pests are reduced by the application of potash and, in certain cases, phosphorus.

Excess nitrogenous fertilizer application reduced the damage caused by the shoot fly and stem borer, *Chilo partellus*.

The use of nitrogen reduced the incidence of *Helicoverpa armigera* on tomato. White fly in sugarcane rose as nitrogen application was reduced.

Crop rotation entails:

If rice is produced after jute, for example, the jute stem weevil will be suppressed and will not attack rice.

Trap Crop:

- Mustard is used as a trap crop against the diamond back moth, *Plutella xylostella* (2:25 ratio) in cauliflower or cabbage fields. Mustard should be planted in matched rows (one 15 days after planting cabbage or cauliflower and another 30 days later).
- *Helicoverpa armigera* is attracted to trap cropping Marigold after every 8 rows tomato.
- Okra is a trap crop used to eliminate *Earias spp*. and *Amrasca devastans* in cotton.

Intercropping:

- A tomato intercropped with cabbage (1:1) reduced *Plutella xylostella* egg production.
- Cotton-cowpea intercropping attracted more coccinellid predators, resulting in increased natural parasitism of spotted bollworms.
- Cowpea is intercropped in groundnut farming systems to attract red hairy caterpillars.
- Proper harvesting reduces the frequency of rice stem borer in rice crops.

b) Physical techniques

These strategies try to control insect populations by using equipment that physically harm them or change their physical surroundings.

Treatment with hot or cold water:

Dry heat, including exposure to sun rays, is effective in eradicating a variety of pests in seeds and stored goods during the hot summer months of April to June. Grain bugs can be destroyed by heating them to 550 degrees Celsius for three hours. Cotton seeds exposed to sunlight in thin layers for 2-3 days in April help to kill diapausing larvae of the pink boll worm. The treatment of sugarcane setts using heat therapy units, either hot water or hot air, kills the scale insects that are brought over from the plant. Treatment of plant storage organs using hot water, such as roots, corns and bulbs.

Moisture content:

The moisture content of grain and that of the store house is a very important factor for controlling insects. Food grains with a moisture level below 11% are relatively resistant to insect attack, whereas moisture absorption. Content higher than 15% makes the grains susceptible to almost all types of insect pest attack. It is therefore recommended that grains be dried in the sun before storing so that its moisture content is not more than 8%.

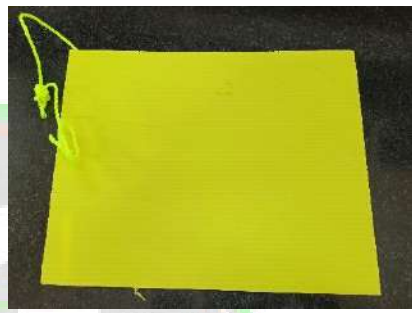
a) Mechanical Control:

Mechanical devices or manual forces are used to manage pests in this sort of control.

Sticky trap:

Use yellow/blue sticky traps coated with castor oil to catch whiteflies, aphids, leaf miners, thrips, and other pests.

a) Fruit fly trap



b) Yellow sticky trap for aphid

Luminous trap:

Before the introduction of synthetic organic insecticides, light traps for attracting and mass-killing months and beetles were utilized as a control strategy. The traps may still be effective for monitoring the population of major insect pests in a given area. The use of light traps to capture adults has proven effective in controlling Plessey borer, root borer, and whit grub damage in sugarcane. Monitoring unit of one light trap per acre, and mass collection unit of two to three per acre.

Table 1: Light trap to attract the different species

Common name	**Scientific name**	**Different crop**	**Family**	**Order**
American Bollworm	*Helicoverpa armigera*	Mungbean, Gram, Wheat, Vegetables, Cotton, Maize	Noctuidae	Lepidoptera
Armyworm	*Spodoptera litura*	Mung bean, Gram,	Noctuidae	Lepidoptera

		Wheat, Vegetables, Cotton		
Termites	*Microtermes* Spp.	All crops, vegetables and ornamentals	Termitidae	Isoptera
Green Bug	*Chinavia hilaris*	Mungbean, Gram, Vegetables, Cotton	Pentatomidae	Hemiptera
Grey weevil	*Myllocerus virdidanus*	Mungbean, Cotton	Curculionoida	Coleoptera

c) Biological control

According to **Paul De Bach (1964)** "The utilization of parasites, parasitoids, predators and pathogens for the regulation of host population density is called as biological control."

Component of Biological control:

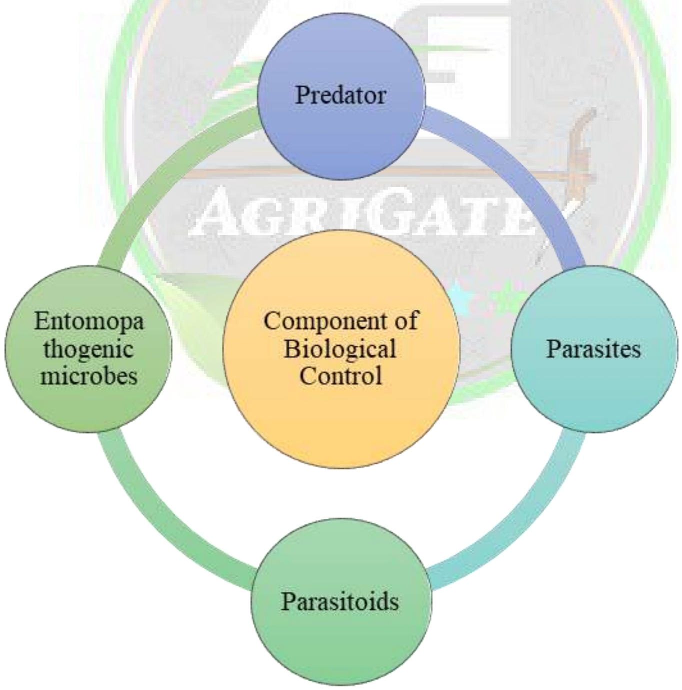


Fig-2: Components of biological control

d) Botanical insecticide:

Botanical insecticides are a viable alternative to synthetic pesticides due to their non-phytotoxicity, biodegradability, and fast decomposition **(Shivkumara *et al*., 2019).**

Botanical insecticides outperform synthetic pesticides in the following ways:

1) Have little mammalian toxicity and so pose few or no health risks or environmental damage.

2) There is no chance of building resistance while using natural forms.

3) Because they are target specific, they are less dangerous to non-target creatures such as parasites, predators, and pollinators.

4) It is not known what causes pest species recurrence.

5) It is not phytotoxic to crop plants.

6) They do not leave residues on crop produce or the environment, contributing to conservation and consumer safety.

e) Host Plant Resistance:

Insect host plant resistance (HPR) is a low-cost, ecologically friendly pest management strategy. The most enticing feature of HPR is that farmers do not need much experience with application techniques or to invest any money. Significant progress has been made in the discovery and creation of agricultural cultivars resistance to major pests in a variety of crops. Resistance genes must be bred into high-yielding cultivars capable of adapting to a wide range of agro ecosystems. Insect resistance should be one of the criterion for releasing varieties and hybrids to farmer cultivation. HPR can be turned into an effective weapon for decreasing insect pest losses by combining genes from wild relatives of crops with unique genes from *Bacillus thuringiensis*.

f) Legal control:

Restriction on the transportation of certain commodities within or beyond the country, or between various parts of the country, by enacting specific laws and regulations. Citrus greening, for example, is a big problem in Pokhara, and movement of seedlings and grafts from Pokhara to various parts is legal regulation.

Why is non-chemical insect pest treatment preferred?

To overcome the problems of following we preferred non- chemical approaches for pest management

a) Insect resistance to pesticides is developing.

b) The resurgence of the treated population.

c) Secondary pest outbreak.

d) Food and forage residue.

e) Pollution of the environment and deterioration of its quality.

f) Extermination of non-target animals and natural enemies.

g) Dangers to human health

Conclusion:

The uncontrolled use of pesticides that are chemical-based has resulted in insecticide resistance, contamination of the environment, pest resurrection, secondary pest outbreaks, and a reduction in the number of natural enemies. In recent years, IPM-based pest control practices have become more useful and applicable for pest management. In this technique, pest populations are kept below ETL by the use of cultural, biological, physical, mechanical, and legal approaches to insect pest management. Non-chemical insect pest control is a feasible answer to this issue. In the long run, this method poses no risk to human health, the environment, or natural adversaries.

References:

De Bach, P. (1964) Biological Control of Insect Pests and Weeds. *Cambridge University Press*, Cambridge, UK, 844 p.

Novartis, (1997). Le livre vert du maïs Cb. Novartis, Saint-Sauveur, France, 109 p.

Reddy, D.S. (2018) Applied Entomology. *New Vishal Publications*, New Delhi, 4th Ed, 264 p. ISBN 13, 9788183990394.

Shivakumara KT, Manjesh GN, Satyajit Roy, Manivel P. (2019) Botanical insecticides; prospects and a way forward in India: A review. *Journal of Entomology and Zoology studies,* **7**(3):206-211.

Volume: 03 Issue No: 11

MAJOR NUTRIENTS - DEFICIENCY SYMPTOMS AND MANAGEMENT IN OILPALM

Article ID: AG-VO3-I11-80

Dr. K. Naganjali, Smt. D. Sravanthi, Dr. K. Gopala Krishna Murthy, Dr. K. Shireesha, Dr. M. Ramprasad, Dr. T. Pavani and Dr. J. Hemantha Kumar

Agricultural College, Aswaraopet, Bhadradri Kothagudem Dist. 507 301.

Professor Jayashankar Telangana State Agricultural University (PJTSAU), Telangana, India

*Corresponding Author Email ID: naganjali_kesipeddy@yahoo.com

Introduction

Nutrient imbalances in oil palm are one of the major limitations to oil palm productivity in oil palm growing countries including India. It is possible to overcome nutrient imbalances by proper nutrient management. Otherwise, nutrient imbalances like deficiency / disorder could be rectified after proper identification followed by application of that particular nutrient(s) either by soil or foliar application. The nutrient deficiencies and disorders in oil palm, their symptoms and corrective measures recommended for Indian plantations are described below. The most frequent mineral deficiency symptoms in plantations are those attributed to N, K, Mg and B.

Oil palm needs a huge amount of nutrients as it produces one of the highest dry matters among the C_3 plants. The nutrient requirement of oil palm varies widely, and depends on the soil type, ground cover conditions, target yield, type of planting material, palm spacing, palm age, as well as climate and other environmental factors. It is also associated with the amount of nutrients removed in harvested fruit bunches, nutrients recycled to the soil through pruned fronds, male inflorescences and leaf wash and nutrients immobilized in the palm biomass. Oil palm removes a higher amount of nutrients compared to other plantation crop.

Oil palm grows well in almost all types of soils. Best suited soils are well drained, deep loamy, alluvial soils rich in organic matter with an adequate water holding capacity. In India, a great variety of soils ranging from red sandy loam/sandy clay loam (Alfisols), alluvial silty loam

(Inceptisols / Entisols), heavy black soils (Vertisols) and acidic red laterite soils (Oxisols) are under use for oil palm cultivation. However, alkaline, highly saline, water logged and coastal sandy soils are avoided for oil palm cultivation.

Nitrogen (N) deficiency:

Nitrogen deficiency occurs commonly due to prolonged water logging leading to poor aeration, inadequate drainage or high water table leading to denitrification. Lateritic soils poor in fertility and acidic in reaction with reduced nitrification lead to low nitrogen availability to plants. Planting in top soil or close to large boulders just lying beneath the soil surface, results in reduced availability of the nutrients. Insufficient N application also caused N deficiency. Inhibition of N mineralization due to the effect of low pH, high salt content and unfavourable soil temperature and water content on soil microbial activity adds to the cause. In nursery, the most obvious symptom is that the seedlings first become dull and pale green colour. As the deficiency becomes more acute there is a gradual colour change to lemon yellow. Growth is also reduced. In the main field, chlorosis appears first on older fronds, later spreading to younger tissues in older palms. The tissues of the midrib become bright yellow or orange, which contrast with the paler chlorosis of the laminar tissues. The swelling at the pinna base (apocone) also becomes yellow or orange in colour as N deficiency is pronounced. Unlike Mg deficiency, both ranks of pinnae become equally chlorotic and there is no shading effect of the upper rank pinnae on the lower one. In the later stages of acute deficiency, dark coloured discolouration begins to appear normally towards the pinnae, and die back develops from the pinnae tip and margin. N deficiency symptoms are observed if the available N content of frond 17 is 2.0 - 2.5%. Severe deficiency occurs if it contains N less than 1.5% of dry matter. Nitrogen (N) deficiency causes a diffuse discoloration of the foliage, which turns yellowish green (Fig. 1a).

Fig: Nitrogen deficiency recognizable by the pale green foliage

A deficiency is especially detectable in young plantations, up to six years old, when it is exacerbated by factors that limit nitrogen resources in the soil: excess water, a lack of legume cover crops and high grass density. These problems therefore need to be dealt with at the same time as fertilization is strengthened. The presence of ferns and waterlogging of the soil in the rainy season reduce the nitrogen resources available for the crop and slow down palm growth.

To control N deficiency in nursery seedlings, it is recommended to spray 2% urea solution at weekly or fortnightly intervals till deficiency symptom disappears. Cultural practices such as eradication of grasses around the seedlings and improving drainage by making drains helps in preventing occurrence of N deficiency. Application N fertilizer @ 1200g N / adult palm / year (equivalent to 3 kg of urea or 6 kg of ammonium sulphate or 2 kg of urea plus 1.5 kg of DAP/adult palm/year) in 3 - 4 splits is recommended. Addition of organic manures like farm yard manure and neem cake help in overcoming the problem.

Phosphorus deficiency:

Phosphorus deficiency occurs when oil palm is grown in acidic and P deficient soils. In small seedlings, the oldest leaves become dull and assume the olive green colour. The chlorotic condition increases in severity. Under field conditions, P deficient leaves do not show specific symptoms other than reduced frond length. A stunned growth with short dark fronds appears in palms (Figure 2a). Trunks of affected palms are narrow and tapered (Figure 2b).

Fig 2a. Phosphorous deficient oil palm

Fig 2b. Phosphorous deficient oil palm (small and stunted) trunk

Application of 600g of P_2O_5 / adult palm / year (equivalent to 4 kg of SSP or 1.5 kg of DAP/ adult palm / year) in 3 - 4 splits is recommended to meet the P requirement of oil palm.

Potassium (K) deficiency:

Potassium deficiency occurs when oil palm is grown in soils of with low K status, peat soils and soils with poor moisture retention ability. Heavy application of fertilizers like calcium ammonium nitrate, rock phosphate and kieserite also induce K deficiency. The development of K deficiency symptoms occurs in the older fronds.

Potassium deficiency is usually described by two types of symptoms: appearance of yellow stripes along leaflet margins that gradually spread to the entire lamina, known as mid-crown yellowing (Fig. 3a) and appearance of small orange spots contrasting with the green colour of the leaflets, known as confluent orange spotting (Fig. 3). These two types of symptoms are found in fertilization trials after several years of potassium (K) deprivation, but their interpretation in commercial plantations is tricky. The yellow stripes only occur when leaf contents have reached extremely low levels (< 0.50%); such a situation is rare when plantations are fertilized, even if applications are not enough to achieve the best yields. Confluent orange spotting can be confused with other damage: foliage fungi such as Cercospora sp., insect or mite bites, abnormalities of genetic origin. Visually diagnosing a potassium (K) deficiency is tricky because it can be concluded that nutrition is satisfactory when it is not and, conversely, that there is a deficiency when there is none.

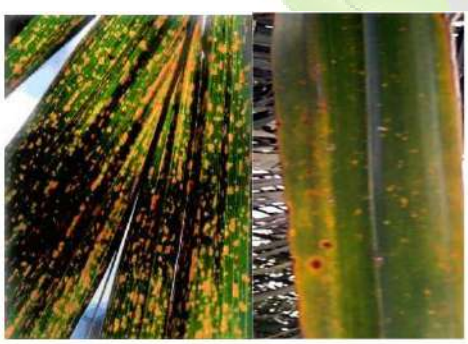


Fig 3. Potassium deficiency symptom (Typical confluent orange spotting

Fig. 3a Mid-crown yellowing in oil palm leaves

A lack of fertilizer applications over many years leads to potassium deficiency which, with these symptoms, reduces bunch yield. Single and compound K fertilizers are evenly spread over the outer rim of the circle and the surrounding inter-row space. Single K fertilizers can be applied irrespective of weather conditions. The large application rates required on sandy textured soils should be applied in several rounds (e.g., 5 kg MOP/palm in four applications of 1.25 kg/palm).

Volume: 03 Issue No: 11

CONSTRAINTS AND CHALLENGES OF ORGANIC FARMING

Article ID: AG-V03-I11-81

P Lakshmanakumar[1], N Rohini[2] and E Sree Gayathri[3]

[1]Associate Professor (Agronomy), Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri, Tamil Nadu – 635 105

[2]Assistant Professor (Horticulture), Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri, Tamil Nadu – 635 105

[3]Ph.D Scholar (Plant pathology), Department of Plant pathology, Agriculture College and Research Institute, TNAU, Coimbatore, Tamil Nadu-641 003

*Corresponding Author Email ID: laksh006@gmail.com

Introduction

Organic agriculture is found to be superior to conventional farming because of increased human labour employment, lower cost of cultivation, higher profits, better input use efficiency and reduced risk leading to increased income, enhanced self-reliance and livelihood security of the farmers and maintaining soil health and environment.

These farming practices include inter-cropping, mulching, integration of crops and livestock manures while, prohibit the use of all synthetic inputs during this agriculture practiced. Their adverse effects on the environment are manifested through erosion, water shortages, salivation, soil contamination, genetic erosion, etc.

Constraints of organic farming

Lack of Awareness

The most important constraint felt in the progress of organic farming is the inability of the government policy making level to take a firm decision to promote organic agriculture.

Output Marketing Problems

It is found that before the beginning of the cultivation of organic crops, their marketability and that too at a premium over the conventional produce has to be assured. Inability to obtain a premium price, at least during the period required to achieve the productivity levels of the conventional crop will be a setback.

Shortage of Bio-mass

Many experts and well-informed farmers are not sure whether all the nutrients with the required quantities can be made available by the organic materials. Even if this problem can be surmounted, they are of the view that the available organic matter is not simply enough to meet the requirements.

Inadequate Supporting Infrastructure

In spite of the adoption of the NPOP during 2000, the state governments are yet to formulate policies and a credible mechanism to implement them. There are only four agencies for accreditation and their expertise is limited to fruits and vegetables, tea, coffee and spices. The certifying agencies are inadequate.

High Input Costs

The small and marginal farmers in India have been practicing a sort of organic farming in the form of the traditional farming system. They use local or own farm renewable resources and carry on the agricultural practices in an ecologically friendly environment. However, now the costs of the organic inputs are higher than those of industrially produced chemical fertilizers and pesticides including other inputs used in the conventional farming system.

Marketing Problems of Organic Inputs

Bio-fertilizers and bio-pesticides are yet to become popular in the country. There is a lack of marketing and distribution network for them because the retailers are not interested to deal in these products, as the demand is low. The erratic supplies and the low level of awareness of the cultivators also add to the problem.

Higher margins of profit for chemical fertilizers and pesticides for retailing, heavy advertisement campaigns by the manufacturers and dealers are other major problems affecting the markets for organic inputs in India.

Low Yields

In many cases the farmers experience some loss in yields on discarding synthetic inputs on conversion of their farming method from conventional to organic.

Restoration of full biological activity in terms of growth of beneficial insect populations, nitrogen fixation from legumes, pest suppression and fertility problems will take some time and the reduction in the yield rates is the result in the interregnum. It may also be possible that it will take years to make organic production possible on the farm.

Challenges during adoption of organic farming

- Farmers face
  - Of organic farming, among these, some are the main constraints like high cost of organic inputs, certification need, insufficient marketplace for organic products, and low yield and tiny price, are found to be the main constraints.
  - Besides this, a touch demand for organic products, inconvenience of using organic techniques, higher production risk, and unavailability of consolidated land suitable for organic farming
  - constraints are the most problem followed by infrastructural, technological, and situational within the process of adoption of organic farming.
  - It is more labour-intensive than conventional production.
  - On the one hand, this increased labour cost is one factor that creates organic food costlier. Organic farming has not yet managed to assume the centre-stage of Indian agriculture.
  - These challenges, if left unresolved, can negatively affect the agricultural sector at policy, commercial and infrastructural levels as well as the expansion of organic farming, besides affecting the standard of organic food products
  - More importantly, it is crucial to address these issues to safeguard the financial security of the farming sector

    One of the leading challenges is that the extensive use pesticides and chemicals against insect pests and weed management caused an evolution of the pest and weed species.
  - This is the primary hurdle within the transition from conventional farming to organic farming (Reddy, 2010)

Conclusion

Organic farming gaining popularity after the introduction of modernize technique "revolution era" i.e. high inputs apply at that time cause adverse effect on soil texture, long time persistence in nature, disturb ecological balance and pesticide residue consistently remain in foodstuff which is render the life activity of human and others.

Organic agriculture has been neglected in the agricultural policy, and therefore there is less government assistance for the promotion of organic farming, as it exists for the conventional agriculture in the form of subsidies, agricultural extension services and official research. Given proper encouragement, organic farming will progress tremendously in India.

References

Bhushan, M. Mandal, T. Aditya, and Kumar, K. (2017). Problems and prospects of Organic Farming in samastipur district, Bihar, India. Journal of Crop and Weed, 13(1), 51-54.

Gaur, M. (2016). Organic Farming in India: Status, Issues and Prospects. Sopaan Ii, 1(1), 26-36.

Reddy, S. (2010). Organic Farming: Status, Issues and Prospects: A Review. Agricultural Economics Research Review, 23, 343-358.

Volume: 03 Issue No: 11

PAPAIN: A PAR EXCELLENT ENDOPEPTIDASE

Article ID: AG-VO3-I11-82

Dr. M. Shanmuganathan* and Dr. S. Jeyarani

Agricultural College and Research Institute, Tamil Nadu Agricultural University

Kudumiyanmalai – 622 104, Tamil Nadu

*Corresponding author email ID: shanmuganathan.m@tnau.ac.in

Introduction

Papain is relatively a simple protease enzyme having endopeptidase activity with broad range of functions. It is obtained from the tropical papaya (*Carica papaya*) immature green fruit, leaves, roots and latex sap of plant. The amount and its activity of papain isolated from the different parts of papaya plant vary depending on the age of the tree. Latex of papaya fruits is a source of four important cysteine endopetidase including papain, chymopapain, glycyl endopeptidase and caricain. All papaya proteinases are between 212 and 218 aminoacid and exhibit a strong degree of homology among themselves. X-ray structure analysis has shown that they adopt identical 3D folds. Papain is a minor constituent of the expelled latex but it has been more widely studied because it is more easily purified. The papain is expelled as an inactive precursor and become active enzyme within 2 minutes if the fruit is being injured and the latex ooze out. Greener the immature fruit, more active is the papain. It is used by the plant to protect it from the insects. The name papain was given by Wurtz and Bouchut.

It is a cysteine protease enzyme of peptidase C1 family. It displays a broad range of functions such as endopeptidase, exopeptidase, oxidase and esterase. It digest most of the protein substrate, it exhibits broad specificity and cleaving peptide bonds of basic aminoacids, leucine or glycine, also hydrolyzes esters and amides. It hydrolyzes proteins in acidic, neutral and alkaline environment. It is white to light yellow powder with slightly hygroscopicity. It is soluble in water and glycerol.

The resulting aqueous solution is colourless or pale yellow and sometimes milky white. It is almost insoluble in ethanol, chloroform, ether and other organic solvents. Papain was the extensively studied member of the cysteine proteinase class of enzyme and was the first cysteine proteinase to have its 3D structure. It contains 15.5% nitrogen and 1.2% sulphur.

Structure of Papain

Papain is expressed as an inactive precursor called as prepropapain. The precursor contains 345 aminoacids and consists of a signal sequence (1-18), a propetide (19-133) and the mature peptide (134-345). The formation of active papain requires several cleavage steps including an initial cleavage of the 18 aminoacids pre-regions followed by further cleavage of the glycosylated 114 aminoacids containing pro-region, it serves as an intrinsic inhibitor and folding template. The matured enzyme contains a single polypeptide chain with three disulfide bridges and a sulfhydryl group necessary for activity of the enzyme. Its 3D structure consists of the distinct structural domains with a cleft between them. This cleft contains the active site which consists of catalytic dyad. This catalytic dyad is made up of the aminoacid cysteine – 25 and histidine – 159. The mechanism by which it breaks peptide bonds, involves the use of a catalytic dyad with a deprotonated cysteine. A nearby Asn – 175 helps to orient the imidazole ring of His-159 to allow it to deprotonate the catalytic Cys-25. This cysteine then performs a nucleophilic attack on the carbonyl carbon of a peptide backbone. This forms a covalent acyl enzyme intermediate and releases the amino terminus of the peptide. Then the enzyme is deacylated by a molecule of water and the carboxy terminal portion of the peptide is released. Papain prefers to cleave the protein after an arginine / lysine proceeded by a hydrophobic unit (Ala, Val, Leu, Ile, Phe, Try, Tyr) and not followed by a valine.

Properties of Papain

Papain is a globular structure protein with 212 amino acids. Its properties are as follows;

Molecular weight	:	23.406 Da
Optimal pH for activity	:	6.0 to 7.0
Optimum temperature for activity	:	65°C
Flash point	:	29°C
Storage temperature	:	2 – 8°C
Solubility in water	:	Soluble 10.0 mg/ml

Form	:	Lyophilized powder
Water Solubility	:	Soluble in water, insoluble in most of the organic solvents
Stability	:	Hygroscopic
Isoelectric point	:	8.88
Active site residues	:	Cysteine (C 158) Histidine (H 292) Asparagine (N 308)
Best visualized at	:	278 nm wavelength
Flash point	:	29°C
Storage temperature	:	2 - 8 °C
Activity	:	≥ 10 units/mg protein

Unit Definition: One unit enzyme will hydrolyze 1.0 μmole of N-α-benzoyl-L-arginine ethyl ester per minute at pH 6.2 at 25°C.

Papain solution has good temperature stability but it is highly unstable at acidic condition (i.e) at pH <2.8. Its activity is highly altered by factors like pressure (800 kPa) and temperature (60°C) as they may have impact on the active site due to oxidation of thiolate ions.

Uses of Papain

Papain is commercially available as both powder and liquid forms. It exhibits antifungal, antibacterial, anti-inflammatory and anti-biofilm activities due to its proteolytic and elastolytic properties. It has wide range of commercial application in the leather, cosmetics, textiles, detergent, food and pharmaceutical industries *viz.*,

- It is used to tenderizing meat and clarifying beer for long time
- It is good for breaking down the large peptides present in protein rich foods such as meats, poultry, fish, nuts, eggs and cheese into much smaller building blocks of aminoacid
- Act as a clarifying agent in many food industry
- Used in the fur and hide tanning to ensure uniform dying of leather
- Used for pain and swelling as well as fluid retention following trauma and surgery

- Used in face masks and peeling lotions as a very gentle exfoliant
- Added to some tooth pastes and mint sweets as a tooth whitener
- Can be used to assemble thin films of titanic used in photovoltaic cells
- Used to improve gastrointestinal dysfunction and common digestive issues like bloating and constipation
- Reduce inflammation in patients with asthma, arthritis and other inflammatory condition
- Release pain in muscles due to intense workout, sore throat pain and pain associated with shingles
- Removing bio-films caused by pathogenic bacteria in the food industry
- Production of protein hydrolysates and bioactive peptides
- Tenderize meat and improving its texture
- Used in cell isolation procedure used to isolate single cells
- Used directly in skin to treat insect / animal bite
- Use to treat parasitic worm and skin disease like psoriasis
- Used as a contact lens cleaner

Conclusion

Papain is a relatively simple protease enzyme having endopeptidase activity consist of 212 aminoacids with broad range of functions. It is extracted from the white latex obtained from immature green fruit of papaya plant. It is commercially available in powder and liquid forms.

References:

Amri, E and F. Mamboya. 2012. Papain, a Plant Enzyme of Biological Importance: A Review. American Journal of Biochemistry and Biotechnology, 8(2): 99-104.

Jatin Jain. 2020. Review on isolation and purification of papain enzyme from papaya fruit. International Journal of Engineering Applied Sciences and Technology, 5(6): 193-197.

Volume: 03 Issue No: 11

UNDERUTILIZED VEGETABLE: *Pergularia daemia*- AS A FAMINE FOOD

Article ID: AG-V03-I11-83

N.Rohini*

*Assistant Professor (Horticulture)

Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri, Hosur, Tamil Nadu

*Corresponding Author Email ID: rohizna@gmail.com

Abstract

Underutilized vegetables are underrated in context of their potential to provide economics and food security. They play a major role in maintaining human health. One such medicinal plant is *Pergularia daemia.* Due to high content of minerals, proteins, and vitamins, the underutilized vegetable crops are recognized as a vital component in achieving nutritional security. The majority of underutilized vegetable crops are tolerant to adverse agroclimatic conditions. It is a perennial herb belonging to Asclepiadaceae family which is spread in tropical and sub-tropical regions. The entire parts plant is used to treat Jaundice since ancient times. It has anthelminthic, laxative and anti-pyretic properties. Lack of information on the nutritional and medicinal value of this crop , unavailability of planting material, and a lack of information on production practices are all likely reasons for the delayed development and poor status of this crops. The present appraisal aims to provide detailed survey of literature on the habitat, phytochemical and pharmacological properties of *Pergularia daemia.*

Key words - Medicinal plant, habitat, *Pergularia daemia*, Phytochemical, Pharmacological studies, Traditional uses

Introduction

Ever since ancient times nature has been an important source of medical products and it is estimated that nearly 50,000 species of medicinal plants present in our country. Of these only

60% of plants are officially used by practitioners and 40% of plants are used traditionally. According to World Health Organization, approximately 70- 80% of world's population uses herbal medicine. The medicinal plant sector is a part of time honoured tradition in our country. One such ethanomedicinal plant is *Pergularia daemia* which is used to treat various illnesses. *Pergularia daemia* belonging to Asclepiadaceae family. It is commonly present along the roadsides of tropical and subtropical regions. It is commonly known as "Veliparuthi" in tamil and "Hariknot" in English. In tamil, the term "Veli" denotes "a guardian" or "a protector". It is interesting to note that siddha medicine had named only two medicinal plants which can act as a shield for humans. One is Veliparuthi (*Pergularia daemia*) and the other is Kodiveli (*Plumbago zeylanica*), as they both have multiple valuable properties. The purpose of the present study is to highpoint the prevailing information mainly on the tradinal uses of the plants, phytochemistry and various pharmacological properties of *Pergularia daemia* which is used to evaluate the plant as a medicinal agent.

VERNACULAR NAMES

Table 1. Vernacular names of the plant *Pergularia daemia*

S.No	Languages	Vernacular names
1.	Tamil	Uttamani, Seendhal kodi, Veliparuthi
2.	English	Hariknot plant
3.	Sanskrit	Kurutakah, visamika, kakajangha
4.	Nepali	Bichkani laharo
5.	Odia	Brushagandha, utururdi
6.	Assamese	Ajasrngi
7.	Hindi	Utaran, Sagovam, Aakasan
8.	Rajasthani	Gadaria ki bel
9.	Bengali	Chagalbati, Ajashringi
10.	Gujarathi	Chamardudhi
11.	Marathi	Utarn
12.	Oriya	Utrali, Uturdi
13.	Malayalam	Veliparatti
14.	Telugu	Dustapuchettu, Jittupaku, Gurtichettu
15.	Kannada	Halokoratige, Juttuve, Talavaranaballi
16.	Punjab	Karial, Silai, Trotu

Table 2. Taxonomic classification of *Pergularia daemia*

Kingdom	**Plantae**
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Gentianales
Family	Asclepiadaceae
Tribe	Asclepiadeae
Subtribe	Asclepiadinae
Genus	*Pergularia*
Species	*Daemia*

Description

A slender, hispid, foul-smelling perennial climber. Leaves are opposite membranous, 3-9 cm long and about as wide, broadly ovate, orbicular or deeply chordate, acute or short accuminate at apex, pubescent beneath, petioles 2-9 cm long. Flowers are greenish, Yellow or dull white tinged with purple, borne in axillary, long peduncled, drooping clusters. Fruits (follicles) lanceolate, long pointed, about 5cm long, covered with soft spines and seeds are pubescent, broadly ovate. Flowering may occur each year between August and January in Central India, with fruits maturing from October to February. in Central Indian deciduous forest, the stems typically die down in February and reappear with the onset of the rainy season.

Habitat

A widely distributed in the tropical and subtropical areas in India it is very commonly found in hedges throughout most of century to an altitude about 1000 m in Himalayas and 900 m in Southern India. It is widely distributed in tropical Africa, extending to Arabia.

BOTANICAL DESCRIPTION

Pergularia daemia is a slender, hispid, fetid- smelling perennial herb. The leaves are thin, opposite, membranous, 3-9 cm long, broadly ovate, orbicular or deeply cordate, acute or short-acuminate at apex, pubescent beneath. Flowers are greenish- yellow or dull white tinged with purple, sweet scented born in axillary, long-peduncled, drooping clusters. Fruits are paired with follicles, lanceolate, long-pointed, about 5 cm long, covered with soft spines and release many seeds with long white hairs when they split open. Seeds are densely velvety on both sides.

Flowering may occur each year between August and January in central India, with fruits maturing from October to February. In central Indian deciduous forests, the stems typically die down in February and reappear with the onset of the rainy season. The entire plant constitutes the drug which is used as a medicine.

Phytochemical properties

Terpenoids, flavonoids, sterols and cardenolides are among the chemicals that have been isolated from either the leaves, stems, shoots, roots, seeds or fruit. Traditionally it has been used as an anthelmintic, laxative, antipyretic and expectorant, besides treatment of infantile diarrhoea, malarial intermittent fevers, toothaches and colds. Studies have shown hepatoprotective, antifertility, anti-diabetic, analgesic, antipyretic and anti-inflammatory properties of substances in its aerial parts.

Traditional uses

Potential Role of Under utilized vegetables food security and better nutrition many neglected and underutilized vegetables are nutritionally rich and are adapted to low-input agriculture. The erosion of these species, whether wild, managed or cultivated, can have immediate consequences on the food security and well-being of the poor. Their enhanced use can bring about better nutrition. For example, many underutilized vegetables contain more vitamin C and pro-vitamin A than widely available commercial species and varieties. Focusing attention on neglected and underutilized vegetables is an effective way to help maintain a diverse and healthy diet and to combat micro nutrient deficiencies, the so-called 'hidden hunger', and other dietary deficiencies particularly among the rural poor and the more vulnerable social groups in developing countries. Traditionally it has been used as an elmintic, laxative, anti-pyretic and expectorant, besides treatment of infantile Diarrhea, malarial intermittent fevers, toothaches and colds. Numerous medicinal uses have been reported for all parts of the plant throughout its distribution area. The Crushed leaves, or sometimes the crushed young fruits are applied externally to boils abscesses, subcutaneous worm infections and Eczema. Leafy twig infusions and decoctions are widely used as an appetitive, anthelmintic, expectorant, emetic, emmenagogue and to treat diarrhoea, dysentery, colic rheumatism, painful joints and Limbs, cramps in the legs, Malaria, appendicitis, amenorrhoea.

Leaf of *Pergularia daemia*

Whole plant of *Pergularia daemia*

Flowers and bearing habit of *Pergularia daemia*

Flower brusting character of *Pergularia daemia*

Fruits of *Pergularia daemia*

The latex is applied to sore eyes and aching teeth and to treat rheumatism, asthma, Snake bite and to remove thorns from the skin. In Ghana Crusher leaves with capsicum peppers are given as an enema of a leaf in fusion is giving to facilitate childbirth. Infusion of roots is taken against stomach ache, colic and cough and also as abortifacient. Stem bark has been used to treat malaria. Fresh leaf used as fish poison.

Constraints for the development of underutilized vegetable crops

- Lack of awareness among the farming community about the nutritional and medicinal value of underutilized Vegetable crops.
- Poor recognition of these crops in horticulture promotion programmes.
- Lack of desirable planting material .
- Limited application of advance on-farm agro techniques.
- Lack of about post-harvest management practices.
- Lack of researches
- Lack of application of innovative and novel technologies such as biotechnology, plasticulture for enhancement of productivity.
- Limited and inadequate marketing supports
- Improper institutional arrangements and limited role played by financial Institutions in setting up of agro industrial and horticulture based industrial Units.

Conclusion

Underutilized vegetables embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions . The possible reasons for the low utilization of underutilized vegetables, in spite of their recognized importance are due to lack of availability of planting material, lack of awareness on nutritional and medicinal importance and lack of information on production technique of these crops. Thus, the government and private NGO has to be take some steps towards highlighting the underutilized vegetables.

Volume: 03 Issue No: 11

PESTICIDE FORMULATION: BALANCING EFFICACY AND ENVIRONMENTAL SAFETY

Article ID: AG-VO3-I11-84

***Laxman Singh Saini**

Ph. D Scholar, Department of Entomology

Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan, 303329

*Corresponding Author Email ID: sainilaxman22x@gmail.com

Abstract

Pesticides play a vital role in safeguarding crops from pests, diseases, and weeds in agriculture. However, the responsible use of pesticides necessitates effective management to mitigate potential environmental and health impacts. A crucial aspect of this management is pesticide formulation, where active ingredients are combined with other components to create products that are both efficient in pest control and environmentally safe. This article explores the significance of pesticide formulation, its key components, and its role in striking a balance between effectiveness and environmental safety. Proper formulation enhances stability, ease of handling, uniform application, and safety of pesticides, while also minimizing risks to non-target organisms. Factors such as chemical properties, target pests, environmental conditions, and regulatory compliance influence formulation decisions. Balancing efficacy with environmental safety is paramount, as well-formulated pesticides reduce drift, ensure targeted delivery, lower toxicity, and enhance biodegradability, contributing to sustainable pesticide use.

Keywords: Pesticide formulation, Environmental safety, Pest control, Active ingredients

Introduction

Pesticides have long been essential tools in agriculture to protect crops from pests, diseases, and weeds. Their use, however, comes with the responsibility of managing their potential impacts on the environment and human health. One critical aspect of this management is pesticide formulation, the process of combining active ingredients with other components to create a product that is both effective in pest control and environmentally safe. This article delves into the significance of pesticide formulation, the key components involved, and its role in achieving a balance between efficacy and environmental safety.

The Crucial Role of Pesticide Formulation

Pesticide formulation is a pivotal step in the development and application of pest control products. Its importance lies in several key areas:

1) **Enhanced Stability:** Many active ingredients in pesticides are sensitive to environmental factors such as temperature, humidity, and light. Formulation helps stabilize these active ingredients, preserving their effectiveness during storage and transportation. Without proper formulation, pesticides may degrade or lose their potency, rendering them ineffective.
2) **Improved Handling:** Formulation determines the physical properties of pesticides, including their viscosity, density, and flowability. These properties impact how easily pesticides can be handled, mixed, and applied. Formulations ensure that pesticides can be conveniently mixed with water or other carriers, making them suitable for application through various methods, such as spraying, dusting, or soil application.
3) **Uniform Application:** Formulated pesticides are designed to disperse evenly when applied to crops. This uniformity is essential for ensuring that the active ingredients are distributed consistently across the target area, maximizing their effectiveness in pest control. Proper formulation prevents issues like clogging of spray nozzles and ensures that the pesticide adheres uniformly to plant surfaces.
4) **Safety:** Formulation includes the addition of safety measures, such as colorants or odorants, to make the pesticide easily recognizable and distinguishable from other substances. This helps prevent accidental ingestion or exposure, enhancing overall safety for applicators and handlers.
5) **Enhanced Efficacy:** The choice of formulation components can influence how well a pesticide adheres to plant surfaces, penetrates pests, and withstands adverse weather conditions. A well-formulated pesticide is more likely to deliver its active ingredients effectively to the target pests, improving its pest control efficacy.
6) **Reduced Risk to Non-Target Organisms:** Formulations can be designed to minimize the risk of harming non-target organisms, including beneficial insects, pollinators, and wildlife. This is achieved by controlling the release and persistence of active ingredients, ensuring that they have a minimal impact on non-target species.

7) **Biodegradability:** Some formulation components can enhance the biodegradability of pesticides, reducing their persistence in the environment. This can be particularly important for reducing the long-term ecological impact of pesticide use.

Key Components of Pesticide Formulations

Pesticide formulations consist of various components, each serving a specific purpose:

1) **Active Ingredients:** These are the chemical compounds responsible for controlling pests, diseases, or weeds. Active ingredients can belong to different classes, such as insecticides, herbicides, fungicides, or a combination of these, depending on the target pest.
2) **Solvents:** Solvents are used to dissolve the active ingredients, ensuring their even distribution within the formulation. Common solvents include water, oils, and organic solvents like acetone or xylene.
3) **Emulsifiers and Surfactants:** Emulsifiers help mix oil-based pesticides with water, while surfactants reduce the surface tension of liquids, enabling better coverage of plant surfaces. These components disperse and stabilize the active ingredients.
4) **Adjuvants:** Adjuvants are additives that enhance the effectiveness of the pesticide. They can improve adhesion to plant surfaces, increase penetration into pests, and reduce drift during application.
5) **Inert Ingredients:** Also known as "other ingredients," inert ingredients constitute a significant portion of pesticide formulations. While they do not control pests, they can influence properties like color, odor, and stability. Inert ingredients must undergo rigorous safety testing.

Key factors that influence pesticide formulation:

1) **Chemical Properties of Active Ingredients:** The chemical properties of the active ingredients, including their solubility, polarity, and stability, play a crucial role in determining the type of formulation that can be used. For example, water-soluble active ingredients may be formulated as soluble concentrates, while hydrophobic compounds may require emulsification or encapsulation for effective dispersion.

2) **Target Pest and Application Method:** The type of pest or target organism and the method of pesticide application influence formulation decisions. Different pests may require specific formulations to ensure effective control. Foliar sprays, soil drenches, granules, or seed treatments all demand different formulation approaches to ensure optimal delivery to the target.

3) **Environmental Conditions:** Environmental factors, such as temperature, humidity, and sunlight, can impact the stability of pesticide formulations. Formulators need to consider the likely conditions during storage and application. For instance, in regions with high temperatures, formulations with enhanced stability may be required to prevent degradation.

4) **Safety and Toxicology:** Pesticide formulations must adhere to safety standards and minimize risks to applicators, handlers, and the environment. Formulators add safety measures, such as colorants and odorants, to enhance visibility and reduce accidental exposure. The choice of solvents and co-formulants must also consider potential health and environmental risks.

5) **Release and Persistence:** The release rate and persistence of the active ingredient in the environment are critical considerations. Formulations can be designed to provide controlled release, prolonging the pesticide's effectiveness while minimizing environmental impact. Slow-release formulations, for example, can reduce the frequency of application.

6) **Compatibility with Tank Mixes:** Pesticides are often tank-mixed with other products, such as fertilizers or adjuvants. Formulations need to be compatible with these tank mix partners to avoid chemical interactions that could reduce efficacy or cause instability.

7) **Regulatory Compliance**: Pesticide formulations must meet regulatory requirements set by government agencies. These regulations encompass factors like labeling, toxicity, environmental fate, and residue levels. Meeting these requirements is essential for product registration and market approval.

8) **Ease of Handling and Application:** Formulations must be practical for handling and application by users. This includes considerations of viscosity, flowability, and ease of mixing. User-friendly formulations reduce the risk of application errors and accidents.

9) **Environmental Impact:** Environmental considerations, such as minimizing drift, runoff, and non-target effects, are critical in formulation design. Reducing environmental impact is essential for sustainable pesticide use. Some formulations are engineered to be less toxic to non-target organisms and reduce collateral damage.

10) **Cost-Efficiency:** The cost of production and packaging can influence formulation decisions. Balancing cost-efficiency with efficacy and environmental considerations is essential for market competitiveness.

11) **Desired Release Profile:** The desired release profile of the active ingredient influences formulation choices.

Formulators can design formulations for immediate release, sustained release, or delayed release to align with specific pest control needs.

12) **Residue Tolerance and Pre-harvest Intervals:** For agricultural pesticides, pre-harvest intervals and residue tolerances for crops must be considered. Formulations must allow for the safe use of pesticides while complying with these requirements.

Balancing Efficacy and Environmental Safety

Pesticide formulation plays a pivotal role in minimizing the environmental impact of pesticide use:

1) **Reduced Drift:** Proper formulation controls the size and consistency of pesticide droplets during application, reducing the risk of drift. Drift occurs when pesticide particles are carried away by the wind, potentially affecting non-target areas.

2) **Targeted Delivery:** Some formulations release pesticides gradually, ensuring they remain in the target area and do not leach into the surrounding environment.

3) **Lower Toxicity:** By dispersing active ingredients evenly and minimizing their contact with non-target organisms, pesticide formulations can reduce the overall toxicity of the pesticide.

4) **Enhanced Biodegradability:** Certain formulation components can enhance the biodegradability of pesticides, reducing their persistence in the environment.

Conclusion

Pesticide formulation represents a critical aspect of pesticide management that strikes a balance between pest control efficacy and environmental safety. Through the careful selection of active ingredients, solvents, emulsifiers, surfactants, and adjuvants, pesticide manufacturers can create formulations that maximize pest control effectiveness while minimizing drift and reducing environmental impact. As the agricultural industry grapples with the challenge of feeding a growing global population, responsible pesticide formulation and application are essential components of sustainable and environmentally friendly farming practices.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

UNVEILING THE DEFENSE ARSENAL: EXPLORING THE PATHOGENESIS-RELATED PROTEIN-1 FAMILY IN BANANA

Article ID: AG-V03-I11-85

Prashina Mol P and Anuradha C*

ICAR-National Research Centre for Banana

Thogamalai Road, Thayanur Post, Tiruchirappalli - 620 102. Tamil Nadu, India.

*Corresponding author email address: anuradha.chelliah@gmail.com

Introduction

Plants have developed sophisticated defense mechanisms to combat a range of biotic and abiotic stresses. These stressors trigger various protective responses, including the hypersensitive response (HR), synthesis of antimicrobial compounds, and the production of pathogenesis-related (PR) proteins. PR proteins, encoded by the host plant, are generated in reaction to both biotic and abiotic challenges, serving as a defense against potential damage (Antoniw and Pierpoint, 1978). These proteins play a crucial role in systemic acquired resistance (SAR), offering enduring protection against future pathogenic infections. The discovery and characterization of PR proteins in plants originated from observations in tobacco plants infected with the tobacco mosaic virus (Van Loon et al., 1970). Identified PR proteins encompass chitinases (Legrand et al., 1987), β-1,3-glucanases (Kauffmann et al., 1987), thionins, thaumatin-like proteins, peroxidases, ribosome-inactivating proteins, defensins, nonspecific lipid transfer proteins, oxalate oxidase, and oxalate-oxidase-like proteins, among others (Broekaert et al., 1997; Van Loon et al., 1999).

Different types of PR Proteins

Initially, pathogenesis-related (PR) proteins were classified into five families (PR-1–5) based on criteria such as molecular weight, isoelectric point, localization, and biological activities, as outlined by Bol et al., 1990. Subsequently, the classification expanded to 11 families (PR-1 to 11) in tomato and tobacco. The evolution of this classification system saw the addition of antimicrobial peptides associated with the inducible defense response, leading to the creation of PR-12 (Terras et al., 1992), PR-13 (Epple et al., 1995), and PR-14 (Garcia-Olmedo et al., 1995). Presently, PR proteins are organized into 17 families based on their distinct properties and functions, as detailed in Table 1 (Breen et al., 2017; Vanloon et al., 1999).

Table 1: List of PR protein family and their properties and functions

Family	Type member	Properties
PR-1	Tobacco PR-1a	Antifungal
PR-2	Tobacco PR-2	β-1,3-glucanase
PR-3	Tobacco P, Q	Chitinase type I,II, IV,V,VI,VII
PR-4	Tobacco `R'	chitinase type I, II
PR-5	Tobacco S	thaumatin-like
PR-6	Tomato Inhibitor I	proteinase-inhibitor
PR-7	Tomato P'	endoproteinase
PR-8	Cucumber chitinase	chitinase type III
PR-9	Tobacco `lignin-forming peroxidase	peroxidase
PR-10	Parsley `PR-1'	ribonuclease-like
PR-11	Tobacco class V chitinase	chitinase, type I
PR-12	Radish Rs-AFP3	defensin
PR-13	Arabidopsis THI2.1	thionin
PR-14	Barley LTP4	lipid-transfer protein
PR-15	Barley OxOa (germin)	Oxalate oxidase
PR-16	Barley OxOLP	Oxalate oxidase-like
PR-17	Tobacco PRp27	Unknown

Pathogenesis-related protein 1 family

In 1970, the identification of members belonging to the Pathogenesis-related protein 1 (PR-1) family occurred in *Nicotiana tabacum* infected with tobacco mosaic virus (Vanloon et al., 1970). During pathogen attacks, PR-1 proteins, among the most abundantly synthesized in plants, exhibit antimicrobial properties by sequestering sterols from microbial membranes. Classified as either acidic or basic based on their theoretical isoelectric point, PR-1 proteins belong to the cysteine-rich secretory protein, antigen 5, and pathogenesis-related-1 (CAP) protein superfamily (Gibbs et al., 2008). The CAP domain, approximately 150 amino acids in length, is present in over 2500 species and is involved in sterol and ion binding. Folding into a distinctive α-β-α sandwich structure, the CAP domain is stabilized by conserved disulfide bonds, with magnesium binding crucial for sterol binding. The Caveolin-binding motif (CBM) serves as a putative sterol-binding motif (Choudhary et al., 2014).

Embedded within PR-1 proteins is a stress response peptide known as CAPE1 (CAP-Derived Peptide 1), characterized by a conserved consensus motif PxGNxxxxxPY spanning 11 amino acids. This CAPE1 peptide acts as a defense signaling molecule, contributing to the antimicrobial activities of PR-1. Typically containing N-terminal secretion peptides, PR-1 proteins accumulate in the extracellular/apoplastic space. Their presence in the apoplast plays a role in inhibiting pathogen transmission by thickening the cell wall, suggesting a potential widespread antimicrobial effect (Leah et al., 1991). However, some reports indicate the accumulation of certain PR-1 proteins in the vacuole of protoplast and crystal idioblast (Dixon et al., 1991).

PR-1 proteins secreted into the intercellular space can promptly engage with invading pathogens, not only contributing to pathogen defense but also responding to various abiotic stresses (Hon et al., 1995; Snider et al., 2000; Zeier et al., 2004; Kothari et al., 2016; Akbudak et al., 2020). Moreover, PR-1 proteins have been implicated in influencing plant growth, flowering, and seed development (Lotan et al., 1989; Memelink et al., 1990).

Mechanism of action of PR-1 Proteins

Sterol sequestration mediated action of PR-1

Gamir et al. (2016) proposed that the antimicrobial effects of PR-1 hinge on the sequestration of sterols. PR-1 proteins actively sequester sterols from microbial membranes, and two hypotheses have been suggested to explain how PR-1 interferes with sterol function in microbes. The first hypothesis suggests that PR-1 proteins bind with sterols in the surrounding environment, disrupting their uptake by the pathogens. Alternatively, the second hypothesis proposes that PR-1 proteins, in a more direct approach, extract sterols from the pathogens, potentially necessitating the traversal of the cell wall to access sterols in the microbial plasma membrane. In this latter scenario, PR-1 proteins would need to breach the cell wall to reach the microbial plasma membrane and acquire sterols. This mechanism aligns with plant defense strategies that target pathogen sterols, employing the production of anti-mycotic polyene antibiotics. These antibiotics bind to ergosterols present in fungal membranes, inducing cellular leakage and contributing to the plant's defense against microbial threats.

SA mediated activation of PR-1 protein

Elevated levels of salicylic acid (SA) play a pivotal role in altering cellular redox potential, causing the reduction of the non-expressor of pathogen-related gene 1 (NPR-1) oligomer into its active monomeric form. This monomeric NPR-1 subsequently translocates into the nucleus, where it serves as a transcriptional co-activator for SA-responsive genes, including PR-1. When confronted with a pathogenic challenge, the activation of the defense signaling pathway, primarily mediated by SA, occurs. This activation triggers the accumulation of PR proteins, ultimately reducing pathogen load and mitigating the onset of disease in uninfected plant organs.

Typically, there are two categories of pathogens: biotrophic and necrotrophic. Biotrophic pathogens activate the SA pathway, promoting the transcription of NPR-1. This, in turn, leads to the activation and accumulation of SA signature gene products, such as PR-1, PR-2, and PR-5, both locally and systemically. This process contributes to the establishment of SAR (Ali et al., 2017) (**Figure 1**).

PR-1 proteins in Banana

Banana, a crucial global food crop, confronts a range of biotic challenges including Fusarium wilt, leaf spot, bacterial wilt, bunchy top viral disease, weevils, and nematodes. Additionally, it grapples with abiotic challenges such as salinity and drought (Nansamba et al., 2020). Addressing these stresses and developing resilient banana varieties necessitates understanding resistance mechanisms and employing innovative transgenic methods. Further, plants have evolved intrinsic defense mechanisms to counteract diverse stresses. One outcome of the initial recognition and subsequent signaling cascades is the activation of PR-1 proteins' expression (Kattupalli et al., 2017).

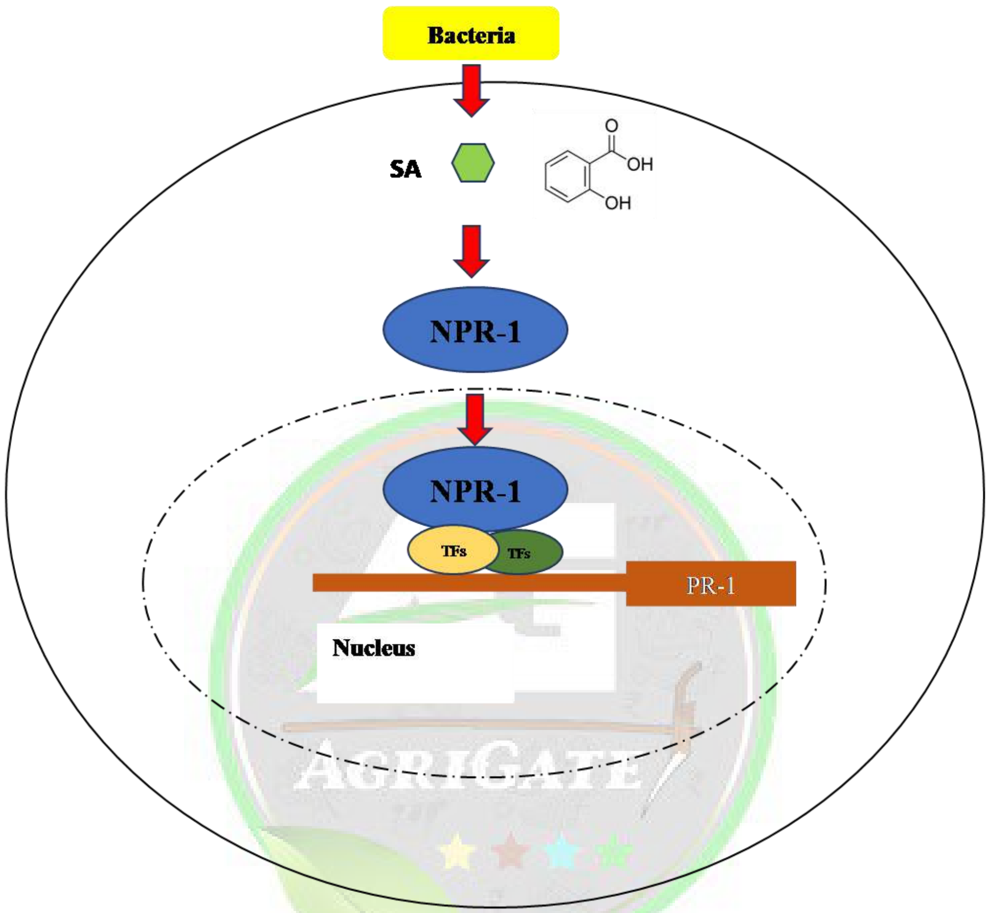


Figure 1: SA mediated mechanism action of PR-1 proteins in plants

A total of 15 and 11 PR-1 proteins, characterized by conserved domains and motifs, were identified from the A and B genomes of bananas, respectively (Anuradha et al., 2022). PR-1 proteins, known for their thermostability and resistance to proteases (Van Loon et al., 1994), are low-molecular-weight proteins. Among the A genome PR-1 proteins, five were acidic (pI 4.09-6.09), while the remaining 10 were basic with a pI ranging from 7.24 to 9.83. In the B genome, four proteins were acidic (pI 4.09-4.89), and seven were basic with a pI between 7.46 and 9.84 (**Tabe.2**). Phylogenetic analysis revealed that banana PR-1 genes cluster more closely with rice PR-1 genes than with Arabidopsis, aligning with the monocotyledonous nature of both bananas and rice.

Table 2. PR1 proteins in A and B genomes of banana.

No.	Gene_ID	CDS Length	Protein Length	Molecular weight	pI	Signal Pep
PR1 proteins in A genome of banana						
1	Ma02_g15050.1	489	163	17769.00	5.1	24
2	Ma02_g15060.1	489	163	17250.00	4.09	24
3	Ma02_g15080.1	489	163	17335.00	4.3	24
4	Ma03_g04850.1	561	187	20994.00	7.31	20
5	Ma03_g17050.1	504	168	18798.00	7.4	23
6	Ma04_g02330.1	549	183	20172	8.04	22
7	Ma04_g24640.1	630	210	22963.00	6.06	19
8	Ma04_g29630.1	492	164	17519.00	8.38	25
9	Ma04_g29640.1	492	164	17461	8.27	25
10	Ma04_g34800.1	723	241	26112	7.2	NO
11	Ma05_g24210.1	507	169	18426.00	9.83	22
12	Ma08_g04730.1	540	180	19430	8.73	27
13	Ma08_g27280.1	570	190	20145.00	8.2	27
14	Ma08_g28120.1	642	214	23543	6.5	20
15	Ma10_g06320.1	540	180	19701	8.5	24
PR1 proteins in B genome of banana						
1	Mba02_g14110.v1.1	489	163	17671.00	4.66	24
2	Mba02_g14120.v1.1	489	163	17333	4.09	24
3	Mba02_g14140.v1.1	489	163	17234	4.26	24
4	Mba03_g17210.v1.1	504	168	18895.00	7.82	23
5	Mba04_g02230.v1.1	318	106	10996.00	8.23	23
6	Mba04_g30300.v1.1	492	164	17399.00	8.38	25
7	Mba04_g30310.v1.1	492	164	17431.00	8.46	25
8	Mba04_g35260.v1.1	576	192	20788.00	4.89	25
9	Mba05_g23810.v1.1	507	169	18454.00	9.84	25
10	Mba08_g26880.v1.1	567	189	20070.00	8.56	28
11	Mba08_g27690.v1.1	642	214	23491.00	7.46	20

The exon-intron organization of PR-1 genes in bananas displayed uniformity, indicating limited variation, which is typical for functional genes (Lescot et al., 2008; Wang et al., 2019). The expansion of the PR-1 gene family in banana was attributed to segmental duplication followed by tandem events, serving as a crucial force driving the emergence of new biological functions and the survival of bananas. The high degree of synteny between banana and rice, as well as the A and B genomes of banana, underscores the impact of genome-scale duplication events and subsequent cycles of genome duplication and diploidization in the evolutionary history of *Musa* (Lescot et al., 2008). This synteny relationship suggests the preservation of gene order, emphasizing the interconnectedness of these genomes in their evolutionary trajectory (Davey et al., 2013).

An expression analysis conducted through qRT-PCR on selected PR-1 genes in bananas, as reported by Anuradha et al. (2022), unveiled their involvement in combating Fusarium wilt, Sigatoka leaf spot, and nematode infections. This emphasizes the pivotal role of PR-1 in the defense mechanisms against these detrimental diseases in banana plants. In a separate investigation, a comparative genomic analysis was carried out on certain PR gene family proteins, including PR-1, in two distinct banana varieties: *Musa acuminata* cv. Pahang (AA group) and *Musa balbisiana* cv. Klutuk Wulung (BB group), each possessing different genomes (A and B genomes). This study aimed to identify potential markers for the development of resistant bananas against blood disease (Anindita et al., 2020). Additionally, Kesari et al. (2010) reported the identification of the first fruit-specific PR-1 protein in bananas. This protein plays a role in the ripening and softening of the fruit. The PR-1 protein identified in this context exhibited a significant degree of similarity with PR-1 proteins found in various other plant species. This underscores the conservation of certain features among PR-1 proteins across different plants and highlights their diverse roles in various aspects of plant biology, including defense and fruit ripening.

Conclusion

In conclusion, PR-1 family members emerge as highly produced proteins in response to plant-pathogen interactions. Two proposed mechanisms underlie the mode of action for PR-1 is sterol sequestration and salicylic acid mediation. This versatile functionality positions PR-1 as a promising candidate for the development of banana varieties that can withstand multiple stresses. Leveraging the insights into PR-1's dual mechanisms can pave the way for creating resilient banana cultivars capable of tackling various biotic and abiotic challenges.

References

Akbudak, M. A., Yildiz, S., & Filiz, E. (2020). Pathogenesis related protein-1 (PR-1) genes in tomato (*Solanum lycopersicum* L.): Bioinformatics analyses and expression profiles in response to drought stress. Genomics, 112(6), 4089-4099.

Ali, S., Mir, Z. A., Tyagi, A., Bhat, J. A., Chandrashekar, N., Papolu, P. K., & Grover, A. (2017). Identification and comparative analysis of *Brassica juncea* pathogenesis-related genes in response to hormonal, biotic and abiotic stresses. Acta physiologiae plantarum, 39, 1-15.

Anindita, K. S., Septiani, P., &Dwivany, F. M. Comparative Genomics Analysis of the Pathogenesis-related (PR) Genes on Two Banana Genomes (A and B Genomes) in Response to Banana Blood Disease Infection.

Antoniw, J. F., & Pierpoint, W. S. (1978). Purification of a tobacco leaf protein associated with resistance to virus infection.

Anuradha, C., Chandrasekar, A., Backiyarani, S., Thangavelu, R., Giribabu, P., & Uma, S. (2022). Genome-wide analysis of pathogenesis-related protein 1 (PR-1) gene family from *Musa spp*. and its role in defense response during stresses. Gene, 821, 146334.

Bol, J. F., Linthorst, H. J. M., & Cornelissen, B. J. C. (1990). Plant pathogenesis-related proteins induced by virus infection. Annual review of phytopathology, 28(1), 113-138.

Breen, S., Williams, S. J., Outram, M., Kobe, B., & Solomon, P. S. (2017). Emerging insights into the functions of pathogenesis-related protein 1. Trends in plant science, 22(10), 871-879.

Broekaert, W. F., Cammue, B. P., De Bolle, M. F., Thevissen, K., De Samblanx, G. W., Osborn, R. W., & Nielson, K. (1997). Antimicrobial peptides from plants. Critical reviews in plant sciences, 16(3), 297-323.

Choudhary, V., Darwiche, R., Gfeller, D., Zoete, V., Michielin, O., & Schneiter, R. (2014). The caveolin-binding motif of the pathogen-related yeast protein Pry1, a member of the CAP protein superfamily, is required for in vivo export of cholesteryl acetate. Journal of lipid research, 55(5), 883-894.

Davey, M. W., Gudimella, R., Harikrishna, J. A., Sin, L. W., Khalid, N., &Keulemans, J. (2013). A draft *Musa balbisiana* genome sequence for molecular genetics in polyploid, inter-and intra-specific Musa hybrids. BMC genomics, 14, 1-20.

Dixon, D. C., Cutt, J. R., & Klessig, D. F. (1991). Differential targeting of the tobacco PR-1 pathogenesis-related proteins to the extracellular space and vacuoles of crystal idioblasts. The EMBO Journal, 10(6), 1317-1324.

Epple, P., Apel, K., & Bohlmann, H. (1995). An Arabidopsis thaliana thionin gene is inducible via a signal transduction pathway different from that for pathogenesis-related proteins. Plant Physiology, 109(3), 813-820.

Gamir, J., Darwiche, R., Van't Hof, P., Choudhary, V., Stumpe, M., Schneiter, R., & Mauch, F. (2017). The sterol-binding activity of Pathogenesis-Related Protein 1 reveals the mode of action of an antimicrobial protein. The Plant Journal, 89(3), 502-509.

García-Olmedo, F., Molina, A., Segura, A., & Moreno, M. (1995). The defensive role of nonspecific lipid-transfer proteins in plants. Trends in microbiology, 3(2), 72-74.

Gibbs, G. M., Roelants, K., &O'bryan, M. K. (2008). The CAP superfamily: cysteine-rich secretory proteins, antigen 5, and pathogenesis-related 1 proteins roles in reproduction, cancer, and immune defense. Endocrine reviews, 29(7), 865-897.

Hon, W.C. et al. (1995) Antifreeze proteins in winter rye are similar to pathogenesis-related proteins. Plant Physiol. 109, 879–889

Kauffmann, S., Legrand, M., Geoffroy, P., &Fritig, B. (1987). Biological function of 'pathogenesis-related'proteins: four PR proteins of tobacco have 1, 3-β-glucanase activity. The EMBO journal, 6(11), 3209-3212.

Kesari, R., Trivedi, P. K., & Nath, P. (2010). Gene expression of pathogenesis-related protein during banana ripening and after treatment with 1-MCP. Postharvest Biology and Technology, 56(1), 64-70.

Kothari, K.S. et al. (2016) Rice stress associated protein 1 (OsSAP1) interacts with aminotransferase (OsAMTR1) and pathogenesis-related 1a protein (OsSCP) and regulates abiotic stress responses. Front. Plant Sci. 7, 1057

Leah, R. et al. (1991) Biochemical and molecular characterization of three barley seed proteins with antifungal properties. J. Biol. Chem. 266, 1564–1573

Legrand, M., Kauffmann, S., Geoffroy, P., &Fritig, B. (1987). Biological function of pathogenesis-related proteins: four tobacco pathogenesis-related proteins are chitinases. Proceedings of the National Academy of Sciences, 84(19), 6750-6754.

Lescot, M., Piffanelli, P., Ciampi, A. Y., Ruiz, M., Blanc, G., Leebens-Mack, J., & Town, C. D. (2008). Insights into the Musa genome: syntenic relationships to rice and between Musa species. BMC genomics, 9(1), 1-20.

Lotan, T. et al. (1989) Pathogenesis-related proteins are developmentally regulated in tobacco flowers. Plant Cell 1, 881–887

Memelink, J. et al. (1990) Tobacco genes encoding acidic and basic isoforms of pathogenesis-related proteins display different expression patterns. Plant Mol. Biol. 14, 119–126

Nansamba, M., Sibiya, J., Tumuhimbise, R., Karamura, D., Kubiriba, J., &Karamura, E. (2020). Breeding banana (*Musa spp*.) for drought tolerance: A review. Plant Breeding, 139(4), 685-696.

Snider, C.S. et al. (2000) Role of ice nucleation and antifreeze activities in pathogenesis and growth of snow molds. Phytopathology 90, 354–361

Terras, F. R., Schoofs, H. M., De Bolle, M. F., Van Leuven, F., Rees, S. B., Vanderleyden, J., &Broekaert, W. F. (1992). Analysis of two novel classes of plant antifungal proteins from radish (*Raphanus sativus* L.) seeds. Journal of biological chemistry, 267(22), 15301-15309.

Van Loon, L. C., & Van Kammen, A. (1970). Polyacrylamide disc electrophoresis of the soluble leaf proteins from *Nicotiana tabacum*var.'*Samsun*'and '*Samsun* NN': II. Changes in protein constitution after infection with tobacco mosaic virus. Virology, 40(2), 199-211.

Van Loon, L. C., & Van Strien, E. A. (1999). The families of pathogenesis-related proteins, their activities, and comparative analysis of PR-1 type proteins. Physiological and molecular plant pathology, 55(2), 85-97.

Van Loon, L. C., Pierpoint, W. S., Boller, T. H., &Conejero, V. (1994). Recommendations for naming plant pathogenesis-related proteins. Plant Molecular Biology Reporter, 12, 245-264.

Wang, Z., Miao, H., Liu, J., Xu, B., Yao, X., Xu, C., Zhao, S., Fang, X., Jia, C., Wang, J., Zhang, J., 2019. *Musa balbisiana* genome reveals subgenome evolution and functional divergence. Nat. Plants 5 (8), 810–821.

Zeier, J. et al. (2004) Light conditions influence specific defence responses in incompatible plant–pathogen interactions: uncoupling systemic resistance from salicylic acid and PR-1 accumulation. Planta 219, 673–683.

Volume: 03 Issue No: 11

PHYSIOLOGICAL DISORDER AND THEIR MANAGEMENT IN FLOWER CROPS

Article ID: AG-V03-I11-86

***C. Ravindran and M. Kavitha**

Associate Professor and Head, Horticultural Research Station, TNAU, Kodaikanal, Dindigul, Tamil Nadu, India

Assistant Professor (Bio-chemistry), RVS Padmavathy College of Horticulture, Semppatti, Dindigul, Tamil Nadu

*Corresponding Author Email ID: ravi.vini@gmail.com

ROSE

1. Bent neck

Insufficient flower stem hardening or insufficient maturation of the stem tissues below the harvested flower results in stem collapse. The reasons are appearance of plugging materials like pectin, cellulose and microbes, extreme temperatures during shipping or storage and water deficiency in the neck tissues. Premature harvesting and excessive water loss also cause bent neck.

2. Bull head or malformed flowers

The central petals of the bud are only partly developed and the bud appears flat. The causes are lack of carbohydrates for petal development, thrips infestation and low temperature during shipping or storage

3. Blind wood

Flowers have sepals and petals, but the reproductive parts are absent or aborted. Blind wood is generally short and thin. But it may attain considerable length and thickness when it develops at the top of the plant. The causes are low temperature and insufficient light during growth and development, insect pests and fungal diseases.

4. Blackening of petals

The major cause is low temperature (20^0C at day and 4^0 C at night).

5. Flower bud abortion

No flower bud initiation occurs or if at all it starts, it does not proceed beyond the initiation of pistils and stamen primordials. The causes are competition among growing shoots for assimilates, deficiency of Boron, night temperatures below 15^0C and day temperatures above 28^0C. Control measures include application of CCC @ 500 ppm and GA @ 100 ppm or application of Boron @ 30 to 60 ppm.

CHRYSANTHEMUM

Leaf yellowing

Chrysanthemum flowers are not affected by ethylene, nor do they produce it. However, exposure to ethylene may accelerate leaf yellowing.

2. Freezing injury

Freezing will occur at temperatures below -1^0C. Symptoms include water soaking and collapse of leaves and petals.

3. Floral abnormalities

The common flower abnormality in chrysanthemums is the crown bud, wherein the bud development is severely retarded and the involucral bracts become glossy and enlarged. The plants which are grown in long days after receiving a few short days produce crown buds. Low night temperature ($<15^0$C) during flower development causes pink colouration on white petals. Quilling of florets occurs at low light intensity during flower development and at lower night temperatures. Delayed or no floral induction in chrysanthemum is observed with too long photoperiods and low night temperatures and also due to copper and manganese deficiency. This can be controlled by the application of Manganese sulphate (3 g/l) and Copper sulphate (1 g/l) applied at vegetative, bud initiation and flowering stages.

Many of the abnormalities commonly occur when the period of floret formation coincides with unfavourable conditions. In long days and high temperature, bracts may appear on the receptacle. Sometimes transfer of plants to long days at the period of floret formation encourages the production of more ray florets and so enhances doubleness, while short days enhance singleness. Bleaching of petals may occur due to too high temperature during floral development.

4. Quilling of florets

Petals get twisted and become cup shaped. The peripheral florets lose turgidity. This is due to boron deficiency and low night temperature (<15^0C) and can be controlled by applying Borax @ 3g/l during the vegetative, bud initiation and flowering stages.

5. Bleaching of petals

Day temperature above 40^0C and night temperature below 15^0C causes bleaching of petals.

CARNATION

Calyx splitting

Calyx splitting is an important disorder in carnation, which has been associated with many factors like genetic, environmental, nutritional and other cultural practices. The cultivars with short and broad calyx are more susceptible than the ones with long and narrow calyx. Irregular or fluctuating temperature during flowering also induces calyx splitting. Low temperature below 10°C leads to the development of an extra whorl of petals inside the calyx. The calyx unable to hold these extra growing petals, splits up. Nutritional make up of plants also influences calyx splitting. Low nitrogen, high ammoniacal nitrogen or low boron levels enhance calyx splitting. Closer spacing has also been reported to encourage calyx splitting.

Selection of cultivars that are less prone to calyx splitting, regulation of day (20-25°C) and night (12.5-15.5°C) temperatures and maintenance of optimal levels of nitrogen (25-40 ppm) and boron (20-25 ppm) in the growing medium can minimize this disorder. Spraying of borax @ 0.1% at fortnightly intervals will reduce the disorder. Calyx splitting can be reduced by placing a rubber band around the calyx of the flower which has started opening. Foliar application of 0.1 % borax can control calyx splitting. Some varieties such as Espana, Cabaret, Red Corso, Pamir and Raggio-di-Sole are less prone to calyx splitting.

Sleepiness

Sleepiness causes huge post harvest losses in cut carnation. It occurs due to exposure of flowers to ethylene or water stress. Also, the incidence of sleepiness has been found to be higher when the flowers are stored for a longer period or when they are exposed to high temperature. Spraying of STS 0.4 mM before harvesting the flowers can correct this disorder.

Grassiness

Grassiness refers to failure of plants to produce flowers. This is a genetic disorder which varies from variety to variety. Removal and destruction of affected plants is the only way of correcting this disorder.

Slabside

This disorder refers to uneven opening of flower buds resulting in the petals protruding on one side only, giving an asymmetrical and lopsided shape to the flower. It is common during cooler periods. This can be overcome by gradually increasing the temperature to optimum level.

Calyx tip die back

Potassium deficiency and water stress cause tip die back. The disorder commences with browning of the calyx tip and it progresses downwards damaging a major part of the calyx. This disorder is often followed by occurrence of secondary fungal infection which makes the flower unmarketable. Spraying of potassium chloride @ 5g/l two times at 10 days intervals and providing adequate water @ 4.5 l/m^2 can minimize this disorder.

Internode splitting

Splitting of internodes affects the quality of cut flowers. Splitting is due to boron deficiency. Application of borax @ 2g/ m^2 will correct internode splitting

GERBERA

Flower bending

It is caused by **l**oss of cell turgidity and also by calcium deficiency. It can be controlled by application of Calcium Nitrate @ 0.2%.

Double-faced flower

It is caused by imbalance of nutrients and excessive vegetative growth while the flower buds are very small. Maintaining nutrient balance helps to control this problem.

Non-uniform flower blooming

It is caused by physical injury to flower stem, pest damage and phytotoxicity. Avoiding application of excess fertilizers can minimize this problem.

Short stems

It is caused by high salinity level, moisture stress and low soil temperature. It is controlled by maintaining moisture status in the soil.

ANTHURIUM

Colour breakdown of spathe

This can be recognized by colour breaks, which may or may not be accompanied by distortion of the spathe. Calcium deficiency is one of the major causes for this disorder. It can be controlled by application of Calcium nitrate @ 25 g/m^2 or lime @ 5 g/plant/month

2. Sticking

Flowers do not open properly and the spathe is stuck. This disorder is variety dependent. Low relative humidity is the cause. During the early stage, the flowers are loosened by hand.

3. **Jamming**

Flowers get jammed in the sheath since the leaf is wound too tightly around the flower. Cracks develop on the underside of the spathe. It is variety dependent and occurs during arid conditions. It also occurs more frequently in cultivars with long sheaths. Humidifying the top layer of the substrate is recommended to provide a favourable micro- climate.

4. Folded ears

The suspected cause is an environmental-physiological interaction. Temperature below 15^0C causes this disorder.

5. Sun burn

Overall fading of the spathe colour or browning of the spadix occurs which is caused by direct sunlight. This can be avoided by efficient management of light.

6. Crooked stem

The suspected cause is an environmental-physiological interaction involving excessive nitrogen feeding and fluctuating wet and dry conditions. Heavy shade levels and lack of pruning may also contribute to crooked stems.

7. Deformed spathes

The suspected cause is an environmental-physiological interaction. The spathe may be wrinkled or curled. Deformed spathes can be caused physiologically by physical and chemical damage early in the development of flowers.

8. Bleached flowers

Impaired colour development occurs in the lobe area of the spathe and in severe cases the entire flower including the spadix may show the signs of insufficient colour development, stunting, distortion and necrosis. The suspected cause of bleaching is an environmental-physiological interaction. It can be controlled by preventing excessive application of ammonium nitrogen, excessive salt build up and temperature fluctuations.

9. Vog spotting

Purple spots that later turn whitish appear randomly on the flower spathe resulting from sulphur dioxide gas emitted during volcanic eruptions and taken in through stomata, causing a localized internal burn.

10. Phytotoxicity

Incorrect fertilizer, sticker or pesticide application rates or methods can cause necrotic or distorted areas on the spathe

ORCHID

1. **Sun burn**

Excessive light of above 2400 to 3600 foot candles causes sunburn. It can be controlled by effective shade management.

2. **Wilting of floral parts**

Rapid temperature changes and high temperature combined with dry air causes wilting of floral [parts. Good ventilation can alleviate this problem

3. **Water stress**

Water stress causes wilting of *Cymbidium* and *Phalaenopsis*. Low rate of transpiration associated with low uptake of water are major factors involved in such problems.

GLADIOLUS

1. Geotropic bending of spikes

The tips of gladiolus spikes show tendency to bend against gravity if placed horizontally for longer periods. The season is accumulation of IAA on the lower portion of spike which causes asymmetrical elongation of cells. Harvested spikes should always be placed vertically and not horizontally.

2. Tip burn

Discolouration and drying up of leaf tips occurs. High levels of aerial fluorides in the atmosphere is a major cause. Spray of Blitox 50 WP(0.3%) at the initiation of the symptom can control the disorder.

3. Blindness

It results in complete absence of spikes. Zinc deficiency is one of the major causes and it can be corrected by application of Zinc @ 20-100 ppm.

4. Topple

The collapse of a small portion of the internode just beneath the flower occurs and it is called 'sugar stem' or 'wet stem'. It occurs due to Calcium deficiency and it can be connected by application of Calcium nitrate

Volume: 03 Issue No: 11

PLANT SYSTEM BIOLOGY – INSIGHTS AND ADVANCEMENTS

Article ID: AG-V03-I11-87

Sri Subalakhshmi V. K. I.[1]*

[1]Assistant Professor, Genetics and Plant Breeding, J.K.K. Munirajah College of Agricultural Science, T.N. Palayam, Erode Dt. – 638 506

*Corresponding Author Email ID: srisubalakhshmii@jkkmcas.org

Introduction

Systems biology is an analytical technique that considers a system of interacting units as a whole, instead of breaking it down into its component parts. The transition of research from a data collection project to an explanatory project has been made possible by systems biology. The concept of incorporation of systems theory into biological sciences was first proposed in 1940s by the biologist Ludwig von Bertalanffy (1973) which was further developed in the 1950s by Ashby (1956).

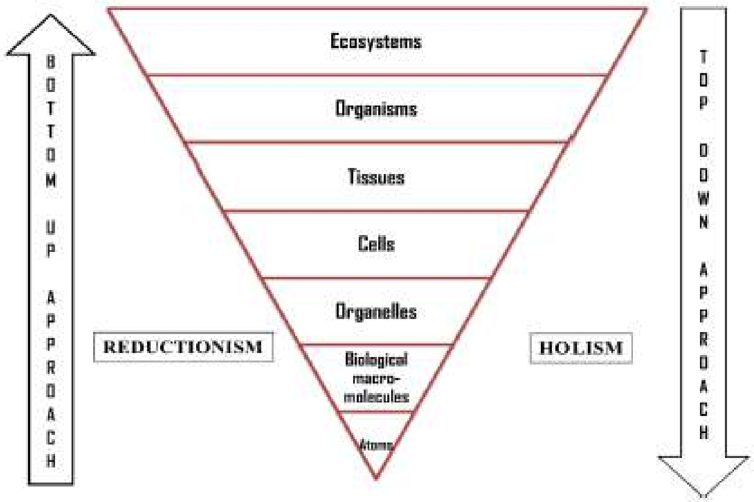
Characteristics

- ✓ System have hierarchical structure
- ✓ The structure is held together by numerous linkages to construct complex networks

Three types

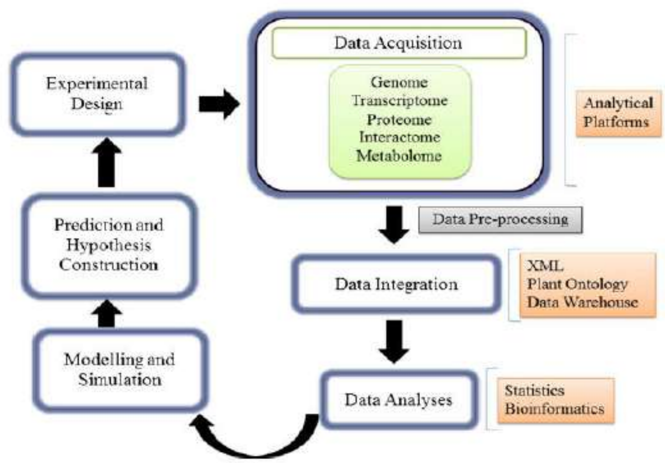
- ✓ Top down
- ✓ Bottom up
- ✓ Middle-out

Using high-throughput omics technology to obtain a comprehensive understanding of biological systems is known as top down. In contrast to middle-out, which is predicated on the idea of starting somewhere in between the top and bottom levels and working out towards a hierarchy of models, bottom-up begins with molecular properties and results in the derivation of models to be tested and validated. Of these, the biological systems have been described most frequently using the top-down and bottom-up approaches.



Plant System Biology

The study of interactions between biological components utilising models and/or networks to integrate genes, metabolites, proteins, regulatory elements, and other biological components is known as plant systems biology.



Genomics

The 'genome' comprises of the complete genetic material of the organism. Genomics means the study of the organism's whole genome. The study of an organism's entire genome is known as genomics. Plant genomics began with the single gene sequencing era and progressed to whole genome sequencing, medium density arrays, single nucleotide polymorphisms (SNPs), and finally whole genome resequencing. Therefore, it serves as a requirement for comprehending how genes function in an organism's development and propels the transition from the genomics to the systems biology approach in order to obtain a comprehensive understanding.

Genome-wide association studies (GWAS)

An organism's phenotype is the result of its interaction between its individual genes and the environment; many phenotypes are quantitative in nature, and their aetiology is complex, involving multiple environmental and genetic factors. For example, plant yield, flowering time, sugar content, and fruit weight are examples of quantitative traits that result from the segregation of multiple genes and are influenced by environmental interactions. Phenotypic variation is typically attributed to genetic variation corresponding to the nucleotide sequences during evolution. Candidate gene and genome-wide analyses are essential for mapping the genotype-phenotype relationship.

Epigenomics

The traditional mendelian theory of inheritance of acquired traits was unable to explain a wide range of biological events, including paramutation, parental imprinting, control of transposon activity, and transgenic silence, prior to their chemical makeup was discovered.These occurrences seemed to follow the non-mendelian method of inheritance and surpassed the Mendelian rules. An entirely new area of epigenetics has emerged as a result of the intense search for appropriate explanations and processes behind these apparent deviations from Mendelian theory. The study of heritable variations in gene expression and function that cannot be accounted for by variations in DNA sequence is known as epigenetics. Various epigenetic regulators throughout the entire genome are described under the term "epigenome."

Transcriptomics

All genomic equivalents that are expressed as RNA transcripts, including coding (mRNA) and non-coding (tRNA, miRNA) RNAs at a specific time in a cell or population of cells under a specific set of environmental conditions, are collectively referred to as the transcriptome. Modern techniques for deciphering the transcriptome involve the use of NGS technologies and microarray analysis, in contrast to the conventional transcriptional analyses that involved northern blots. Since it has been in use for so long, microarray technology has grown to help us understand gene regulation networks and how they behave in different environments.

Proteomics

Proteome, termed by Wilkins in 1996 is the entire protein complement of the system, expressed at a given time and under-defined environmental conditions. Proteomics is the systematic study of the proteome. Because there are so many different post-translational modifications, the proteome is far more complicated than the transcriptome and is therefore far more dynamic. Proteomics primarily examines protein structure, function, and post-translational modifications, which primarily involve phosphorylation and ubiquitination. It also analyses variations in protein expression.

Metabolomics

The term metabolome includes the entire set of small molecule metabolites, produced by any organism. The thorough examination of every metabolite in an organism under specific conditions is known as metabolomics. Compared to genes and proteins, the collection of metabolites in an organism exhibits greater variability in terms of their physical and chemical characteristics, differing greatly in terms of size, polarity, quantity, and stability. As a result, metabolic profiles are considered the cornerstone of systems biology research since they provide a biochemical phenotypic evaluation of the plants.

Interactomics

A cell's or any system's ability to function depends on the dynamic and balanced interactions between its macromolecular components, which include proteins, lipids, DNA, RNA, and other tiny molecules with various biochemical features. The most often observed interactions among these are interactions between proteins, followed by interactions between DNA/RNA and proteins in plants. Histone proteins that are bound to DNA to generate the chromatin structure are one example of DNA-protein interactions. These proteins are previously mentioned and play a role in the epigenetic regulation of numerous physiological processes. Consequently, the understanding of cellular systems depends on interactomics, the thorough examination of interactions between many macromolecules, primarily protein–protein interactions in an organism.

Other omics approaches

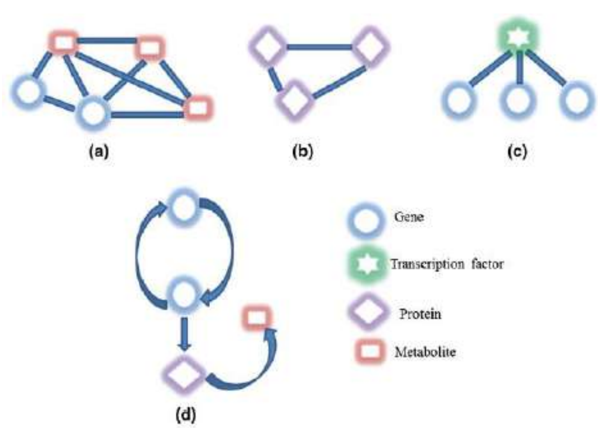
Recent methods include hormonomics, which studies all a plants endogenous hormone, and lipidomics, which is a thorough study of the lipid entities of the organism. Plant hormones with low molecular weights include salicylic acid, ABA, cytokinin, gibberellins, ethylene, brassinosteroids, jasmonates, and a recently discovered strigolactone that inhibits shoot branching. Other plant hormones include lectinomics, which is the study of carbohydrate-binding proteins called lectins through bioinformatics. Additionally, phenomics—the high-throughput systemic study of phenotypes is a novel idea that has generated a lot of interest in modern times. Its potential applications in plant biotechnology will probably the most significant.

Integration of multiple omics data

With the aid of the several omics technologies covered in the preceding section, high-throughput analytics advancements have allowed us to understand more about individual proteins. To accurately represent the complex structure and behaviour of biological systems, a solitary omics approach would not be sufficient. Therefore, by integrating the various omics datasets, molecular research is gradually moving towards the holistic perspectives of systems biology to obtain a biologically relevant understanding of plant systems. Consequently, a precise picture of the entire plant system can be obtained by integrating several biological information levels. The numerous omics datasets need to be pre-processed before they can be integrated. Building complete models of plant systems through data integration is essential to the effective development of the systems concept. Good statistical analysis, suitable experimental design, and accurate result interpretation are necessary for the successful integration of data.

Modeling and simulation in plant dynamics

In systems biology, cells or higher units of biological organization are understood as systems of inter acting elements. Modeling and simulation are central to bridge the gaps between theory and experiment.



a). Gene-to metabolite network; b). protein-protein interaction network; c). transcriptional regulatory network; and d). gene regulatory network

Modeling usually starts with construction of biological networks from the available molecular datasets. Network construction and analysis are the crucial components of systems biology. The elements of the system are represented as graph nodes (also called vertices) and the interactions are represented as edges, that is, lines connecting pairs of nodes.

In biological networks, nodes (or vertices) represent the molecules present inside a cell (e.g., proteins, RNAs and/or metabolites) and links (or edges) between nodes represent their biological relationships (e.g., physical interaction, regulatory connections, metabolic reactions). Signs representing activation or inhibition can be shown on edges to augment the information content of the network.

Softwares and algorithms for plant systems biology

The use of bioinformatics softwares is inevitable for the comprehensive study of plant systems biology. In addition to the tools and resources used in the analyses of the individual omics platforms, several resources are required for the elucidation of the complete picture. These include the tools for network visualization, modelling environments, pathway construction and visualization tools, systems biology platforms and repositories of the models. The various pathway databases for systems analyses include KEGG, BioCyc, Aracyc, Pathway Interaction Database (PID) and BioCarta. The core systems biology networks include SynBioWave, Cell Illustrator, Moksiskaan, MEMOSys, Babelomics, MetNet, etc.

Conclusion and future perspectives

In the modern era, plants provide a solution to a number of environmental issues, such as the lack of food and water. Systems biology can be used as a tool to comprehend plants through mechanistic efforts and eventually serve as a basis for partial solutions, despite the challenge of finding a single ideal solution. Genetic modifications could potentially increase the yieldof individual plants. Systems biology may provide a wealth of information regarding how plants react to both internal and external stimuli. Holistic systems biology approaches offer a comprehensive understanding of plant systems, even though simplistic molecular approaches are unavoidable for advancing our understanding.

Volume: 03 Issue No: 11

IMPROVED CROP MANAGEMENT PRACTICES FOR LONG-TERM PULSE PRODUCTION: AN INDIAN

Article ID: AG-VO3-I11-88

Ankit Kumar[1*], Ashik Kumar Meena[1], Jitendra Kumar[2], Shankar Ram[1] and Anil Kumar Sharma[1]

[1]Department of Agronomy, School of Agricultural Science, Nagaland University, Medziphema Campus, Nagaland- 797106

[2]Department of Entomology, School of Agricultural Science, Nagaland University, Medziphema Campus, Nagaland- 797106

*Corresponding Author Email ID: a3486068@gmail.com

Abstract

Pulses are an integral part of Indian agricultural economy next to cereals and oilseeds in terms of acreage, production and economic value. Pulses are rich source of protein and energy, but in India, these are largely cultivated under energy starved conditions resulting in poor pulse productivity. This is mainly because of unavailability of quality seed at desired time, cultivation on marginal and sub-marginal lands and imbalanced use of fertilizers and non-adoption of crop improved management practices. India is the largest producer and consumer of pulses in the world, accounting for about 25% of global production, 27% of consumption and 34% of food use. To reduce the demand supply gap, government of India launched various programmes in pulses. Still, prime attention is required to meet the food security challenges, especially in case of pulse sector. In order to enhance and sustain the pulse productivity at high levels, the development and promotion of low–cost pulse production technology need greater attention so that technology is widely adopted by the practicing farmers. The most potential technologies in pulse production include improved crop establishment and management practices, integrated soil fertility and pest management practices, etc. which enhances not only the productivity and profitability but also warrants environmental and social sustainability besides nutritional

security. Various agronomic researches have shown that improved cultivation practices, such as seed replacement with improved varieties, raised bed planting method, use of biofertilizers, foliar application of fertilizers at critical stages in rainfed areas, application of secondary and micro-nutrients and adoption of appropriate modules for integrated weed and pest management, etc. have great potential in gearing–up pulses productivity. Thus, there is a great challenge for policy makers, farm scientists and farming community to enhance pulse productivity using improved farm technology to meet–out the national and local pulse requirements. Thus, this article presents a critical review on capacity of various improved crop management practices to scale–up pulses productivity on one hand and highlight future research priorities on the other with the prime objective of sustaining pulse production in India.

Key words: *Fertilizer, Food, Productivity, Pulses, Quality Seed*

Introduction

India is one of the major pulse producing countries contributing about 25% to the global pulse production. Pulses are also an important component of Indian agricultural economy next to food grains and oilseeds in terms of acreage, production and economic value. Pulses are an integral part of vegetarian diet of a large population in India. Besides being a rich source of proteins and essential amino acids; they also maintain soil fertility through biological nitrogen fixation in symbiotic association with Rhizobium bacteria present in their root nodules. Thus, pulses play a vital role as nitrogen fixing mini-factories, which help in sustaining crop productivity and soil health. Pulses are rich sources of protein and energy but in India, these are largely cultivated under energy starved conditions, mostly on marginal and sub-marginal land and more than three-fourth of the area under pulses is still rainfed resulting in poor crop productivity (Choudhary 2013). India is the largest producer of pulses in the world, with 25% share in the global production. The important pulse crops are chickpea, pigeon pea, mungbean, Urd bean, lentil and field pea. In India, production of pulses is around 19.3 million tonnes with a very low average productivity of 764 kg/ha. Currently, total area under pulses is 26.3 million ha. Pulse productivity in India is much lower than other pulse producing countries. This is mainly because of unavailability of quality seed at desired time, cultivation on marginal and sub-marginal lands, injudicious use of fertilizers and non-adoption of crop management practices and poor marketing infrastructure. The country is importing pulses to the tune of 2.5-3.5 million tonnes every year for meeting the demand of the growing population; this led to decline in the availability of pulses in the country from 69 g/capita/day in 1961 to 33 g/ capita/day in 2009-10 (Ali and Gupta 2012). To overcome the problem of protein energy malnutrition, a minimum of 50 g pulses/capita/day should be available in addition to other sources of protein. Thus, to make the nation pulse sufficient, average yield level has to increase substantially up to 1 200 kg/ha by 2020 (The Hindu 2005). To achieve this, more than 4.0% growth rate in pulse production is required. Pulses contain 20-25% proteins and essential amino acids required for proper growth and development of human body. These are comparatively cheaper than animal protein (milk and egg) for majority of vegetarian population in India and hence referred to as 'poor man's meat'. India is the largest producer and consumer of pulses in the world, accounting for 27% of consumption and 34% of food use (FAO). India is also the top importer with 11% share of global imports during 1995-2001 (Gregory 2003). To reduce the demand-supply gap, Government of India launched various programmes like integrated scheme of oilseed, pulses, oil palm and maize (ISOPOM), national food security mission (NFSM) and front-line demonstrations (FLD) programme in pulses. Still, prime attention is required in pulse production to meet the challenges of increasing population. Thus, there is a great challenge for policy makers, scientists and farming community to enhance pulse productivity and diversify their cropping systems to meet out the national and local pulse requirements. Thus, it is prime time to introspect on the status and capacity of various improved crop management practices to scale–up pulses productivity on one hand and highlight future research priorities on the other with the prime objective of sustaining pulse production in India.

Improved crop management practices:

Pulses have excellent source of high quality protein, essential amino acids, fatty acids, minerals and vitamins for millions of Indians. In order to enhance and sustain the pulse productivity at desired levels w.r.t. Indian perspective for better food and nutritional security, the development and refinement of low–cost pulse production technologies need greater emphasis so that these technologies are acceptable to resource-constrained Indian farmers. The most potential technologies in pulse production include improved crop establishment and management practices, integrated soil fertility and pest management practices, etc. which enhances not only the productivity and profitability but also warrants environmental and social sustainability besides nutritional security. It is desirable that agricultural practices should be economically viable, environmentally sustainable and socially acceptable inclusive of food safety and quality dimensions. A brief insight into status and production abilities of various improved crop management practices has been vividly presented below.

Selection of suitable varieties/cultivars:

Varietal improvement programme in pulses was initiated in 1917 with selections from different parts of the country especially pigeon pea. Today, a large number of improved varieties have been released for improved yield, disease and pest resistance, short duration, synchronous maturity and short stature, etc. suitable to varied agro-climatic and soil conditions. Thus, in particular, development of short duration, disease resistant and high yielding varieties in the recent past made these crops a viable alternative to low yielding coarse cereals under rainfed conditions and also provided an opportunity for expansion in rice fallows and in double cropping systems. Breeding work is also underway to produce short duration varieties and hybrids for almost all pulse growing areas throughout country. A list of some promising pulse cultivars for different production zones in India given below.

Table 1: Promising pulse types in India and their distinguishing characteristics

Crops	Variety	Characteristics
Cajanus cajan	UPAS 120	Extra early variety, Drought escapes
	Azad	Resistant to sterility mosaic
	Narendra Arhar 1	Tolerant to wilt and pod borer
	ICPH 8	Hybrid, 30 % more yield than UPAS 120
Vigna radiata	Varsha	Synchronous and early maturity
	PM 5	Bold seeded, extra early and resistant to yellow mosaic virus
	SML 668	Root-knot nematode tolerant and yellow mosaic resistant
	VBN (GG 2	Suitable for all seasons and yellow mosaic resistant
Phaseolus mungo	PDU 1	Suitable for spring season
	VBN 5	Suitable for all seasons and yellow mosaic and powdery mildew resistant

	Shekhar 2	Yellow mosaic and *Cercospora* leaf spot resistant
Vigna unguiculata	Swarna	High protein cultivar
	Pusa Sampada	Free from common diseases
	DFC 1	Fodder type
	Pusa Komal	Bacterial blight resistant
Macrotyloma uniflorum	CRIDA Latha	Powdery mildew and yellow mosaic resistant
	VL Gahat 10	Yellow mosaic resistant
	Birsa Kulthi 1	*Macrophomina* blight resistant
Phaseolus aconitifolia	Jawala	Suitable for western part of India
	CAZRI Moth 1	Drought resistant
	FMM 96	Resistant to yellow mosaic
Cicer arietinum	Pusa 256	Resistant to wilt, tolerant to *Ascochyta* blight, suitable for late planting
	Uday	Late sowing and tolerant to wilt
	Pant G 186	Resistant to wilt, blight and suitable for late planting
	Sweta (kabuli)	Wilt resistant and bold seeded
Pisum sativum	IPF 99-25	Resistant to powdery mildew, tall type
	Pusa Prabhat	Extra early maturity
	Alankar	Resistant to powdery mildew
	TRCP 8	Resistant to powdery mildew
Lens esculenta	VL Massor 103	Tolerant to rust
	Pant L 5	Resistant to wilt, rust and blight, bold seeded
	HUL 57	Small seed, tolerant to rust and wilt
Phaseolus vulgaris	IIPR 96-4	Resistant to bean common mosaic virus
	HPR 35	Red seed with purple streaks
	IPR 98-5 (Utkarsh)	Cold tolerance, attractive seed colour

Source: Bana *et al.* (2014) and Parsad (2012)

Tillage management

Tillage is necessary for manipulation of soil with farm tools and implements for obtaining ideal conditions for seed germination, seedling establishment and growth of crops (Das *et al.* 2014). Main aim of tillage is to produce good soil condition and tilth for crop establishment and initial root and shoot development. Kharif pulses require tillage for opening the soil through soil turning plough and two cross harrowing followed by planking. In *rabi* pulses soil turning plough after kharif crops and two cross-harrowing or two three cultivations by cultivator followed by heavy planking is needed. If necessary a pre-sowing irrigation should be given to ensure adequate moisture. Summer mungbean (*Vigna radiata*) residue recycling through soil turning plough in pulse as well as cereal based cropping systems lead to enhanced system productivity, profitability and soil health. In dry land areas, deep ploughing results in better moisture conservation, root proliferation and higher productivity over shallow cultivation.

The heavy soils require one pre-shower deep ploughing followed by 2-3 cultivations and harrowing after early shower. Tillage practices also depend upon climate and soil conditions. All the growth parameters were significantly improved when the seed bed prepared with only one ploughing due to better tilth. Conventional tillage is best for tarai region of India for higher productivity of lentil because in conventional tillage more aeration and proliferation of roots takes place which extracts more soil moisture and nutrients from per unit area of soil. Tillage consumes maximum energy, hence efforts have been started world over since 1970s to reduce energy use on the farm by efficiently applying different inputs and reducing the number of tillage operations to bare minimum for seed bed preparation to harness higher or equivalent yields. This led to development of zero-tillage and conservation tillage concepts. Zero tillage practices can have beneficial impacts on productivity as well as minimizing environmental degradation such as soil erosion in legume and cereal crop growing areas (Das *et al.* 2014).

Planting time and sowing depth:

Time of sowing is the most important non-monetary input having significant effect on crop growth, phenological development, insect-pest and weed dynamics and crop productivity. The environmental conditions, *viz.* temperature, photo-period and moisture availability, etc. significantly changes with time of sowing. Delayed planting restricts vegetative growth and pod bearing branches, decreases biological-nitrogen fixation and also leads to forced maturity. At the same time, it also increases incidence of pests, especially pod borer (*Helicoverpa armigera*) in chickpea. Contrary to that sometimes off-season cultivation of green peas, beans, cowpea and other legume vegetables leads to enhanced profitability due to premium prices in the market though the yield levels are quite lower owing to less congenial climate (Rahi *et al.* 2013). Rabi greengram can be sown up to end of December and this is practiced in southern part of country, where the winters are not severe. Sowing of summer greengram in first fortnight of March recorded higher yield as compared to last week of March. Suitable time for summer blackgram is March and for spring season January is the best month to obtain higher productivity. September first week is the suitable time for horse gram sowing during Rabi season. Optimum sowing depth depends on type of crop/cultivar, growing season, soil moisture, soil texture, and more importantly on seed size of the respective pulse crops.

Planting geometry:

Optimum spacing requirement depends on type of crop and cultivar, growing season and planting system. Most of short duration pulse varieties need narrow spacing, while long duration varieties perform well under wider spacing. An appropriate planting density in field crops and vegetables lead to better harness of the solar radiation to translate into higher crop yields. It is reported that sowing in first week of June recorded highest grain yield with both narrow and wider spacing in different varieties and sowing beyond that date reduced the pulse yield. Sowing of mungbean at 20 cm × 10 cm spacing was found more adequate. In general, kharif sown crop requires wider spacing and less plant population compared to summer sowing due to fairly warm temperature, prolonged vegetative growth and profuse branching (Prasad 2012).

Optimum seed rate:

Seed requirement varies with cropping system, growing season, test weight and germination percentage of the seed material. The seed rate also varies according to weather conditions and duration of crop growth. Primarily, plant population desired per unit of land area determines the seed/seedling rate. Spacing between rows, spacing of plants within row, plant size and seed germination, etc. affect the rate of planting required to reach a particular plant population. In a study, it was revealed that optimum seed rate for higher yield of greengram is 37.5 kg/ha during summer and 30 kg/ha during rainy season in Punjab (Sekhon *et al.* 2006). In intercropping systems, the seed requirement depends on proportion of area available to each crop; and in case of drylands, slightly higher seed rate is required. In hill and mountain ecosystems, the seed rate for pulses are quite higher owing to less soil moisture availability in rainfed areas, erratic rainfall pattern and low temperature; adequate enough to better harness the solar radiation to translate into higher crop yields.

Method of sowing:

Sowing method is an important factor which has direct effect on seed requirement, plant establishment, and cultural operations and efficiency of production inputs. Sowing of pulses is mainly through broadcasting seeds in seed bed followed by planking; or drilling seeds in furrows opened by plough with or without attachment of seedling tube through tractor or bullock operated seed drills. In kharif pulses, raised/ridge-furrow planting technique has been found very successful in draining excess water from crop root zone and increase the yield by 25-30% over flat bed planting. Ali (1998) observed that in Ludhiana (Punjab), flat sowing recorded significantly higher pigeonpea yield over other treatments, but at Hisar and Pantnagar in North Indian conditions, raised bed with 2.7 m width recorded significantly higher yield over other sowing methods. It might be due to proper drainage of excess water from crop root zone and less incidence of insect-pest and diseases. Thus, application of appropriate sowing method also determines the success and productivity of crops in particular environmental, temporal and field variability regimes.

Nutrient management:

Balanced supply of nutrients in adequate amount and available form holds the key to successful crop production. Fertilizer management encompasses on adding right amount of nutrients at right time through an appropriate method so as to minimize nutrient losses, thereby, making efficient nutrient-use for enhancing crop productivity and maintaining soil fertility. Pulses require less amount of nitrogen as they are capable of fixing atmospheric N biologically through Rhizobium bacteria but need adequate phosphorus and sulphur for their root proliferation and synthesis of sulphur containing amino acids. Legume nitrogen fixation starts with formation of a nodule. A common soil bacterium, Rhizobium, invades the root and forms root nodules. Biological nitrogen fixation is the process that changes inert N_2 to biologically useful NH_3, thus, pulses require less fertilizer N though their P requirement is high. It is inevitable to add the fertilizer P in pulses through phosphatic fertilizers and microbial inoculants. A breakthrough is essential in this matter to promote P fertilizer use in legumes by the farmers. It is observed that farmers use sub-optimal doses of P fertilizers in pulses. Pulses also require comparatively higher amount of some micronutrients like molybdenum and iron which are integral constituents of nitrogenase enzyme, essentially required for nitrogen fixation. Application of sulphur significantly increases the grain (9.1%) and straw yield (9.6%) and protein content with application of 20 kg sulphur/ha. In a study, application of micronutrients alone or in combination did not influence yields significantly, but a combination of all three micronutrients (Zn+Mo+B) resulted in significant increase in grain yield. Kushwaha (2007) reported that combined application of Rhizobium + phosphorus solubilizing bacteria (PSB) + nitrogen + phosphorous or inoculation of Rhizobium and PSB alone or in combination registered higher net returns over control due to lower cost of biofertilizers. Combined application of 40 kg sulphur/ha and 5 kg zinc/ha recorded significantly higher grain and pod yield of pea over 40 kg sulphur/ha and control. Soil test crop response (STCR) based targeted precision nutrient management practices in legumes and other field crops can also be good alternative to enhance crop productivity with economic use of chemical fertilizers in Indian conditions. Application of VAM fungi also play an important role in phosphorus transformations, P economy and enhanced productivity in green peas in acid Alfisol (Yadav *et al.* 2015). Application of micronutrients, viz. zinc, boron and iron also influenced the performance of pulses. Application of 40 kg P_2O_5/ha as rock phosphate combined with phospho bacteria and VAM increased grain and straw yield of horsegram. A significant response of chickpea to application of 15 kg K_2O/ha in both medium and high K soils and maximum response in medium soils. Sulphur is also essential for pulse crops like NPK and its deficiency is common under intensive pulse cropping systems. Long duration crops like pigeonpea responded up to 40 kg S/ha, whereas short duration pulses like chickpea, lentil and urdbean showed significant response up to 20 kg S/ha.

Green manuring of pulses for long-term productivity of soils

Green manuring of pulses usually perform multiple functions that include soil improvement w.r.t. physicochemical and biological properties as well as enhancement of soil microbial biomass and enzymatic activity. In a study, regular incorporation of *Sesbania aculeata*, cowpea and mungbean green manuring improve availability of micronutrients to crop plant, i.e. zinc, iron, manganese, and copper in soil compared to summer fallow (Pooniya and Shivay 2013). Incorporation of *Sesbania aculeata* residue also enhanced soil microbial activities, which are vital for the nutrient turnover and long-term productivity of soils, leading to enhanced productivity of field crops. Sesbania green leaf manuring and cowpea intercropping also enhances the soil fertility and consequently crop productivity (Bana *et al.* 2012).

Water management

In general, all the kharif pulses are grown under rainfed conditions without irrigation in India. On the contrary, pulse crops need proper drainage as they are very sensitive to waterlogging. Pulses grown during spring/summer and winter months require irrigation when the soil moisture becomes limiting factor. At critical growth stages of flowering and pod formation, kharif pulses also responded to irrigation when there is dry-spell. In general pulse crop first irrigation should be given 20 days after sowing and subsequent irrigations at 10 days interval. Delay in application of first irrigation (30 DAS) could not reverse the growth and yield even if subsequent irrigations were given at short intervals. The use of furrow irrigation with raised-bed systems improve the irrigation water-use efficiency under permanent raised-bed seeding where tillage is done on top of the beds. Furrow irrigated seeding system in north-west India resulted in both higher yield and significant water savings (16-20%) for a wide spectrum of legumes compared to traditional farmers' practice. The application of anti-transpirants in soybean, it was revealed that MgCO3 (5%) and KNO3 (1%) enhance soybean productivity significantly. Thus, this can be a new area of research to be explored in other legumes, i.e. pulse crops to enhance their production under rainfed areas. Application of VAM fungi also holds great promises in tolerance to water stress besides phosphorus nutrition management in rainfed peas.

Weed management

Critical period of crop weed competition varies among different pulses. Several studies showed that critical period was 40-60 days after sowing (DAS)..

Table 2: Major weed spp. Associated with pulses

Kharif pulses	*Rabi* pulses
Cyperus rotundus	*Chenopodium album*
Amaranthus viridis	*Fumaria parviflora*
Commelina benghalensis	*Lathyrus spp.*
Euphorbia hirta	*Melilotus alba*
Portulaca oleracea	*Vicia sativa*
Eragrostis spp.	*Phlaris minor*
Digera arvensis	*Argemone Mexicana*

Unchecked weeds cause 20-90% yield losses in different pulse crops. The major weed flora associated with pulses are presented in Table 2. Integrated weed management (IWM) is basically integration of effective, dependable and workable weed management practices such as cultural, mechanical, chemical and biological that can be used economically by the farmers. Gajera *et al.* (1998) reported that mulching with sugarcane trash @ 8 tonnes/ha is effective for control of weeds and equally important in increasing yield, conservation of soil moisture, moderation of soil temperature and suppression of weed growth in pigeonpea

Plant protection:

Pulses are susceptible to many insect-pests and diseases. The losses in yield due to lack of plant protection measures vary from 46-96% depending on the crop and varieties. Integrated pest management (IPM) in pulses refers to application of an inter-connected set of principle and methods to minimize problems caused by insects, diseases, weeds and other agricultural pests. IPM includes use of resistant or tolerant varieties, crop rotation with non-host crops etc. Intercropping of gram + linseed/mustard or gram + coriander encourages natural enemies of pod borers. Use of bio-insecticide NPV @ 250-500 LE/ha controls pod borers. Use of neem seed kernel extract (5%) is also helpful for control of pod borers. Use of sex pheromone trap is also helpful in controlling pod borers. Integrated disease management (IDM) is a approach that uses all available management strategies to maintain disease pressures below an economic injury threshold. It does not advocate a routine chemical application program to prevent disease, but promotes the integration of cultural, physical, biological and chemical control strategies.

The basic objectives are to reduce the possibility of introducing diseases into the crop and avoid creating conditions suitable for disease establishment and spread. IDM includes deep summer ploughing and field sanitation, growing resistant varieties, seed treatment with fungicides, crop rotations with sorghum and tobacco, soil solarization and soil treatment with formaldehyde, captan and vapam etc., application of neem cake @ 150 kg/ha basically to reduce root-rot. AM fungi also induce disease tolerance in legume crops. Various fungicides and bio-agents are tried as seed treatment to control pulse diseases. Application of carbendazim + thiram and bio-agent (Trichoderma viride) in combination with vitavax are best for reducing wilt incidence in pulses.

Table 3: Major insect pest of pulses

Kharif pulses	*Rabi* pulses
Gram pod fly *(Melanagromyza obtusa)*	Gram pod borer *(Helicoverpa armigera)*
Hairy caterpillers *(Spilosoma cajetani)*	Cut warms *(Agrotis ipsilon)*
White fly *(Bemisia tabaci)*	Aphids *(Aphis craccivora)*
Bristle beetle *(Mylabris spp.)*	Gram semilooper *(Autographa nigrisigna)*
Termites *(Odontotermes obesus)*	Pea leaf minor *(Liriomyza huidobrensis)*

Other options to increase pulse production in India

During last few decades, growth in pulses production has increased significantly. The major factor for achieving this record production is introduction in new areas and nontraditional production belts. We have to bring pulse crops to non-traditional areas of rice fallows in central and eastern parts of the country – Bihar, Madhya Pradesh, Chhatisgarh, Odisha, eastern Uttar Pradesh and West Bengal. Chickpea production in Andhra Pradesh is an example. Introduction of chickpea crop into non-traditional areas like south Indian states is an example of technological and institutional breakthroughs. Introduction of chickpea into black cotton soils, utilization of rabi fallow lands, adoption of short duration HYVs' (KAK 2 and JG 11), and large scale mechanization to cope-up labour shortage are some of the contributors for area expansion in chickpea in south Indian states. Thus, Indian government needs to provide adequate policy and institutional support to production of pulses in rice fallow areas to complement efforts of scientists in raising productivity levels of these crops and bring larger rice fallows under pulses production. In this context, government should extend more facilities to pulses growers in rice fallow areas.

Intercropping and new cropping systems:

Increased efforts to produce more food have resulted in tremendous shift in cropping systems towards cereal-cereal based cropping systems. India is the largest producer and consumer of pulses with about 25-28% of global share. It is paradoxical that India being one of the major pulse growing countries at global level accounts for about 11% share of world pulse imports. Similarly, edible oil imports are also high. Thus, intercropping and growing short duration varieties between kharif and rabi seasons, by relay cropping, intercropping of pulses can ensure further utilization of existing arable lands. Replacement of upland paddy with pulses is another viable option having potential to give better net returns to farmers. Fallow substitution in irrigated lands has resulted in increased production in several countries. Thus, Department of Agriculture and Cooperation (DAC), GOI, New Delhi has also proposed a strategy for increasing production and productivity of pulses that involves a thrust on non-conventional cropping systems. Agriculture plays a key role in overall economic scenario and rural livelihoods of India. The growing climate change threats besides El Nino events in current scenario are now supposed to have significant impact on the yields of certain major food crops which would definitely affect the world food security in general and its regional impacts in particular as per the world scientific community. This means, agriculture production in rainfed regions, which constitute about 65% of the area under cultivation and account for about 40-45% of the total production in India, is expected to suffer severe water crisis due to delayed monsoon, uneven rains distribution as a result of above climate change threats. But, pulses are one of the important segments of Indian agriculture after cereals with 25% share in the global pulse production and covering an area of about 263 m ha, majority of which falling under rainfed condition where irrigation facilities are inadequate or not available. Pulses are predominantly grown under resource poor and harsh environments frequently prone to drought and other biotic and abiotic stresses. The pulses have great potential to bear the vagaries of the changing climate, provided other crop management practices are strictly followed to harness good yields.

In addition, pulses also play an important role in improving soil health, long term fertility and sustainability of the cropping systems. It meets up to 80% of its nitrogen fixation from air and leaves behind substantial amount of residual nitrogen and organic matter for subsequent crops. Pulses are being neglected since green revolution. As a result, the productivity of the pulses in India is quite low. Besides, to meet the demand of pulses, India imports huge amount of pulses every year. Thus, there is a great challenge to enhance pulse productivity to meet out the national and local pulse requirements. In this paper, an attempt has been made to discuss improved pulse production practices which can play a vital role in sustainable pulse production in India. Besides this, area expansion through their introduction in non-traditional area would also add to national pulse production. The improved production practices and strategies with context to pulses crop in Indian perspective discussed in this paper would definitely enlighten the agricultural professionals and policy makers to enhance their capabilities for sustainable pulse production in India inspite of various production vulnerabilities.

References

Ali M and Gupta S. 2012. Carrying capacity of Indian agriculture: Pulse crops. Current Science 102 (6): 874–81.

Ali M, Mishra J P and Chauhan Y S. 1998. Effective management of legume for maximizing biological N fixation and other benefits. (In) Residual effect of legume in rice and wheat cropping system in the Indo-Gangetic plains pp 127–8.

Bana R S, Gautam R C and Rana K S. 2012. Effect of different organic sources on productivity and quality of pearlmillet and their residual effect on wheat. Annals of Agricultural Research 33 (3): 126–30.

Bana R S, Pooniya V, Choudhary A K and Rana K S. 2014. Agronomic interventions for sustainability of major cropping systems of India. Technical Bulletin (ICN: 137/2014), Indian Agricultural Research Institute, New Delhi, p 34.

Choudhary A K. 2013. Technological and extension yield gaps in pulses in Mandi district of Himachal Pradesh. Indian Journal of Soil Conservation 41 (1): 88–97.

Das T K, Choudhary A K, Sepat S, Vyas A K, Das A, Bana R S and Pooniya V. 2014. Conservation agriculture: A sustainable alternative to enhance agricultural productivity and resourcesuse-efficiency. Technical Extension Folder, IARI, New Delhi.

Gajera M S, Ahlawat R P S and Ardeshna R B. 1998. Effect of irrigation schedule, tillage depth and mulch on growth and yield of winter pigeonpea. Indian Journal of Agronomy 43 (4): 689–93.

Kushwaha H S. 2007. Response of chickpea to nitrogen and phosphorus fertilization under rainfed condition. Journal of Food Legumes 20 (2): 179–81.

Pooniya V and Shivay Y S. 2013. Enrichment of Basmati rice grain and straw with zinc and nitrogen through ferti-fortification and summer green manuring crops under Indo-Gangetic Plains of India. Journal of Plant Nutrition 36: 91–117.

Prasad R. 2012. Textbook of Field Crops Production-Food Grain Crops, Vol I, pp 248–319.

Rahi S, Thakur S K and Choudhary A K. 2013. Off-season pea cultivation: An income enhancement venture in Mandi district of Himachal Pradesh. (In) Proceedings of National Seminar on Indian Agriculture: Present Situation, Challenges, Remedies and Road Map, held at CSK HPKV, Palampur during 4-5 Aug. 2012, CSK HPKV Publication, pp 47–8.

Sekhon H S, Singh G, Sharma P and Sharma P. 2006. Agronomic management of mungbean grown under different environments. Improving income and nutrition by incorporating mungbean in cereal fallows in the Indo-Gangetic Plains of South Asia, DFID Mungbean Project for 2002–2004. (In) Proceedings of the Final Workshop and Planning Meeting, Punjab Agricultural University, Ludhiana, India, 27–31 May 2004, pp 82–103.

The Hindu. 2005. The Hindu Survey of Indian Agriculture.

Yadav A, Suri V K, Kumar A, Choudhary A K and Meena A L. 2015. Enhancing plant water relations, quality and productivity of pea (Pisum sativum L.) through AM fungi, inorganic phosphorus and irrigation regimes in an Himalayan acid Alfisol. Communications in Soil Science and Plant Analysis 46 (1): 80–93.

Volume: 03 Issue No: 11

ADVANCING TRANSPARENT PHOTOVOLTAICS: EFFICIENCY, AESTHETICS AND REAL-WORLD FEASIBILITY OF THIN FILM TECHNOLOGY

Article ID: AG-VO3-I11-89

Ramineni Harsha Nag[1*], Ajay Kushwah[1], Madhusudhan B.S.[1], Sunil Kumar Rathod[1], Kesav Kumar[1] and Somnath[1]

[1]Ph.D. Scholar, ICAR-Indian Agricultural Research Institute, New Delhi-110 012, India

*Corresponding Author Email ID: harshanag13@gmail.com

Introduction

The demand for novel sustainable energy sources has become one of the most challenging topics addressed by worldwide researchers in the last years, which stems from the increasing development of a consumerist world. Industrialization and the rapid growth of the global population have catalyzed a search for practical renewable energy sources with the huge aim of fossil fuel replacement. However, pushing global energy consumption far from fossil fuels demands novel and not expensive technologies for converting sustainable sources. Due to its accessibility, cleanliness, and abundance, solar energy has emerged as the most promising choice for the plan of a concretely sustainable world; it is utilized in different ways, such as for heating water, producing electricity through photovoltaic (PV) technologies, etc. PVs can fulfill this demand many times over if adopted on a wide scale. However, the installed PV plants currently satisfy only around 1% of the global energy demand. Moreover, an important barrier to the further growth of a solar energy scenario and the large-scale installation of PV technologies is given by the relatively weak energy density of sun irradiation in comparison to the energy demand. Given that such a small portion of the global energy requirement can be satisfied by the nowadays installed PV plants, mainly in isolated and particularly sunny regions, it is required to boost the solar energy-related infrastructure if the real aim of society is that of converting enough light to compensate for a relevant amount of non-renewable energy consumption.

Thin film photovoltaics (TPVs)

Thin film photovoltaics (TPVs) are one of the most prolific technologies in TSC and are achieved via different methods. Some of these methods depend on the fabrication of the material and pastes to accomplish transparency, and others depend on the deposition method of pastes on FTO glass. In this section, categorization will be based on the deposition methods, and in each method, the fabrication of pastes and the type of material will be clarified. TPV is basically a thin film that has a thickness ranging from a few nanometers to tens of micrometers of active material deposited on glass in different ways. Thin film technology reduces the cost of solar cells by conserving the materials used in fabricating the cell; it is easy to deposit thin films on many different substrates, from rigid to flexible and insulators to metals, allowing for new applications. By reducing the thickness of the film, the transparency increases in some materials, such as titanium dioxide. Thin film solar cell TFSC is fabricated by combining material layers that are usually used to make solar cells, but as thin films, which reduces the cost of the solar cell's materials, by depositing the optimal amount of material that allows the solar cell to function properly. The properties of these materials are different from each other, and the cell's overall performance is affected by each layer. The interaction between these layers is important due to the variety of their crystal structures. There are many ways to deposit thin films on a substrate, such as chemical bath deposition (CBD) technique, physical vapor deposition (PVD) technique or sputtering, electrodeposition, screen-printing, pulsed laser deposition (PLD), and spray and atomic layer deposition (ALD).

Why they are not popular in India?

Transparent solar photovoltaics have not gained significant popularity in India, and several potential reasons exist for this. First, the higher cost of transparent solar panels compared to traditional opaque ones could deter cost-sensitive consumers in India. Second, the lower efficiency of transparent solar panels in converting sunlight into electricity may not align with the need to maximize energy production in a country with abundant sunlight. Additionally, there might have been limited awareness and education about this emerging technology among Indian consumers. Regulatory and policy barriers, market competition, concerns about reliability and longevity, and the challenge of scaling up production could also be factors contributing to the limited adoption of transparent solar photovoltaics in India. However, the situation may have evolved since then, and ongoing developments in this technology should be monitored for updates on its adoption in the Indian market.

Various classifications of transparent solar photovoltaics

Transparent solar photovoltaics can be classified into several categories based on their technology, materials, and applications. Here are some common classifications:

1. Technology-Based Classification:

a. Organic Photovoltaics (OPVs): These use organic materials as the active layer for solar energy conversion. OPVs are lightweight and flexible, making them suitable for various applications, including transparent solar windows.

b. Dye-Sensitized Solar Cells (DSSCs): DSSCs employ a dye to capture sunlight, making them semi-transparent. They are often used for building-integrated photovoltaics (BIPV).

c. Thin-Film Solar Cell: Thin-film technologies like amorphous silicon (a-Si), cadmium telluride (CdTe), and copper indium gallium selenide (CIGS) can be adapted to create transparent solar panels.

d. Perovskite Solar Cells: Perovskite solar cells are a promising emerging technology for transparent applications due to their high efficiency and ease of fabrication.

2. Material-Based Classification:

a. Transparent Conductive Oxides (TCOs): TCOs like indium tin oxide (ITO) are commonly used as transparent electrodes in transparent solar cells.

b. Luminescent Solar Concentrators (LSCs): LSCs use luminescent materials to capture sunlight and guide it to the edges of the panel, where traditional solar cells are located.

c. Nanocrystalline Solar Cells: Transparent solar cells made of nanocrystalline materials offer improved efficiency and transparency compared to some other technologies.

3. Application-Based Classification:

a. Windows: Transparent solar windows can be integrated into buildings to generate electricity while allowing natural light to pass through.

b. Skylights: Skylights with transparent solar panels can provide both natural illumination and energy generation in commercial and residential buildings.

c. Facades: Solar facade systems use transparent photovoltaics to cover the exterior of buildings, combining energy generation with architectural design.

d. Solar Chargers: Transparent solar panels can be integrated into portable electronic devices, such as smartphone screens or laptop covers, to provide a continuous source of power.

4. Efficiency-Based Classification:

a. High-Efficiency Transparent Solar Panels: These panels prioritize efficiency and energy generation over transparency and are often used in situations where some level of opacity is acceptable.

b. Semi-Transparent Solar Panels: These panels strike a balance between transparency and efficiency, making them suitable for applications where both light transmission and energy generation are important.

5. Color-Based Classification:

a. Neutral Transparent Solar Panels: These panels are designed to be as transparent as possible without imparting a noticeable color or tint to the light passing through.

b. Colored or Tinted Transparent Solar Panels: Some transparent solar panels are intentionally designed to have a specific color or tint, which can be used for aesthetic purposes or to match the building's design.

These classifications reflect the diverse range of transparent solar photovoltaic technologies and their applications, each with its unique properties and advantages. The choice of classification depends on the specific requirements of the project or application.

Benefits associated with TPVs in Indian farms and the energy sector

The adoption of transparent solar photovoltaic (PV) technology in Indian farms and the energy sector can bring several benefits:

1. Energy Generation: Transparent solar panels can be integrated into various structures on farms, such as greenhouses, shade structures, and even on the roofs of agricultural buildings. These installations can generate electricity while allowing natural light to pass through. In a country like India with abundant sunlight, this additional source of renewable energy can help offset energy costs and reduce reliance on fossil fuels.

2. Shade and Crop Protection: Transparent solar panels can provide shade to crops and livestock in open areas, reducing heat stress during hot seasons. They can also act as protective covers, shielding crops from extreme weather conditions such as heavy rain, hail, or excess sunlight. This can help improve crop yields and overall farm productivity.

3. Water Management: Farms in India often rely on water pumps for irrigation. Integrating transparent solar panels into these systems can help power the pumps directly, reducing electricity costs and making irrigation more sustainable.

4. Greenhouse Applications: Transparent solar panels are well-suited for greenhouses as they allow sunlight to penetrate while generating electricity. They can help regulate temperatures inside the greenhouse, extend the growing season, and improve crop quality and yield. This is especially valuable for horticulture and floriculture, which are vital components of Indian agriculture.

5. Rural Electrification: In rural areas with limited access to the grid, transparent solar panels can be used in standalone installations to provide electricity for essential farm equipment and lighting, improving the quality of life for rural communities and enhancing productivity.

6. Energy Diversification: Integrating transparent solar technology diversifies farm energy sources. This reduces vulnerability to fluctuations in energy prices and grid outages, providing a more reliable source of power.

7. Environmental Benefits: By harnessing solar energy, farms can reduce their carbon footprint and contribute to environmental sustainability. This aligns with India's goals to reduce greenhouse gas emissions and combat climate change.

8. Job Creation: The adoption of transparent solar technology can stimulate job creation in the renewable energy sector, including manufacturing, installation, and maintenance of these systems, contributing to economic development in rural areas.

9. Demonstration of Sustainable Practices: Indian farms adopting transparent solar technology can serve as examples of sustainable and eco-friendly agricultural practices. This can encourage other farmers to consider similar approaches and contribute to a broader shift toward sustainable agriculture.

While transparent solar technology offers numerous advantages, it's essential to consider factors such as initial investment costs, maintenance requirements, and local regulations when implementing these systems. Collaborative efforts involving government incentives, research institutions, and private companies can help promote the adoption of transparent solar PV technology in Indian farms and the energy sector, furthering the nation's sustainable development goals.

Scope of Transparent Solar Photovoltaics

The future of transparent photovoltaics in agriculture and the energy sector is highly promising. Advancements in technology are expected to increase the efficiency and transparency of these panels, enabling farms and energy facilities to generate more electricity without compromising light transmission. They will find extensive use in agricultural greenhouses, shading structures, and building-integrated applications, enhancing crop productivity and energy efficiency. Additionally, transparent solar panels will contribute to rural electrification, microgrid development, and energy storage integration, making them valuable tools for addressing energy challenges. As sustainability gains importance, transparent photovoltaics will significantly reduce carbon footprints and support clean energy initiatives. Collaborations, regulatory support, and continued innovation will drive their adoption, making them an integral part of future energy and agricultural strategies.

Volume: 03 Issue No: 11

BIOCHAR APPLICATION IN ACID SOIL RECLAMATION

Article ID: AG-VO3-I11-90

Dr.R.Abishek[1*]

[1]Assistant Professor, Department of Soil Science And Agricultural Chemistry,

Kumaraguru Institute of Agriculture, Erode, Tamil Nadu, India-638315.

*Corresponding Author Email ID: abishek.ravichandran111@gmail.com

Introduction

Acid soils, often characterized by low pH values, are a common challenge in agriculture, restricting crop productivity and leading to environmental issues. Soil acidity can be attributed to various factors, including natural processes and human activities. To mitigate these problems and improve soil quality, biochar has emerged as a promising soil amendment. This chapter explores the applications of biochar in acid soil reclamation, emphasizing its mechanisms and benefits.

1. Acid Soils: Causes and Consequences

1.1 Causes of Soil Acidity

- Natural processes: Weathering of minerals, leaching, and organic matter decomposition.
- Human activities: Excessive use of fertilizers, acid rain deposition, and deforestation.

1.2 Consequences of Soil Acidity

- Impaired nutrient availability: Low pH inhibits the uptake of essential elements by plants.
- Aluminum and manganese toxicity: Toxic levels of these metals become available to plants.
- Microbial imbalances: Acidic conditions affect the soil microbiota, reducing beneficial microorganisms.

2 Biochar: A Versatile Soil Amendment

2.1 Biochar Production

- Biochar is produced through the pyrolysis of organic materials (e.g., crop residues, wood, and manure) under controlled conditions, yielding a highly porous carbon-rich material.

2.2 Properties of Biochar

- High porosity: Provides a habitat for microorganisms and retains moisture.
- High cation exchange capacity (CEC): Enhances nutrient retention and availability.
- Altered pH: Biochar can raise soil pH, making it suitable for acid soil reclamation.

3 Mechanisms of Biochar in Acid Soil Reclamation

3.1 pH Modification

- Biochar's alkaline nature counteracts soil acidity, increasing pH to levels conducive for plant growth.
- pH adjustment can be gradual or rapid, depending on biochar type and application method.

3.2 Nutrient Retention

- Biochar's high CEC allows it to adsorb and retain essential nutrients (e.g., calcium, magnesium, and potassium) in the root zone.
- Slow release of nutrients over time reduces leaching and enhances nutrient availability.

3.3 Reduction of Aluminum and Manganese Toxicity

- Biochar can immobilize toxic aluminum and manganese ions, rendering them less available to plants.
- Improved root health and growth result from reduced metal toxicity.

3.4 Microbial Activity

- Biochar fosters a favorable environment for beneficial microorganisms, contributing to soil health.
- Increased microbial activity aids in nutrient cycling, organic matter decomposition, and disease suppression.

4 Benefits of Biochar Application in Acid Soil Reclamation

4.1 Enhanced Crop Productivity

- Improved soil pH, nutrient availability, and reduced metal toxicity result in increased crop yields.
- Enhanced root development and nutrient uptake contribute to healthier plants.

4.2 Carbon Sequestration

- Biochar is a long-lasting carbon sink, helping to mitigate climate change by sequestering carbon in the soil.
- This dual benefit addresses both soil health and environmental concerns.

4.3 Sustainable Agriculture

- Biochar application reduces the need for chemical soil amendments and fertilizers, promoting sustainable farming practices.

- Long-lasting effects mean fewer inputs over time, reducing the economic and environmental costs of agriculture.

5 Practical Considerations for Biochar Application

5.1 Biochar Type and Source

- Choose biochar made from locally available and sustainable feedstocks.

- Consider the specific needs of the soil and the desired outcomes.

5.2 Application Rates and Methods

- Consult soil tests to determine the appropriate biochar application rate.

- Incorporate biochar into the soil through various methods, such as mixing, broadcasting, or injection.

5.3 Monitoring and Evaluation

- Regularly assess soil pH, nutrient levels, and plant health to adjust biochar application as needed.

- Long-term studies can provide insights into the sustained benefits of biochar.

Conclusion

Biochar is a valuable tool for acid soil reclamation, addressing the challenges posed by soil acidity while promoting sustainable agriculture. Its ability to modify pH, enhance nutrient availability, and improve overall soil health makes it a promising solution for farmers and environmentalists alike. As research on biochar continues to evolve, its full potential for acid soil reclamation will become increasingly clear, ushering in a new era of productive and environmentally responsible farming practices.

Volume: 03 Issue No: 11

COLOURED CAPSICUM UNDER PROTECTED CULTIVATION: A BOON FOR VEGETABLE GROWERS

Article ID: AG-VO3-I11-91

***[1]Simarjit Kaur*, [2]Dr. Sandeep Kumar Singh, [3]Arshpreet Singh, [4]Vishakha Mehta and [5]Deepak Kumar**

[1,3,4,5] M.Sc. Agriculture (Horticulture- Vegetable Science), Mata Gujri College, Fatehgarh Sahib, Punjab-140407, India.

[2]Assistant Professor, Department of Horticulture, Mata Gujri College, Fatehgarh Sahib, Punjab-140407, India.

*Corresponding Author Email ID: kaursimar41091@gmail.com

Abstract

Protected cultivation is an approach to raise high value crops throughout the year in every season. It is technique of providing an artificial environment to plants for their healthy growth. Artificial conditions are generated according to the need of crop. Protected cultivation provides best quality and quantity of produce. Among these structures, green houses, poly houses, shade net houses and low tunnels etc. are used. Nowadays coloured vegetables having great demand in market. Capsicum is the widely grown vegetable under the polyhouse conditions and provides more per unit area yield. Coloured capsicum (viz. green, red and yellow) perform better color formation and yield than in open field. Protected structures have so many advantages as well as constraints. Major constraints for protected structures are high initial cost and more maintenance charges. Both input and output returns are high. One of the production constraints for colored capsicum is expensive seeds availability.

Keywords: Protected cultivation, Variety, Higher yield, Quality.

Introduction

Capsicum (*Capsicum annuum* L. var. *grossum*) is also recognized as Shimla mirch, bell pepper, sweet pepper or green pepper. It is rich in Vitamin A, Vitamin C and minerals like

Calcium, Magnesium, Phosphorus and Potassium, a variety of phytochemicals like vitamins, anthocyanins, carotenoids, flavonoids, phenolic acid, capsaicinoids. . It is popular in urban and peri-urban areas for its nutritional value and wide usability in home consumption, catering and industries. Capsicum exists in many colours like green, orange, red, yellow, white and recently black colour. Coloured capsicum contains more nutrients than green capsicum. Red capsicum contains 1.5 times more vitamin C, 8 times more vitamin A and 11 times more beta-carotene than green peppers. Yellow bell peppers have more vitamin C than green ones (Kiruthiga *et al*. 2019). The protected cultivation provides the excellent results in terms of quality and yield than the traditional cultivation. Thus, capsicum is ideal for greenhouse growing due to its optimal plant size, canopy cover, flower settings and fruit production at a lower temperature. Greenhouse technology provides atmospheric conditions according to the crop need such as temperature, light, CO_2concentration and radiation within certain permissible range to obtain the optimum yield (Atre *et al*, 2003). Under naturally ventilated greenhouses, not only crop yield increases but also the crop water use efficiency increases five to ten times as compared to open field production.

Botanical name : *Capsicum annuum* var. *grossum* L.

Family : Solanaceae

Origin : Mexico

Chromosome no.: 2n=24

Edible part : Fruit

Breeding system : Often cross-pollinated

CLIMATIC REQUIREMENT (UNDER PROTECTED STRUCTURE)

Day Temperature(ºC)	Night Temperature(ºC)	Relative Humidity (%)	Light Intensity(Lux)
21- 28ºC	18-20ºC	50- 60%	50,000-60,000

High temperature can lead rapid plant growth and affects the fruit set. If temperature goes above 35º C or falls below 12º C, fruit setting is affected greatly.

SELECTION OF SITE, LOCATION AND SOIL

The land should be away from low-lying areas and rivers. Avoid selecting the undulated site area. It performs better in well drained red soil or sandy loam soil. The soil should have good percolation rate as this crop is sensitive to waterlogging. The ideal pH of soil is 5.8 to 6.8.

SELECTION OF CULTIVARS

On the basis of characters such as uniform size and shape preferably four lobes, fruit weight of >150g, uniform coloring after attaining complete maturity, with a better shelf life of more than 5 days under ambient conditions, In north India recommended hybrids are:-

Green fruited: - California Wonder, Bharat, Indra, Pusa Deepti.

Yellow fruited: - Orobelle, Super Gold, Yellow Wonder, Varun.

Red fruited: - Bombay, Tanvi, Indus 1514.

SEASON AND TIME OF SOWING

Coloured Capsicum is a cool season crop. Inside protected structures, January- February is optimum for its cultivation. For early yield, seeds are sown in the mid-October month and transplanting is done in end November. Shading is required to avoid excessive temperature during summer.

SEED RATE: Use 250-300g seed per hectare.

NURSERY RAISING

The pro-trays are filled with sterilized cocopeat + vermicompost and seeds are sown, one seed per cell to a depth of ½ cm and covered with the same media. After 15 days of sowing, Mono ammonium phosphate (12:61:0) (3g/L) and 22 days after sowing 19:19:19 (3g/L) solution has to be drenched. The seedlings will be ready for transplanting in 30-35 days.

LAND PREPARATION

Raised beds of size 90-100cm wide and 15-22cm height should be made. Between the beds, provide walking space of 40–50 cm. The crop beds are drenched using 4% formaldehyde @4 L/ m^2 of bed and covered with black polyethylene mulch sheet. Four days after treatment, the polythene sheet cover is removed.

MANURES AND FERTILIZERS

Apply 20-25 t/ha FYM during land preparation along with neem cake and 40:60:30 kg NPK/ha as basal dose and 40 kg N/ha on 30, 60 and 90 days of planting.

TRANSPLANTING

Seedlings of 30- 35 days old are used for transplanting. Seedlings should be treated with Azospirillum + PSB culture (20%) for 15 min or drenched with 3 g/L captan before transplanting. Seedlings are transplanted at a depth of 5 cm carefully by avoiding the root damage.

DRIP IRRIGATION AND FERTIGATION

Drip irrigation is given to provide 2-4L/m^2/day depending on the season, crop requirement and weather conditions. WSF (Water Soluble Fertilizers) are given through fertigation from third week after transplanting. Fertigation is to be given twice a week.

MULCHING AND SPACING

Mulching is done to conserve water to control the weeds. Black polyethylene mulch film of 30-100 micron thick, 1.2 m wide, is used to cover the planting beds. The holes of 5 cm diameter are made on the polyethylene film. The recommended spacing is 45cm x 30cm.

STAKING

This is done to provide the support to the plant to handle the load or weight of the fruits onto it. It can be done by hanging ropes and wooden sticks.

TRAINING AND PRUNING

After four weeks of transplanting, the main stem of plant is tied to train along GI wire grid provided on the top of the plants. Capsicum plants are pruned to retain four stem or two stem system. Pruning is done at weekly interval starting from 30 days after of transplanting.

DELEAFING

Deleafing is done by clipping down the leaves touching ground for better aeration to the plants and to prevent disease attacks and pest accumulation.

SOILLESS CULTIVATION- THE BIGGEST ADVANTAGE OF PROTECTED CULTIVATION

One biggest and greatest advantage of protected cultivation is soilless cultivation. Cultivate the crops without soil is known as soilless cultivation. It provides resistance to soil borne and water borne diseases and no nematode damage.

PLANT PROTECTION MEASURES

Major Insects

Insect	Symptoms	Management practice	Image
Thrips	Cause upward curling of leaves, sucks sap and reduce leaf growth, decrease absorption of nutrients and water and affect fruit bearing.	Remove affected plant parts,Spray Neem seeds kernel extract (NSKE 4%) or Pongamia / Neem soap developed by IIHR (7gm/L) or fipronil (1ml/L) or chloropyriphos (2 ml/L) or Imidacloprid (0.5ml/L).	

Mites	Suck sap, downward curling of leaves, leaf, fruit and plant size get reduced.	Remove affected plant part, spray wettable sulphur (2ml/L) or dicofol (2ml/L) or abamectin (0.5ml/L).	
Aphids	Nymph and adult suck sap from leaf veins, spread viral disease.	Neem soap (8-10g/L) or spray dimethodate (2ml/L) or Spray Pongamia / Neem soap (8-10 g/L) or imidacloprid (0.5ml/L) or thiomethoxam (0.5g/L).	
Fruit borer	Nymph feed on fruits and leaves causing heavy destruction of crop	Pick and destroy nymphs, spray carbaryl (3g/L) or thiodicarb (1ml/L) or carbaryl (3g/L) or indoxcarb (1ml/L).	

Major Diseases

Disease	Symptoms	Management	Image
Damping off	Infection takes place at the base of the young seedlings just above the ground level which leads to wilting and later death of seedlings	Drench carbendazim (1g/L) or metalaxyl MZ(2g/L) or copper oxychloride(3g/L) or captan(3g/L) drenched to the base of the plant	
Powdery mildew	Powder like material on the lower surface leading to a powdery growth which leads to drying and dropping of leaves.	Spray Pongamia /Neem oil (7ml/L) + sulphur WDG-80 (2g/L) or wettable sulphur (2g/L)	

Cercospora leaf spot	Cercospora appears initially as tiny yellow spot on leaf surface leading to increased dark grey spots which spreads on leaf.	Spray chlorothalonil (2.5g/L) or mancozeb (2.5g/L) or carbendazim (1g/L)	
Phytophthora	Appears during fruiting and flowering stage resulting in tiny oil like spot on leaf surface resulting in rottening & blackening	Spray copper hydroxy chloride (3g/L) or bordeaux mixture (1%) or metalaxyl MZ (2g/L). Severely infected plant parts should be destroyed	
Viral diseases	Tramsmitted through aphids and thrips leading to upward and downward curling of leaves with yellow spot in the middle of leaf.	Grow nursery beds under nylon cover (50 mesh), proper management of aphids, mites and thrips which acts as disease transmitting vectors and disposal of infected plants.	

Major Disorder

Disorder	Symptoms	Management	Image
Blossom End Rot	BER results from a calcium (Ca) deficiency. Symptoms begin as a light green or yellow-colored sunken spot and expand to a larger collapsed area that begins to turn black from colonization typically by saprophytic Alternaria fungal species.	Use of disease free seedlings for planting & avoid stagnation of water and good drainage to be maintained. Use CaNO3 @ 20ml/L	

HARVESTING AND YIELD

The best time to harvest the peppers is morning hours by hand and is preferable to cut the stem with a knife by avoiding damage to the surrounding peppers. Coloured fruits are harvested when they gained 60- 80 per cent colour development. Under protected structures, the crop duration of green and coloured capsicums is about 7 -10 months and yields about 80-100 t/ha than open filed yields 20-40 t/ha. The fruits are kept in cool place by avoiding direct sunlight.

STORAGE

Temperature (°C)	Relative Humidity (%)	Shelf Life
7- 8°C	90- 95 %	2 to 3 weeks

Conclusion

Coloured capsicum is a high value low volume crop which gives best results with protected cultivation than in open fields. Because of its high nutritive value, the fruits are sold at a premium price (Rs. 150/kg). So, its farming under protected cultivation can lead to additional economic benefits to the farmers by increasing yield and improving quality.

References

Atre A. A., Gorantiwar S. D., Patil H. M., Bhoi D. V. and Kulkarni J. K. 2003.Yield and water use efficieny of capsicum grown under polyhouse. All India seminar on potential and prospects for protective cultivation held on December 12-13 at Ahmednagar (MS): 142-144.

Kiruthiga B., Kumar A. K., Kumar S and Srinivas A. 2019. Effect of different drip irrigation levels on quality parameters of coloured capsicum hybrids(*Capsicum annuum* L. var. *grossum*) under shade net. *International Journal of Chemical Studies* **7**(4): 987-989.

Volume: 03 Issue No: 11

PUG MARKS OF ANIMALS

Article ID: AG-VO3-I11-92

*** Dr. S. Rajathi and Namutha S**
Assistant Professor, Department of Veterinary Anatomy
Veterinary College and Research Institute, Tirunelveli, TANUVAS, Tamil Nadu
*Corresponding Author Email ID: rajathis9936@gmail.com

Introduction

Pugmarks are the footprints of animals that are left behind when they walk on soft surfaces like sand or snow. They are an important tool for wildlife forensics and can be used to identify the presence of an animal in a particular area. Pugmarks can also provide information about the sex, age, size, health conditions of animals and the time and direction in which it moved.

In wildlife forensic, pugmarks have significant importance and considered as valuable evidence. They can be used to link an animal to a crime scene and help determine the gait patterns of the animal. Every individual animal species has distinct pugmarks, and numerous features contained in them can be used to support the identification of an animal.

Pugmarks of animals

Members of the Dog family/Canidae typically move and hunt in packs often walking long distances in a file. In these animals, the claw marks are usually noticeable in front of the toe pads. As compared to the heel pad, the toes are larger which helps them to run down prey. On the other hand, members of the Cat family/Felids lead a solitary existence and depend on stealth for hunting down prey. They are acceptable climbers and some like leopards take their hunt to a tree for abstaining from poaching by different carnivores. The claws/nails are hardly ever visible, and soft heel pad is comparatively large.

Pugmarks can be produced under different circumstances. The impressions of the pug may be caused in mud, snow, sand or similar soft surfaces. These impressions will be depressed or 3-D type and these are known as “sunken pugmarks”. If the pugmark is produced by the deposition of material like dust, dirt, blood, coloured powdery substance, etc…, on hard and smooth surfaces, giving rise to a 2-D print which is called "surface pugmarks".

ARTIODACTYLA

Characteristics of Fore Foot Pugmarks

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Goat	Oval	Small	Absent	Absent	Tip of the hooves mark are circular and bottom is arch in shape
Pig	2 bilaterally symmetrical mark	Medium	Present	Absent	Marks of the dew claws present behind
Deer	Oval	Small	Absent	Absent	Tip of the hooves mark are slightly pointed and bottom is circular
Cow	2 bilaterally symmetrical mark	Large	Absent	Absent	Tip is circular and bottom of the hooves mark is arch in shape
Buffalo	2 bilaterally symmetrical mark somewhat oval	Large	Absent	Absent	Both tip and bottom of the hooves mark is arch in shape
Bull	2 bilaterally symmetrical mark	Large	Absent	Absent	Complete shape of mark is apple shape
Sheep	2 bilaterally symmetrical mark upside down heart shape	Medium	Absent	Absent	Tip of the hooves mark are circular and bottom is arch in shape

PUG MARK OF DEER

PERISSODACTYLA

Characteristics of Fore Foot Pugmarks

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Horse	Upside down heart shape	Large	Absent	Absent	The hoof is not cloven or it is not divided into two equal parts
Donkey	Circular	Medium	Absent	Absent	The hoof is pyramid in shape
Elephant	Round	Large	Absent	Absent	Scale marks are present

PUG MARK OF HORSE

Characteristics of Hind Foot Pugmarks

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Donkey	Circular	Large	Absent	Absent	Rear side of the hoof mark is W in shape
Elephant	Oval	Large	Absent	Absent	The hoof is not cloven
Horse	Upside down heart shape	Large	Absent	Absent	The hoof is not cloven or it is not divided into equal parts

ANISODACTYLA

CHARACTERISTICS OF FORE FOOT PUGMARK

BIRD NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Hen	Anisodactylie	Small	Absent	Absent	All the four toes marks are slightly pointed
Duck	Anisodactylie	Large	Absent	Absent	Webbed feet

CHARACTERISTICS OF HIND FOOT PUG MARK

BIRD NAME	CHARACTERISTICS
Hen	No hind foot present
Duck	No hind foot present

CLAW MARK OF HEN

LEPORIDAE

CHARACTERISTICS OF FORE FOOT PUGMARK

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Rabbit	Somewhat oval	Small	Absent	Absent	Five toes show on front feet

CHARACTERISTICS OF HIND FOOT PUGMARK

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACRTERISTICS
Rabbit	Somewhat baby human foot print shape	Large	Absent	Absent	Five toes show on rear foot

PUG MARK OF RABBIT

FELIDAE

CHARACTERISTICS OF FOREFOOT PUGMARK

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Cat	Central pad is Circular shape	Medium	Absent	Absent	Front of heel pad has 2 lobes and rear has 3 lobes

CHARACTERISTICS OF HIND FOOT PUG MARK

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Cat	Central pad is somewhat upside down heart shape	Medium	Absent	Absent	Front of heel pad has 1 lobe and rear has 2 lobes

PUG MARK OF CAT

CANIDAE

CHARACTERISTICS OF FOREFOOT PUG MARK

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Dog	Upside down heart shape heel pad	Medium	Absent	4 marks present	Front heel pad has 1 lobe and rear has 2 lobes

CHARACTERISTICS OF HIND FOOT PUGMARK

ANIMAL NAME	SHAPE	SIZE	DEW MARK	CLAW MARK	CHARACTERISTICS
Dog	Upside down heart shape heel pad	Medium	Absent	Present	Heel pad is smaller as compared with the heel pad of forefoot

PUG MARK OF DOG

Conclusion

Pug marks are essential for animal identification and useful in forensic veterinary aspects. Measurements of pug marks will differentiate male from female, young from adult within the species and age of the animals can also be judged from pug marks.

Volume: 03 Issue No: 11

RED BANDED THRIPS INFESTATION IN CASHEW PLANTS

Article ID: AG-VO3-I11-93

K. Vanitha*, Babli Mog and Aswathy Chandrakumar

ICAR-Directorate of Cashew Research, Puttur - 574 202, Karnataka, India.

*Corresponding Author Email ID: vanis102@gmail.com

Abstract

Thrips are one of the pests infesting cashew. Red banded thrips infests leaves and flowers. Infestation at nursery stage can lead to death of the seedling. This article provides details on its host range, biology, damage symptoms and management measures.

Key words: thrips, cashew, leaf crinkling, red banded.

Introduction

The cashew is an economically important tree nut crop grown in tropical and semi-tropical regions of the world. It grows in a wide range of climatic and soil conditions. The cashewnuts and the cashew apples (pseudo fruits) are highly nutritious. Cashew has a wide range of food and industrial applications. Apart from nuts and fruits, the cashewnut shell liquid (CNSL) which is a by-product obtained while processing the raw cashewnuts also has its applications in the manufacture of brake linings, friction dust, resins, paint and lacquer, etc. Further, anacardic acid, cardanol and cardol derived from the CNSL have great pharmaceutical applications. Among the various biotic and abiotic stresses limiting cashew productivity, insects are considered important.

Pests of cashew

Cashew is known to be infested by nearly 400 insect pests all over the world (Vanitha and Saroj, 2015). Among all pests infesting cashew, two pests namely tea mosquito bug (*Helopeltis* spp.) (Miridae: Hymenoptera), cashew stem and root borer (*Neoplocaederus* spp.)

(Cerambycidae: Hymenoptera) are considered as important. While there are other pests like leaf miner, apple and nut borer, leaf and blossom webber, thrips, inflorescence caterpillars that can cause considerable damage depending on the season. Thrips are minute insects belonging to the insect order, Thysanoptera. There are thrips species infesting cashew leaves and flowers. A total of 10 species of thrips have been recorded in India, in which leaf thrips include 3 species viz., *Selenothrips rubrocinctus* Giard (Thysanoptera: Thripidae), *Rhipiphorothrips cruentatus* Hood (Thysanoptera: Thripidae) and *Retithrips syriacus* (Mayet) (Thysanoptera: Thripidae).

Red banded thrips (*S. rubrocinctus*)

S. rubrocinctus is widespread in tropical and subtropical countries. Its native range is uncertain, and it is considered to originate either from northern South America or Africa. There is only one species recognized in this genus. Initially, this species was described as cocoa thrips. It is also known as red-banded thrips, due to the presence of two characteristic bright red bands around the abdomen at its nymphal stage. The characteristic features of this species are given below.

a. Pest appearance

Adults are dark brown and about 1-2 mm long. Nymphs are pale yellowish and have a red band around the middle of their body. Eggs are laid singly into the lower epidermis and covered with excrement.

b. Host plants

It is polyphagous and can be found on a wide range of fruit and ornamental trees and shrubs. It is a pest on avocado (*Persea americana*), cashew (*Anacardium occidentale*), cocoa (*Theobroma cacao*), grapevine (*Vitis vinifera*), mango (*Mangifera indica*) etc.

c. Biology

Eggs were laid by the female below the epidermis of the leaf by inserting the ovipositor of the female. Egg stage lasts for 3-4 days. There are two nymphal instars. The nymphal stages are light yellow with two characteristic bright red bands around the abdomen (Fig. 2a) and the total nymphal period lasts 3.5-4.5 days. The pre-pupal stage and pupal stage are 1-1.5 days and 2-3 days, respectively. The total life cycle of the thrips is completed in around 4 days (2 weeks) having a very short life cycle, thus overlapping generations of the thrips cause severe damage to the infested plants (Pragyan and Mukherjee, 2021). Adult thrips are dark brown to black in colour and about 1.2 mm long (Fig. 2b). All the pest stages can be seen on the leaves.

Fig. 1. Developmental stages of *S. rubrocinctus*, a. Nymphal stages carrying its excreta, b. Pupal and adult (black) stage.

d. Symptoms of damage

In cashew seedlings, initially it attacks lower leaves. The symptoms of thrips damage include crinkling of leaves, development of pale brown spots, premature leaf fall, stunting and drying of seedlings. Numerous small, shiny black spots of excreta (honey dew) are commonly seen underneath the leaves and the leaf edges are curled. It is commonly found in the seedlings grown in net house conditions..

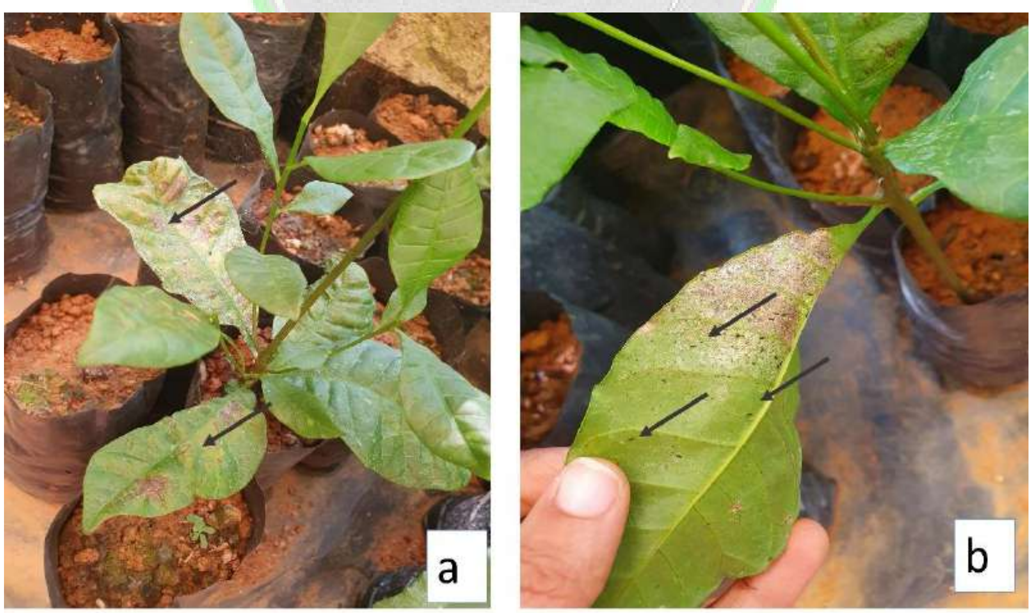


Fig. 2. Damage symptoms of *S. rubrocinctus* a. pale brown spots and crinkling b. arrows indicate adults underneath the leaves.

This pest is more active during summer months. According to Igboekwe (1985), damage by up to 160 adult thrips on 6-week-old cashew plants did not differ significantly from the control but, infestation rates of 240 thrips and above caused significant defoliation and shoot weight loss suggesting the need to spray chemical insecticides to control thrips on the basis of pest numbers. There are reports on this species damage on flowers (Bigger et al., 1969) and fruits also. In the early stages, feeding damage is seen as a silvery sheen on the leaves and skin of fruit or as chlorotic spots. This species is particularly common on weak or damaged host plants, taking advantage of nutritional abnormalities by feeding on the leaves. Populations increase particularly when plants are water stressed (Fennah, 1965)

e. Management measures

There are several natural enemies that help in bringing down the thrips population. Several spider species, mites (*Wasmannia auropunctata*), wasp parasite (*Goetheana shakespearei*), lacewings (Chrysopidae), predatory thrips (*Franklinothrips tenuicornis*, *Franklinothrips vespiformis*), predatory bugs (*Termatophylidea maculata*), especially minute pirate bugs (*Orius thripoborus*).

Chemical controls are not always necessary for this thrips, as natural controls are apparently effective in most of the cases (Denmark & Wolfenbarger 1971).

References

Bigger, M. 1960. *Selenothrips rubrocinctus* (Giard) and the Floral Biology of Cashew in Tanganyika. *The East African Agricultural Journal*, 25:4, 229-234, DOI: 10.1080/03670074.1960.11665270

Denmark, H.A, and Wolfenbarger, D. O. 1971. Red banded thrips, *Selenothrips rubrocinctus* (Giard) (Insecta: Thysanoptera: Thripidae). Entomology Circular No. 108. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, 4 pp. http://edis.ifas.ufl.edu/in256.

Fennah, R. G. 1965. The influence of environmental stress on the cacao tree in predetermining the feeding sites of cacao thrips, *Selenothrips rubrocinctus* (Giard), on leaves and pods. *Bulletin of Entomological Research*, 56: 333-349.

Igboekwe, D. 1985. Injury to young cashew plants, Anacardium occidentale L., by the red-banded thrips, *Selenothrips rubrocinctus* Giard (Thysanoptera: Thripidae). *Agriculture, Ecosystems & Environment*, 13 (1): 25-32, https://doi.org/10.1016/0167-8809(85)90098-2.

Pragyan, S, S. and S. K. Mukherjee. 2021. Studies on biology of red banded foliage thrips (*Selenothrips rubrocinctus*) under Bhubaneswar conditions of Odisha. *Journal of Pharmacognosy and Phytochemistry*, 10(1): 2754-2756.

Vanitha, K. and Saroj, P.L. 2015. Insect pests of cashew and their management. Technical Bulletin No. 27. ICAR-Directorate of Cashew Research, Puttur, 69p.

Volume: 03 Issue No: 11

REMOTE SENSING APPLICATIONS IN AGRICULTURE

Article ID: AG-VO3-I11-94

***P. Shanmugapriya[1], S. Rathika[2], T. Ramesh[3]**

1Senior Research Fellow, Tamil Nadu Agricultural University, Coimbatore-641 003

2Associate Professor, Anbil Dharmalingam Agricultural College and Research Institute,

3Associate Professor and Head, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli-620 027. Tamil Nadu

Corresponding Author E-mail ID: shanmugapriyapalanisamy96@gmail.com

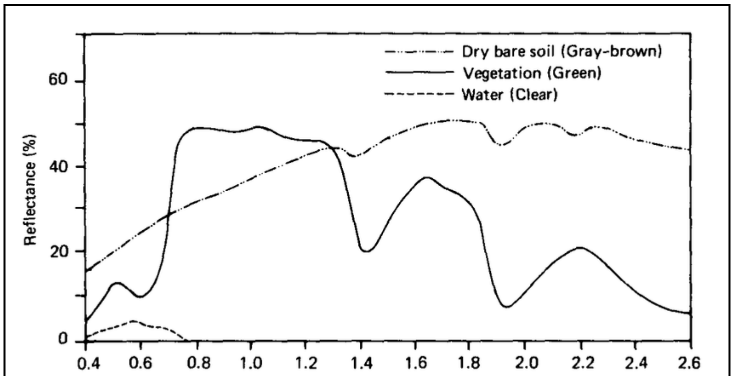
Abstract

Remote sensing is the art and science of obtaining information about an object or area without being in contact with the object. It is a tool for monitoring the earth's surface features by providing timely, synoptic, cost efficient and repetitive information (Justice *et al.*, 2002). Remote sensing technology plays a major role in enhancing the agricultural productivity by characterization and detection of crops and/or soils (Liaghat and Balasundram, 2010), yield estimation (Doraiswamy *et al.*, 2005; Bernerdes *et al.*, 2012), crop phenological information (Sakamoto *et al.*, 2005), detection of stress situations (Gu *et al.*, 2007) and disturbances. Different types of sensors used in remote sensing are capable of providing reliable data on a timely basis on a fraction of the cost of traditional method of data gathering.

Keywords: Remote sensing, electromagnetic spectrum, atmosphere, reflectance

Introduction

The principle behind remote sensing is the use of electromagnetic spectrum (visible, infrared and microwaves) for assessing the earth's features. Detection and discrimination of objects or surface features means detecting and recording of radiant energy reflected or emitted by objects or surface material. Different objects return different amount of energy in different bands of the electromagnetic spectrum, incident upon it (refer figure 1). This depends on the property of material (structural, chemical, and physical), surface roughness, angle of incidence, intensity and wavelength of radiant energy. It can also be used in crop growth monitoring, land use pattern and land cover changes, water resources mapping and water status under field condition, monitoring of diseases and pest infestation, forecasting of harvest date and yield estimation, precision farming and weather forecasting purposes along with field observations.



Source: Lillesand & Kiefer

Stages in Remote Sensing

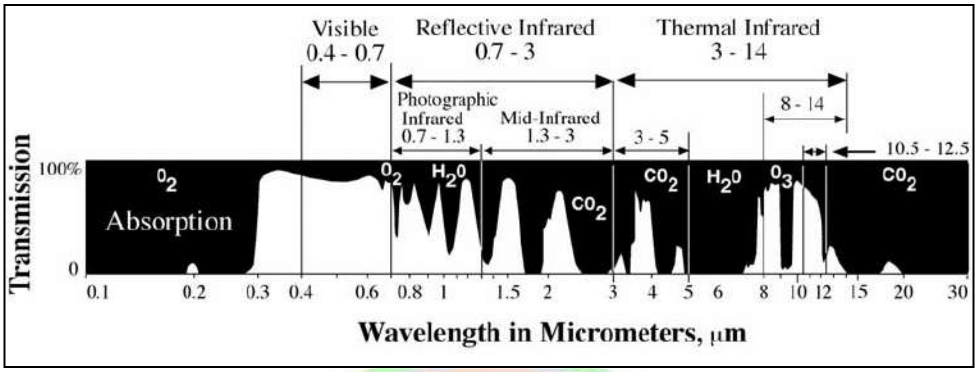
- Emission of electromagnetic radiation, or EMR (sun/self- emission)
- Transmission of energy from the source to the surface of the earth, as well as absorption and scattering
- Interaction of EMR with the earth's surface: reflection and emission
- Transmission of energy from the surface to the remote sensor
- Sensor data output

Atmospheric Absorption

The gas molecules present in the atmosphere are responsible for absorbing the EMR passing through the atmosphere in certain spectral bands. Mainly three gases are responsible for most of absorption of solar radiation *viz.*, ozone, carbon dioxide and water vapour. Absorption relatively reduces the amount of light that reaches our eye making the scene look relatively duller.

Atmospheric windows

The atmosphere selectively transmits energy of certain wavelengths. The spectral bands for which the atmosphere is relatively transparent are known as atmospheric windows. Atmospheric windows are present in the visible part (0.4 µm to 0.76 µm) and the infrared regions of the electromagnetic spectrum. In the visible part transmission is mainly effected by ozone absorption and by molecular scattering. The atmosphere is transparent again beyond about λ= 1mm, the region used for microwave remote sensing.

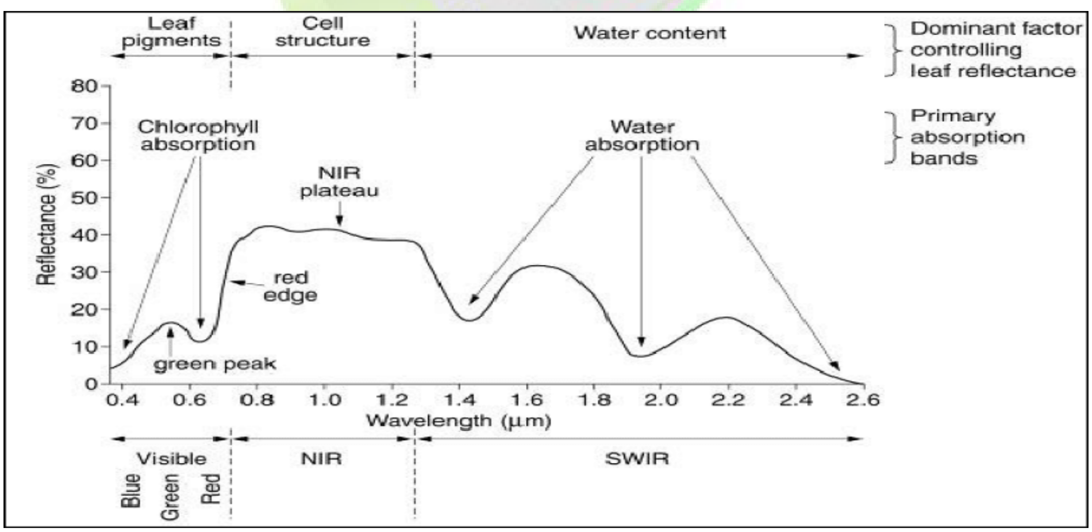


Source: Alavipanah *et al.* (2008)

Reflectance Characteristics of Earth's Cover types

Vegetation:

The spectral characteristics of vegetation vary with wavelength. Plant pigment in leaves called chlorophyll strongly absorbs radiation in the red and blue wavelengths but reflects green wavelength. The internal structure of healthy leaves acts as diffuse reflector of near infrared wavelengths. Measuring and monitoring the near infrared reflectance is one way that scientists determine how healthy particular vegetation may be.



Source: Kallepalli (2014)

Water:

Majority of the radiation incident upon water is not reflected but is either absorbed or transmitted. Longer visible wavelengths and near infrared radiation is absorbed more by water than by the visible wavelengths. Thus water looks blue or blue green due to stronger reflectance at these shorter wavelengths and darker if viewed at red or near infrared wavelengths. The factors that affect the variability in reflectance of a water body are depth of water, materials within water and surface roughness of water.

Soil:

The majority of radiation incident on a soil surface is either reflected or absorbed and little is transmitted. The characteristics of soil that determine its reflectance properties are its moisture content, organic matter content, texture, structure and iron oxide content. The soil curve shows less peak and valley variations. The presence of moisture in soil decreases its reflectance. By measuring the energy that is reflected by targets on earth's surface over a variety of different wavelengths, we can build up a spectral signature for that object. And by comparing the response pattern of different features we may be able to distinguish between them, which we may not be able to do if we only compare them at one wavelength. For example, Water and Vegetation reflect somewhat similarly in the visible wavelength but not in the infrared.

Conclusion

Remote sensing data is increasingly being utilized to map not only land cover but also land use, which has a big impact on CO_2 fluxes. Land use practices that influence land owner carbon credit eligibility will benefit greatly from such data. Finally, agricultural remote sensing is advancing toward nano-scale analyses. Nano-chips are implanted in plant and seed tissue and can be utilized in near-real time to monitor crops in a novel and nontraditional remote sensing application. Clearly, these and other novel methodologies will emphasize the importance of remote sensing in agricultural science analysis in the future.

References

Alavipanaha, S.K., Matinfarb H.R., Rafiei Emamc A., Khodaeid K., Hadji Bagherie R. and Yazdan Panahf A., (2008). Criteria of selecting satellite data for studying land resources. *Desert*. 15:83-102.

Bernardes T., Meriera M.A., Adami M., Giarolle A. and Rudorff B.F.T., (2012). Monitoring biennial bearing effect on coffee yield using MODIS remote sensing imagery. *Remote Sens.* 4:2492-2509.

Doraiswamy P.C., Sinclair T.R., Hollinger S., Akhmedov B., Stern A. and Prueger J., (2005). Application of MODIS derived parameters for regional crop yield assessment. *Remote Sens Environ.* 97:191-202.

Gu Y., Brown J.F., Verdin J.P. and Wardlow B., (2007). A five year analysis of MODIS NDVI and NDWI for grassland drought assessment over the central great plains of the United States. *Geophys Res Lett.* p.34.

Justice C.O., Townshend J.R.G., Vermata E.F., Masuoka E., Wolfe R.E., Saleons N., Ray D.P. and Morisette J.T., (2002). An overview of MODIS Land data processing and product status. *Remote Sens Environ.* 83:3-15.

Kallepalli, A., (2014). Spectral and spatial indices based Specific class identification from Airborne Hyperspectral data. *Master's thesis*, Faculty of Geo-information Science and Earth Observation (ITC), University of Twente.

Liaghat S. and Balasundram S.K., (2010). A Review: The Role of Remote Sensing in Precision Agriculture. *American Journal of Agricultural and Biological Sciences.* 5(1):50-55.

Sakamoto T., Yokozawa M., Toritani H., Shibayama M., Ishitsuka N. and Ohno H., (2005). A crop phenology detection method using time series MODIS data. *Remote Sens Environ.*, 96:366-74.

Volume: 03 Issue No: 11

SEED ABORTION AND METHODS TO OVERCOME IT

Article ID: AG-VO3-I11-95

A. Reshma*

*Scientist (Plant Physiology), Dr. YSRHU-Banana Research Station, Pulivendula

Dr. YSR Horticultural University, A.P. India

*Corresponding Author Email ID: reshmaamasa@gmail.com

Abstract

Seed abortion is a common phenomenon in flowering plants. It is the mortality of immature seeds between fertilization and seed maturation. Seed abortion may be due to several reasons. Four patterns of seed abortion have been described, i.e abortion occurs either at the base of the fruit, the stylar end, both ends of the fruit or at other positions. To overcome seed abortion, a range of *in vitro* methods have been developed to overcome post-fertilization barriers in a number of plant species.

Introduction

Seed abortion, a common phenomenon in flowering plants, is the mortality of immature seeds between fertilization and seed maturation. Pod and seed losses occur through abortion of flowers, pods and seeds, which generally coincides to a cessation of embryo development occurring at different stages either for all or only some of the seeds in a pod. Several multi-ovulated species are reported to show abortion of seeds before maturation.

Seed Abortion is due to several reasons

- Lack of pollination and/or fertilization.
- Resource limitation
- Genetic load: It is mainly caused by recessive lethal and partially recessive deleterious mutations. Genetic load is the difference between the fitness of the theoretically optimal genotype in a population and the fitness of the observed average genotype in a population.

This means that populations with a low genetic load will tend to be healthier, have fitness that is less dispersed, and have offspring that are more likely to survive to reproduction. On the other hand, populations with a high genetic load will have a greater variance in fitness levels; furthermore, a population with a high genetic load is not likely to have as many organisms at or near the optimal fitness.

- Genetic load can be looked at as the probability that an organism will reach its reproductive age. Genetic load is the reduction in selective value for a population compared to what the population would have if all individuals had the most favored genotype. Part of the genetic load is expressed during embryo development. Many predominantly outcrossing perennial species carry high numbers of recessive alleles that cause abortions of homozygous embryos. Abortion is generally rare among seeds derived from random outcrossing, but very common among self-fertilized seeds. Thus, the amount of genetic load expressed at the seed stage depends on the rate of self-fertilization and on the number of embryonic lethal genes an individual carries.
- Parent-offspring conflict: Seed abortion is also reported as a result of overproduction of ovules as a strategy to overcome the unfavourable conditions. It has been suggested that abortion of ovules in perennials is caused partly by early acting genetic load. However, it is still unclear. Variation between maternal genotypes may be an even more important factor causing genetic abortions than early load. Comparison of naturally pollinated and experimentally cross pollinated seeds showed that the abortion rate of naturally pollinated seeds was only slightly, and not statistically significantly higher than that of experimentally cross pollinated seeds (30% vs. 26.5%, respectively). Thus, although early load can be high under self pollination in some crops, it does not account for a high share of abortions of naturally pollinated seeds. Instead, maternal genotype determined the seed abortion rate.

The causes of seed abortion are similar to the causes of pod abscission. To continue development, seeds require a steady flow of water, carbohydrates, and mineral nutrients. Stresses that reduce any of these requirements may increase seed abortion. Because developing seeds are most vulnerable to abortion early in their development, stress during critical growth stage is more likely to reduce seed number per pod than stresses that occur earlier or later in the growing season.

In many plants, the pattern of seed abortion within developing fruits is non random. Four patterns of seed abortion have been described. Abortion occurs either at

(i) the base of the fruit

(ii) the stylar end

(iii) both ends of the fruit or at

(iv) other positions

Overcoming seed abortion:

A range of *in vitro* methods have been developed to overcome post-fertilization barriers in a number of plant species. When abortion occurs in a very young stage and maternal tissue has no negative influence on the development of seeds, ovary culture can be applied: young fruits can be grown *in vitro* to a stage at which dissection of embryos is possible. In some crops, the ovary is large and slicing the ovary in small parts and influencing them, is a better option for rescuing the young seedlings *in vitro*. This technique is referred to as 'ovary slice culture'. When the mismatch between embryo and endosperm development starts very early and ovary culture and/or ovary slice culture fails, ovules can be dissected out of the ovaries and be cultured *in vitro*. If young fruits can stay for a longer time on the mother plant, embryo rescue can be applied by different methods: *in ovulo* rescue and embryo rescue. Since embryo culture employed for the first time 90 years ago, these techniques are applied in numerous crops.

- **Ovary culture and ovary-slice culture**

Ovary culture has been applied in many species: *Brassica*, *Eruca-Brassica* hybrids, *Lilium*, *Nerine* and *Tulipa*, and *Phaseolus*. Ovary-slice culture was applied for the production of inter specific *Lilium* hybrids. Ovaries were harvested 7-40 days after intra stylar pollination and, after surface sterilizing, sliced into 2 mm thick disks.

- **Ovule culture**

In those crops in which the fruit is aborted before embryo culture can be applied, ovule culture is an easy and fast method. This technique is applied in *Lycopersicon*, *Nicotiana* and *Vitis*. Depending on the genotypic combination of the interspecific crossing, the percentage of seedlings obtained from ovule culture varied from 0.5-22.5%.

- **Embryo culture**

Embryo culture can be applied successfully in crosses in which pollinated flowers can stay on the plant for a notable time, before natural abscission occurs. This method has been applied in a large number of crops. Some recent examples are: *Allium*, *Alstroemeria*, *Freesia*, *Howea* , *Lilium*, *Lycopersicon* and *Solanum*. To overcome the problems involved in isolating the young embryos from ovules and providing suitable conditions for their growth, embryo culture has been modified in some systems. The ovule is cut in half and the cut halves, or only the halves containing the embryo, are cultured in a liquid medium. Out of these half ovules germinating embryos emerged, which could be raised to plantlets on a solid medium. A large number of interspecific and intergeneric hybrids have been produced in *Brassica* through sequential culture of ovary, ovule and often embryo. In sequential culture, ovaries are initially cultured for 6-10 days. Enlarged ovules are excised from cultured ovaries and recultured on a fresh medium. Hybrids are realized either directly from cultured ovules or after excising and culturing the embryos.

Conclusion

Embryo culture, sometimes called embryo rescue, is an in vitro technique that has been used for more than half a century to save the hybrid products of fertilization when they might otherwise degenerate. Many unsuccessful crosses result from embryo abortion. Early embryo abortion occurs primarily because the endosperm fails to develop properly. With interspecific crosses, intergeneric crosses, and crosses between diploids and tetraploids, the endosperm often develops poorly or not at all. By aseptically culturing the embryo in a nutrient medium, this problem may be overcome.

Volume: 03 Issue No: 11

THE SEEDS ACT (1966) FOR REGULATION OF SEED QUALITY IN INDIA

Article ID: AG-VO3-I11-96

Parameswari,K[1]., R.Umarani[2] and S. Nakkeeran[3]

[1]Associate professor, Agricultural College and Research Institute, Pudukottai

[2]Director(Seeds), Seed Centre, Tamil Nadu Agricultural University, Coimbatore

[3]Dean, Agricultural College and Research Institute, TNAU, Pudukottai, Tamil Nadu

*Corresponding Author Email ID: parameswarikali@gmail.com

Abstract

Any new variety produced by the plant breeder has to be multiplied to many times to meet the needs of the farmers. In order to ensure the availability of quality seeds, Government of India have enacted Seeds Act 1966 and came into force during 1969. The goal of the seed act is for regulating the quality of certain notified kind / varieties of seeds for sale and for matters connected therewith. This act has designed to create a suitable environment in which the seed man could operate effectively produced good quality seeds and make it available to the farmers in time. This act has 25 sections and covered to the whole of India.The important features of Seed Act 1966 are seed legislation which includes sanctioning legislation and regulatory legislation. Sanctioning legislation formation of advisory bodies *viz.*, Seed Certification Agencies, Seed Testing Laboratories, Foundation and Certified seeds programmes, Recognition seed certification agencies of foreign countries, Appellate authorities, *etc*. Regulatory legislation controls the quality of seeds sold in the market including agencies for regulating the seed quality. Quality control as envisaged in the Act is to be achieved through pre and post control, voluntary certification and compulsory labeling of the seeds of notified kind or varieties.

Introduction

Any new variety produced by the plant breeder has to be multiplied into huge quantity without any deterioration in its seed quality to satisfy the wishes of the farmers. Which will make sure the provision of good quality seeds, Government of India have enacted Seeds Act, 1966 and

Seed Rules, 1968. The Seed (control) order 1983 became promulgated beneath Essential Commodities Act, 1955 so as to make sure the production, marketing and distribution of the seeds.

1. SEEDS ACT 1966

The objective of Seeds Act is for regulating the quality seeds of notified varieties / kinds of seeds on the market and for subjects related therewith. The Seeds Act exceeded by means of the Indian Parliament in 1966 was designed to create a 'climate' in which the seeds man ought to function successfully and to make appropriate excellent seed available to cultivators. Seed Rules under the Act have been notified in September, 1968 and the act changed into implemented in October 1969. This act has 25 sections.

The principal functions of Seed Act, 1966 are:

Seed legislation system has divided into two main groups.

1.1. Sanctioning legislation

Sanctioning legislation authorizes formation of advisory bodies Seed Certification Agencies, Seed Testing Laboratories, Foundation and Certified Seed Programmes, Recognition of Seed Certification Agencies of Foreign countries. Appellate authorities, *etc.*

Central Seed Committee: the main functions of the Central Seed Committee as envisaged within the Act and regulations are:

a. To advise State and Central Governments on all matters associated with seeds
b. To suggest Government regarding notification of such kinds/ varieties for which it thinks it has grown to be essential or expedient to regulate the quality of seeds.
c. To suggest Government at the minimal limits for germination and purity for those kinds/varieties brought below the purview of the Seeds Act
d. To recommend suitable method and standards for certification, for conducting grow-out tests and analysis of seeds.
e. To advise the Central Government for establishment of seed certification agencies in any foreign country for the purposes of this Act.
f. To endorse the price of costs to be charged for analysis of samples by way of the central and state Seed Testing Laboratories and for certification with the aid of certification agencies.
g. To advise the Central and State Governments regarding suitability of Seed testing Laboratories.

h. To send its tips and other pertinent proposals associated with the Act to the Central Government.

i. To perform such different features as are supplemental incidental or consequential to any of the capabilities conferred through the Act or Rules.

Central Seed Certification Board: The government of India has also constituted the Central Seed Certification Board to cope with all issues related to seed certification and to co-ordinate the work of State Seed Certification Agencies.

State Seed Certification Agency: The capabilities designated for the Seed Certification company beneath the Act are:

- Preserve a listing of recognized breeders of seeds.
- Verify, upon receipt of an application for certification, that the variety is eligible for certification, that the seed source used for planting is authenticated and the record of purchase is in accordance with these rules and that the expenses had been paid;
- Take seed sample and inspect seed lots produced underneath the procedure laid down by the certification agency and feature such samples examined to ensure that the seed conforms to the prescribed standards of certification.
- Investigate seed processing units to verify the possibilities admixtures of different kinds and varieties aren't introduced.
- Make sure that action at all stages, e.g. field inspection, seed processing plant inspection, analysis of samples taken and issuance of certificates (inclusive of tags, marks, labels and seals) is taken expeditiously.
- Adopt academic programmes designed to promote the usage of certified seed, consisting of a publication listing certified seed growers and source of certified seed.
- Grant certificates (which includes tags, labels, seals, and so on.) in accordance with the provisions of the Act and these Rules.
- Maintain such records as may be important to verify that seed fields for the production of certified seed have been eligible under the Rules,
- Inspect fields to make sure that the minimum standards for isolation, rouging (where applicable), use of male sterility (in which relevant) and comparable elements are maintained at all times, as well as to ensure that seed-borne diseases aren't present in the field than those provided in the standards for certification.

Central Seed Testing Laboratory (National Seed Research and Training Centre):

The functions assigned to this laboratory are:

a. Initiate testing programme in collaboration with the State Seed Testing Laboratories and designed to promote uniformity in test results among all seed laboratories in India.

b. Acquire information continuously on the quality of seeds observed in the marketplace and make this data available to the Committee.

c. Carry out such other features as can be assigned to its by way of the Central Government from time to time and

d. Act as referee laboratory in testing seed sample for achieving uniformity in seed testing. The State Seed Testing Laboratories are required to send 5 percent samples to the Central Seed Testing Laboratory along with their analysis results.

State Seed Testing Laboratories: The Act envisages the establishment of State Seed Testing Laboratories in each State by notification in the official Gazette. The feature of the State Seed testing Laboratory is to carry out the seed analysis work of the State in a prescribed manner

Appellate Authority: The Act envisages appointment of an appellate authority/authorities through an official notification in the Gazette through the State Governments to look at the grievances of certified seed producers in opposition to a seed certification officials.

Recognition of seed certification agencies of foreign countries: The Central Government, on the advice of the Central Seed Committee and by way of notification inside the reliable Gazette, may additionally recognize any seed certification agency mounted in any foreign country, for the cause of the Indian Seeds Act, 1966.

1.2. Regulatory legislation

Regulatory legislation controls the quality of seeds sold in the market including suitable agencies for regulating the seed quality.

On quality control basis, the Seeds Act could easily be divided into the following

1.3. Minimum limit and labelling of the notified kind / varieties of seed

Quality control as envisaged in the Act is to be performed through pre-and-post marketing control, voluntary certification and compulsory labeling of the seeds of notified kind / varieties.

1.3.1. Power to notify the kind / varieties

New varieties evolved by the State Agricultural Universities and ICAR institutes are notified and release /notified respectively under section 5 of the seeds act in consultation with the Central

Seed Committee and its sub committees constitute under section 3 and 3(5) of the Seed Act. As on date, more than 2500 varieties and 130 varieties were notified and denotified under this section.

1.3.2. Labelling provision

Minimum limits for germination, physical purity and genetic purity of varieties / hybrids for crops have been prescribed and notified for labelling seeds of notified kind/ varieties under section 6(a) of the Seed Act.

1.3.3. Seed testing

There may be a provision to set up a Central Seed Testing Laboratory and State Seed Testing Laboratory to discharge functions under section 4(1) and 4(2) of the Seed Act. In the year, 1968 there were 23 State Seed Testing Laboratories in the country. At present, there are 102 Seed Testing Laboratories functioning within the country.

1.3.4. Seed Analyst

State Government should appoint the Seed Analysts through notification in the official Gazette under section 12 of the Seed Act defining his place and his jurisdiction. Seed Analyst should possess certain minimal qualification as prescribed under clause 20 part IX of Seed Rules.

Duties of Seed Analyst

a. On receipt of a sample for evaluation the Seed Analyst shall first confirm that the mark and the seal of fastening as provided in clause (b) of sub-section (1) of segment 15 are intact and shall not the condition of the seals theron. It may be opened via any other officer legal in writing in that behalf by means of the Seed Analyst, who shall document the circumstance of the seal on the packet.

b. The Seed Analyst shall analyse the same in accordance with provisions of the Act and Seed Rules.

c. The Seed Analyst shall provide the replica of the copy of the result of the analysis to the persons specified in sub-section (1) of section 16 of the Act.

d. The Seed Analyst shall, from time to time, forward to the State government the reports giving the result of analytical work executed by him.

1.3.5. Seed Inspectors

The State Government, under section 13 of the Act may appoint such a person as it thinks fit, having prescribed qualification (Clause 22 part IX of Seed Rule) through notification, as a Seed

Inspector and outline the regions within which he shall exercising jurisdiction for enforcing the seed law. Every Seed Inspector shall be deemed to be a public server within the meaning of section 21 of the Indian Penal Code (45 of 1860) and will be official subordinate to such authority because the State Government may additionally specify on this behalf.

He has power to examine records, register and document of the seed dealer. He'll additionally workout such different powers as can be vital or carrying out the functions of this Act or rule made there below. Obligations of Seed Inspectors are described in clause 23 of Part IX of Seed Rule. He can issue stop sale order in case the seed in question contravenes the provision of relavent Act and Rules for which he can use form No.III. When he seizes any record, register, documents or another material he must inform a magistrate and take his order for which he can use Form No.IV.

Powers of Seed Inspectors

1. To take samples of seed of any notified kind/variety from any person selling such seed, or purchaser of consignee and send such samples for analysis to the Seed Analyst notified for the area
2. To enter and search, at all reasonable time, with such assistance, if any, as he considers necessary, any place in which he has reason to believe that an offence under this Act has been or is being committed and order in writing the person in possession of any seed in respect of which the offence has been or is being committed, not to dispose of any stock of such seed for at specific period not exceeding thirty days or, unless the alleged offence is such that the defect may be removed by the possessor of the seed, seize the stock of such seed.
3. To examine any record, register, document or any other material object found in any place mentioned in clause (2) and seize the same, if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act and exercise such other powers as may be necessary for carrying out the purposes of this Act or any Rule made there-under.
4. On demand to pay the cost of seed, calculated at the rate at which such seed is usually sold to the public, to the person from whom the same is taken.
5. To break-open any container in which any seed of any notified kind or variety may be contained, or to break-open the door of any premises

6. Provided that the power to break-open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, refuses to open the door on being called upon to do so.
7. Where the Seed Inspector takes any action under clause (a) of sub-section (1), he shall, as far as possible, call not less than two persons to be present at the time when such action is taken and take their signatures on a memorandum to be prepared in the prescribed form and manner.
8. The provisions of the Code of Criminal Procedure, 1898, shall, so as may be, apply to any search or seizure made under the authority of a warrant issued under section 98 of the said Code.

1.3.6. Penalty

If any person, contravenes any provision of the Act or Rule, or prevents a Seed Inspector from taking sample under this Act or prevents a Seed Inspector from exercising any other power conferred on him could be punished under section 19 of the Act with a fine of five hundred rupees for the fist offence. In the event of such person having been previously convicted of an offence under this section with imprisonment for a term, which may extend to six months or with fine, which may extent to one thousand rupees or with both.

1.4. Seed certification

The object of the Seed Certification is to maintain and make available to the public through certification of high quality propagating material of notified kind / varieties so grown and distributed as to ensure genetic identify and genetic purity. The certified standards inforce are Indian Minimum Seed Certification Standards and seed certification procedures form together for the seed certification regulations. Seed of only those varieties which are notified under section 5 of the Seed Act shall be eligible for certification.

- Breeder seed
- Foundation seed
- Certified seed

1.5. Restriction of export and import of seeds - Seed Control Order, 1983

There is a provision to restrict export and import of seeds of notified kinds or varieties. The section 17 define as under "No person shall for the purpose of sowing or planting by any person (including himself) export or import or cause to be exported or imported any seed of any notified kind or variety unless. a) it conforms to the minimum limits of germination and purity specified for that seed under clause (a) of Section 6, and b) its container bears in the prescribed manner the mark or label with the correct particular thereof specified for that seed under clause (b) of section 6.

1.5.1. Gist of the Seed Control Order 1983

Issue of licence to dealers: All persons carrying on the business of selling, exporting and importing seeds will be required to carry on the business in accordance with terms and conditions of licence granted to him for which dealer make an application in duplicate in Form 'A' together with a fee of Rs.50/- for licence to licensing authority unless the State Government by notification exempts such class of dealers in such areas and subject to such conditions as may be specified in the notification.

Renewal of licence: A holder of licence shall be eligible for renewal upon and applicable being made in the prescribed form 'C' (in duplicate) together with a fee of rupees twenty before the expiry of licence or at the most within a month of date of expiry of license for which additional fee of Rs.25/- is required to be paid.

Appointing of licensing authority: The state government may appoint such number of persons as it thinks necessary to be Inspector and define the area of such Inspector jurisdiction through notification in the official Gazette.

Time limit for analysis of samples by Seed Testing Lab: Time limit for analysis of samples by seed testing lab and suspension / cancellation of license may be done by licensing authority after giving an opportunity of being heard to the holder of license, suspend or cancel the license on grounds of mis-representation of a material particular or contravention in provision of the order.

Suspension/cancellation of licence: The licensing authority may after giving an opportunity of being head to the holder of licence, suspend or cancel the licence on grounds of mis-representation of material particular or contravention in provision of the order.

Appeal: The State Government may specify authority for hearing the appeals against suspension / cancellation under this order and the decision of such authority shall be final. Any person aggrieved by an order of refusal to grant or amend or renew the licence for sale, export/ import of seed may within 60 days from the date of Order appeal to the designated authority in the manner prescribed in the order.

Miscellaneous: The licencing authority may on receipt of request in writing together with Rs.10/- form amend the licence of such dealer. Every seed dealer are expected to maintain such books, accounts and records to this business in order and submit monthly return of his business for the preceding months in Form 'D' to the licensing authority by 5th day of every month.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

MILLETS: THE NUTRIENT-RICH GRAINS THAT ARE CHANGING THE FOOD LANDSCAPE

Article ID: AG-VO3-I11-97

Shivani Singh and*Dr.Seema Sonkar

Reseach Scholar (Department Of Food Science &Nutrition, Chandra Shekhar Azad University Of Agriculture& Technology, Kanpur, U.P.208002. India

Associate Professor (Department Of Food Science &Nutrition, Chandra Shekhar Azad university Of Agriculture &Technology, Kanpur, U.P., 208002, India

*Corresponding Author Email ID: Seema07csa@gmail.com

ABSTRACT

Millets, often referred to as “miracle grains,”have been gaining significant attention in recent years for their impressive nutritional value, environmental sustainability, and potential to combat food security issues. These small but mightly grains are not only versatile in the kitchen but also play a crucial role in ensuring food security, especially in regions prone to drought and erratic weather patters and also explore the wonders of millets, their nutritional benefits, sustainable farming practices, and their growing popularity in the global food market. Millet is a diverse group of small seeded grains that have been cultivated for thousands of years, playing a crucial role in global food security and it provides on overview of millet, encompassing its historical significance, nutritional value, agriculture adaptability, and emerging importance in modern diets. Millets resilience in diverse climates and its ability to thrive in managerial lands make it a valuable crop for addressing food security challenges. Futhermore, millets rich nutrients profile ,gluten-free nature, and sustainability attributes contributes to it growing popularity as a nutritious and environmentally friendly option in contemporary diets, and it has multifaceted significance of millet in both traditional and modern agriculture and nutrition ,highlighting its potential to promote food security and sustainable food systems.

KEY WORDS; Miracle grain, Health benefits, Nutritinal Powerhouse, Antioxidant, Gluten-free.

Introduction

Millets are a group of small –seeded grains that have cultivated for thousands of years ,primarily in Africa And Asia. There are Various types of millets, including pearl millet, finger millet, foxtail millet, proso millet, and barnyard millet, among others. Each type of millet has unique qualities that make them suitable for various culinary applications.

NUTRITIONAL POWEHOUSE: Millets are a nutritional treasure trove. They are rich in complex Carbohydrates, dietary fiber, vitamins and minerals. These grains are a great source of protein, making them am excellent choice for vegetarians and vegan. In addition to protein, millets contain essential nutrients like iron, magnesium, phosphorous, Vitamins particularly(B3&B9).Their low glycemic index also makes them ideal choice for individuals looking to manage blood sugar levels.

HEALTH BENEFITS:-Millets is a highly nutritious grains that offers various health benefits.

1.Heart Health:-Millets are naturally cholesterol-free and rich in magnesium, which supports heart health by regulating blood pressure and reducing risk of cardiovascular diseases.

2.Weight management:-The high fiber content in millets promotes a felling of fullness, aiding inweight management and preventing overeating.

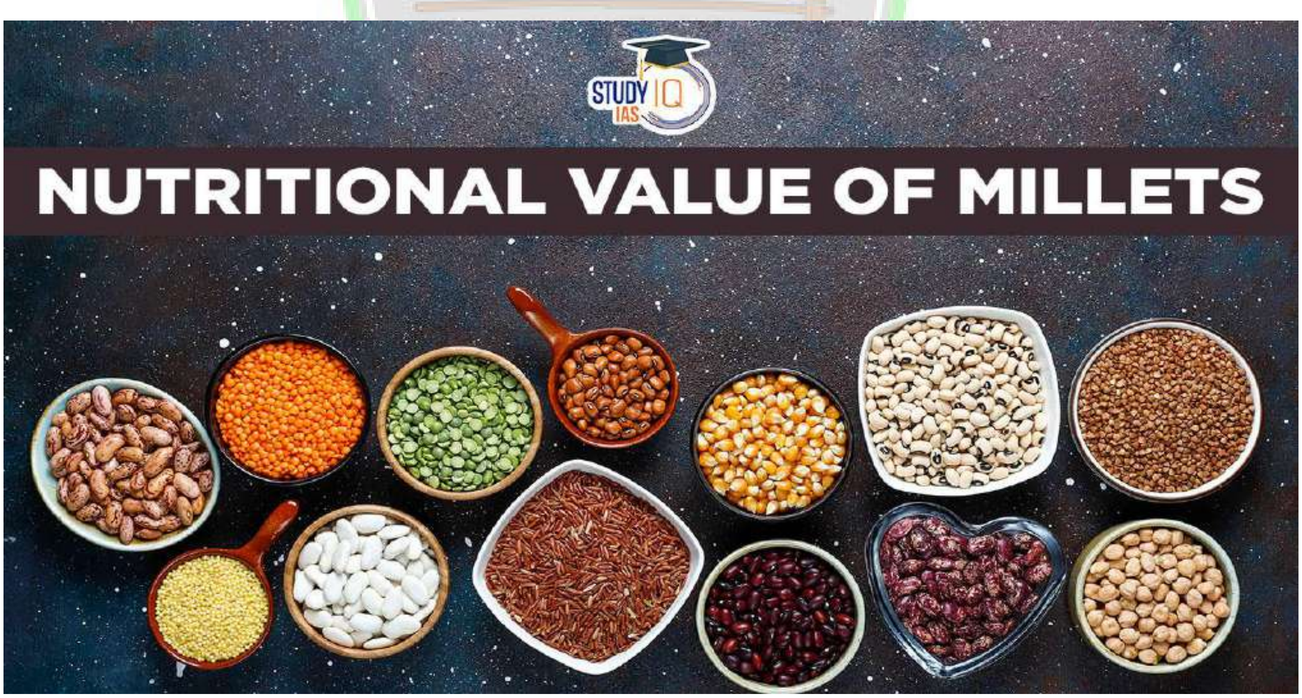
3.Gluten Free:-Millets are naturally gluten-free ,making them suitable for individuals with celiac disease or gluten senstivity.

4.Digestive Health:-The dietary fiber in millets supports digestive health by preventing constipation and promoting a healthy gut microbiome.

NUTITIONAL VALUE OF MILLET:-PER 100gm

Millets	Moisture (g)	Protein (N*6.25)	Fat (g)	Mineral (g)	Dietary fiber(g)	Carbohydrate (g)	Energy (kcal)
Finger millet	13.1	7.3	1.3	2.7	11.5	72.0	328
Proso millet	11.9	12.5	1.1	1.9	_	70.4	341
Foxtail millet	11.2	12.3	4.3	3.3	2.4	60.9	331
Little millet	11.5	7.7	4.7	1.5	2.53	67.0	341
Kodo millet	12.8	8.3	1.4	2.6	2.47	65.9	309
Barnyard millet	11.9	6.2	2.2	4.4	1.98	65.5	307
Brown top millet	11.3	9.0	1.9	3.9	_	71.3	338

Source :From Research Gate(nutritional value of small millet are per 100gm)



MEDICINAL VALUE OF MILLETS

Millets in addition to its nutritional value, offers several medicinal properties and potential health benefits, here are some of the medicinal value of millets. and it should be a part of balanced diet and additionally, millets should be prepared and cooked appropriately to maximize their nutritional and medicinal value.

1.DIBETES MANAGEMENT

2.HEART HEALTH

3.DIGESTIVE HEALTH

4.WEIGHT MANAGEMENT

5.ANTIOXIDANT PROPERTIES

6.BONE HEALTH

7.GLUTEN-FREE ALTERNATIVES

8.IRON ABSORPTION

9.SKIN HEALTH

10.ANTIMICROBIAL PROPERTIES

SUSTAINABLE FARMING

Millets are climate-resilient crops that require minimal water and can thrive in arid and semi-arid regions. They also have a short growing cycle, reducing the risk of crop failure due to changing weather conditions. These factors make millets an environmentally sustainable choice for agriculture, particularly in regions facing climate challenges.

GLOBAL POPULARITY

The global demand for millets has been steadily increasing due to their nutritional benefits and sustainability. In recent years, millets have found their way into international markets as a consumers seek healthier and more sustainable food options. They are from breakfast cereals and energy bars to gluten- free flours for baking.

Conclusion

Millets are just grains they represent a sustainable and nutritious solution to some of the world's most pressing food and environmental challenges. Their versatility in the ,kitchen, coupled with their numerous, health benefits, has made them a favorite among nutrition-conscious consumers. As we move towards a more sustainable and health-conscious future, millets are likely to play an increasingly significant role in our diets and global food security & millets revolution that is reshaping our food landscape. Incorporating millets into your diet can to overall heath and well being. Its nutritional richness, with low glycemic index and gluten- free nature, make it valuable addition to balanced diet and improve digestive heath, manage blood sugar level or simply diversify your meals, millets is a nutritious grain to consider.

Volume: 03 Issue No: 11

SOYBEAN-MIRACLE CROP FOR POULTRY INDUSTRY

Article ID: AG-V03-I11-98

Dr.A.Thanga Hemavathy*, Dr.R.Vinoth+, Dr.S.Kavitha++

Dr.S.Premalatha+++ and M.Uma Devi++++

* Associate Professor(PBG), Department of Pulses, TNAU, Coimbatore, Tamil Nadu

\+ Teaching Assistant (PBG), IOA, TNAU, Kumulur, Trichy, Tamil Nadu

\+ + Associate Professor(SST), Dept. of SST,TNAU, Coimbatore

\+ + + Associate Professor(PBG), Dept. of Cotton, TNAU, Coimbatore

\+ + ++ Associate Professor(PBG), Dept. of oilseeds, TNAU, Coimbatore

*Corresponding Author Email ID: hemavathytnau@gmail.com

Introduction

Soybean (*Glycine max* (L.) Merril) is the world's most important seed legume which contributes 25% to the global edible oil, Soybean is the most important oilseed crop in India. Owing to its oil and protein profile, this crop has an important role in nutritional security of masses. It has a central position in agriculture along with barley, cassava, groundnut, maize, millet, potato, oil palm, rapeseed, rice, rye, sorghum, sugar beet, sugarcane, sunflower, and wheat which were considered as the most cultivated plants worldwide. Its central role is not only constituted due to the dense protein and high-quality oil contents but also industrial raw material supply. Tofu, soy milk, soy sauce, and miso are the main nutritious human soy products. Also, extracted soy oil, with over 75% oleic acid and under 10% polyunsaturated fatty acids, is one of the most preferred oils sold commercially in the United States today. Long shelf-life required fry, spray, and ingredient oils should preferably contain higher oleic acid due to the better persistence to oxidation. Soy meal is also a major source of protein used in pig and poultry industries. The companion animal industry prefers soy meal as a protein source in animal diet, especially for dogs. High-quality amino acid composition and highly digestible protein content leads to the use of soy meal in aquaculture diets. On the other hand, soy oil has various industrial uses as pharmaceuticals, plastics, papers, inks, paints, varnishes, and cosmetics.


In the verge of global warming effects, renewable energy sources as an alternative to fossil fuel are getting importance. Soybean is also an important biodiesel crop in many countries along with maize, especially in South America countries. Besides the alternative bioenergy crop role, it has also environmental effects as being capable of utilizing atmospheric nitrogen through biological nitrogen fixation and is therefore less dependent on synthetic nitrogen fertilizers. While drought is one of the most plant growth and development limiting factors in present days, nitrogen deficiency is equally crippling for plants, as well, due to its structural, genetic, and metabolic functions in crop yield. Highly stable and non-reactive N_2 is the most abundant constituent of the Earth's atmosphere, still no eukaryotic organism can use it directly.


Some members of *Leguminosae* (*Fabaceae*) family including soybean have adopted the ability to establish symbiotic interactions with diazotrophic bacteria known as rhizobia in evolutionary adaptations. By this means, a process called ‘biological nitrogen fixation is a low-cost N source that sufficiently increases soybean yield with low environmental impact and avoids the use of synthetic N fertilizers.

Some members of *Leguminosae* (*Fabaceae*) family including soybean have adopted the ability to establish symbiotic interactions with diazotrophic bacteria known as rhizobia in evolutionary adaptations. By this means, a process called ‘biological nitrogen fixation is a low-cost N source that sufficiently increases soybean yield with low environmental impact and avoids the use of synthetic N fertilizers.The unique chemical composition of soybean seed which includes about 20% oil and 40% protein besides number of nutraceutical compounds such as isoflavons, tocopherol and lecithin has made it one of the most valuable agronomic crops in the world.

Conclusion

The food dervied from soybeans are generally considered to provide both specific and general health benefits and being a cheaper source of high quality protein the crop has a potential to alleviate large scale protein mal nutrition prevailing the poor section of society in the country. Currently the utilization of soybean for food uses in India is meager, if the high quality soybean protein is included in daily diet of Indian masses, it can help in mitigating the wide spread energy protein malnutrition. Already the government of India as well as private sector have taken initiatives to increase the food use of soybean in the country.

References

Willis S. The use of soybean meal and full fat soybean meal by the animal feed industry. In: 12th Australian Soybean Conference. Bundaberg: Soy Australia; 2003

Yuhong G, Rasheed A, Zhao ZH, Gardiner JJ, Ilyas M, Akram M, et al. Role of conventional and molecular techniques in soybean yield and quality improvement: A critical review. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2021;49(4):12555.

Volume: 03 Issue No: 11

NURSERY PREPARATION AND ITS MANAGEMENT FOR SUSTAINABLE SUGARCANE INIATIVE (SSI)

Article ID: AG-V03-I11-99

G. SENTHIL KUMAR*

Assistant Professor (Agronomy), Department of Rice,

Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, India

*Corresponding Author Email ID: senthilkolathur@gmail.com

Introduction

Sugarcane is vegetatively propagated and the seed material is called sett, which is a small cut sections of sugarcane stem.

Selection of setts

- It is preferable to select the top 1/3rd portion of the cane for seed purpose to ensure uniform germination.
- Immature canes are better suited for seed material
- Ideal age of seed crop is 6-8 months
- The cane is intended to be taken up for seed should receive 25 kg more N than normal crop
- Normally an area of 1/10th hectare of nursery crop will give setts for planting one hectare.

Preparation of setts for planting

- Take seed material from a short crop (6 to 8 months nursery crop) free from borers, scales, mealy bugs, grassy shoot and smut and resistant to red rot disease.
- Detrash the cane with hand
- Use sharp knife to prepare setts without splits
- Discard setts with damaged buds, sprouted buds, splits
- Sett treatment

Sett rate (for 1 ha)

Depending upon the number of buds/eyes present in each sett, they are called single budded, double budded and three budded setts.

- Three - budded setts - 50,000 nos.
- Two - budded setts - 75,000 nos.
- Single budded setts - 1,87,500 Nos.
- Chip buds (SSI) - 12,500 Nos.

Bud selection

In SSI method, single budded chips from the healthy mother canes are used for raising nursery.

1. Select healthy canes of 6 to 8 months old which have good internode length (7 to 8 inches) and girth
2. observe and avoid canes with disease infestation like fungus growth, spots etc.
3. Cut the required quantity of canes. Farmers who are unable to go for immediate chipping of buds may keep the cut canes for about a week under shade.
4. Remove buds from the selected canes using an implement called bud chipper. The bud chipper comprises a handle and a cutting blade fixed on a wooden plank.
5. Keep the cane on the plank and adjust it in such a way that a single bud is placed exactly below the cutting blade. When the handle is pressed, single bud chip comes off the cane.
6. Large number of buds (about 150/hr) can easily be chipped off in this way in a short period of time.
7. The chipped buds have to be treated with organic or chemical solutions.

Nursery

- Young seedlings are raised in the nursery.
- It is better to establish a shade net shed for the purpose of nursery management. It is a fully covered structure meant to provide shade and create other favorable conditions like warm and wind free environment.
- Fill half of each cone in the pro tray with well decomposed coco-pith/ coir pith.

- Place the buds flat or in a slightly slanting position in the cones of a tray.
- Do not press or push it hard. Ensure that the bud side faces up.
- Cover the bud chips in trays completely with coco-pith/coir pith.
- After filling all the trays, place them one above the other and finally keep an empty tray upside down at the top.
- About 100 trays (4 sets, each consisting of 25 trays) are to be placed together and wrapped tightly with polythene sheets. Place small weights on the bundles and keep it for 5 to 8 days in the same position to create high temperature and humidity.
- Take measures to control termites around the trays by drenching the soil with Chlorpyriphos 50 EC (5ml/lit) and ensure that there are no weeds in and around the nursery area.
- Care should be taken to avoid water, air or sunlight entering into the trays by tightly covering and keeping the bundles in shade net or preferably inside a room.
- Create artificial warmth through electric bulbs if the climate is too cold. This is the most crucial phase of the nursery management. Under proper conditions (especially, warm temperature) within 3 – 5 days, white roots (primordia) will come out and shoots will also appear in next 2 to 3 days.
- Either on the 5th or 8th day (based on the climatic conditions), all the trays with sprouted buds are to be removed from the polythene sheet and kept side by side in beds on the ground to facilitate watering and other nursery management practices.
- Based on the moisture content of coco-pith, watering to the trays (seedlings) has to be initiated in the evenings for the next 15 days using rose cans. Shoots will start growing strong and leaves will start sprouting. After appearance of two leaves, application of water can be increased gradually depending on moisture level in trays.
- During six leaf stage (about 20 days old seedling), grading of the plants has to be done. Stop giving water for a day to loosen the coco-pith in the trays, this enables easy lifting up of the young seedlings.
- Plants of similar age (height) can be lifted up and placed in one tray. This way grading of plants according to their height is achieved and damaged or dead plants can be removed.
- Ideal age for transplanting: 25-35 days.

Volume: 03 Issue No: 11

TAMARIND - A POTENTIAL MULTIPURPOSE TREE FOR VALUE ADDITION AND LIVELIHOOD AMELIORATION

Article ID: AG-VO3-I11-100

A. Mayavel[1]*, M.Akshayasri[1], P. Chitra[1], B.Nagarajan[1], C. Bagathsingh[1], G. Radha Krishnan[1] and M. Amaravel[1]

Institute of Forest Genetics & Tree Breeding, Forest Campus, Coimbatore - 641 002, Tamil Nadu, India

*Corresponding Author Email ID: mayavela@icfre.org

Abstract

Tamarind (*Tamarindus indica* L.) is a versatile tree widely cultivated in agroforestry systems, it is a rich in source of calcium, phosphorus, iron, and vitamins, and it has unique nutritional profile, with tartaric acid as a notable component, making it a popular ingredient in Indian cuisine. Recognizing the demand for Tamarind, various value-added products have been developed to enhance ease of handling, storage, transportation and extending shelf life.Tamarind value added product such as Tamarind Toffee, Tamarind Pulp Powder, Tamarind Pickle, Tamarind Jam, Tamarind Syrup, Tamarind Candy, Tamarind Paste, Tamarind Chutney, Squash, and Wine each offering distinct flavors and potential health benefits. The development of these value-added products enhances consumer acceptance from a nutritional perspective while benefiting farmers in the post-harvesting process. In essence, Tamarind and its diverse products contribute to the world of culinary delights and offer a passage between farmers and consumers, enriching both ends of the spectrum.

Key Words: Value addition, Nutritional attributes and Shelf life.

Introduction

Tamarind (*Tamarindus indica* L.) a tropical fruit found in Africa and Asia, belonging to the family of Leguminosae. It is an evergreen tree grown in arid and semi-arid regions of India and also called as "Indian Date". Among all countries, India ranks first place i.e., (300,000 tons) in production as well as the export of Tamarind pulp (Narina *et al*., 2018). Tamarind fruit is a good source of calcium, phosphorus, iron and vitamins such as vitamin A and C (Manjula *et al*., 2017). Nutritional value of Tamarind pulp as presented in Table 1 (Singn *et al*., 2007)& (Rana *et al*., 2018).

Table 1. Nutritive value per 100g of Tamarind pulp

Constituents	Pulp(ripe)
Moisture(g)	28.2 - 52.0
Ash(g)	2.9
Protein(g)	3.10
Fat(g)	0.1
Carbohydrate(g)	67.4
Ascorbic acid(mg)	0.7 - 3.0
Tartaric acid(mg)	8 -23.8
Thiamine(mg)	0.16
Riboflavin(mg)	0.07
Niacin(mg)	0.6 - 0.7

Tamarind contains tartaric acid which is mainly used as an acidulant and hence utilized in preparation of various Indian dishes (Mani *et al*., 2020). Companies involved in the production of juice and jam recognize the medicinal and nutritional value of various parts of the tamarind plant (Emmy *et al*., 2010). Tamarind is a seasonal fruits and are available only for a limited duration. Tamarind fruits can be processed into various value-added products, making it a convenient option with the benefits of ease of handling, transportation, storage, and utilization, thereby extending its shelf life and enhancing its value. The pulp is used for seasoning in preparing foods and flavoring confections, curries, and sauces, and as a major ingredient in juices and other beverages (De Caulwe*et al*., 2009). The ripen Tamarind fruit was also used for preparation of various value added products like Wine, Squash, Jelly, Jam, Candy, Sauce, Pickle. Value added products. Further development of these value added products from Tamarind pulp to an industrial status was recommended to raise the demand in the market, as well as benefit both farmers in the post harvesting process and consumer acceptance from a nutritional point of view. (Mani *et al*., 2020).

Value added products of Tamarind fruit pulp

Processed Pulp

Tamarind pulp is rich in pectin and reducing sugars and contains significant amount of organic acids, 98% of tartaric acid. Tamarind pulp is often made into a juice, jam, jelly, infusion or from a variety of products can be prepared. The Tamarind pulp in an excellent source of potassium which is used for controlling the heart rate and blood pressure(Singh *et al*., 2007)

Tamarind Toffee

Tamarind toffee is a delectable confection that expertly blends the sweet and tangy flavors of Tamarind with the chewy, sugary goodness of toffee. It's a treat that has won the hearts and taste buds of people around the world, celebrated for its intriguing and balanced combination of sweet and sour notes. This irresistible candy is typically created by mixing Tamarind pulp with sugar and then shaping the resulting mixture into toffee, often wrapped in individual paper pieces for easy consumption(Sunil kumar, 2020).

Tamarind pulp powder

Tamarind pulp powder, also known as Tamarind powder or Tamarind extract powder, is a versatile and convenient product derived from Tamarind pulp. It is prepared by processing Tamarind pulp into a dehydrated, powdered form. This fine powder is cherished for its unique sweet and tangy flavor, making it a popular ingredient in various culinary applications.Tamarind pulp powder is used in various recipes, including curries, soups, and stews, sauces, marinades, and chutneys. It's particularly well-suited for dishes that benefit from Tamarind's distinct flavor.(Priyadarshi *et al*.,2019).

Tamarind Pickle

Mature ripen Tamarind fruit without shells and seeds is commonly used for making pickles by blending with spices and salt.It's a multipurpose condiment used with snacks or as a flavorful addition to dishes like samosas and curries. The Tamarind pickle may also be good for digestion and has some antioxidants. This pickle retains its quality and taste for up to one year(Singh *et al*., 2007).

Tamarind Jam

Tamarind jam, a delightful spread, combines the natural tanginess of Tamarind with the sweetness of sugar, creating a uniquely satisfying taste. It's a topping for bread and pastries, but it's also a secret ingredient that enhances various recipes, from glazes to desserts. Tamarind jam adds a touch of wellness to its delicious charm, making it a cherished addition to kitchens worldwide(Jimoh *et al*., 2012).

Tamarind syrup

Tamarind syrup is a flavorful liquid condiment made from Tamarind fruit pulp, sugar, and water. It's recognized for its unique and delightful taste, combining the natural tanginess of Tamarind with the sweetness of sugar. This syrup is a versatile addition to the culinary world, used in both cooking and beverages. Additionally, Tamarind syrup is believed to offer potential health benefits, including aiding digestion and providing antioxidants(Kotecha and Kadam 2003).




Processed Pulp   Tamarind Toffee TamarindPulp Powder Tamarind Pickle




Tamarind Jam   Tamarind Syrup Tamarind Candy Tamarind Paste



Tamarind Chutney Tamarind Squash   Tamarind Wine

Various Tamarind value added products

Tamarind Candy

Tamarind candy is a delightful confection that's known for its unique sweet and tangy flavor. It's typically created from Tamarind pulp, sugar, and various seasonings. The Tamarind natural tartness pairs perfectly with the sweetness of sugar, creating a balance of flavors that tickles the taste buds. Tamarind candy comes in various forms, including chewy gummies, hard candies, and even coated varieties. (Mani *et al*., 2020)

Tamarind Paste/Pure

Tamarind paste, also known as Tamarind puree, is a tangy ingredient made from Tamarind fruit. It's created by extracting the pulp from Tamarind pods, and then refining it into a thick paste. This paste has a sweet and sour flavor and is used in various cuisines. It's commonly found in curries, chutneys, and marinades(Priyadarshi *et al*.,2019).

Tamarind chutney

Tamarind chutney, also known as Tamarind sauce, is a condiment cherished for its sweet and tangy flavors. It's made from Tamarind pulp and a mixture of spices. This chutney is a staple in various cuisines, with South Asian and Middle Eastern cooking being particularly prominent.Tamarind chutney is also used as a sauce, make it a tasty and wellness-boosting addition to the culinary world(Sunil kumar *et al*., 2020)

Tamarind Squash

Tamarind squash, a pleasant drink, is made from Tamarind fruit pulp, sugar, and water. It offers a unique flavor that combine the natural tanginess of Tamarind with the sweetness of sugar. This beverage is popular in various regions and can be savored by diluting it with water, adding ice, or even blending it with soda, depending on individual taste (Manjula *et al*., 2017).

Tamarind Wine

Tamarind wine is a one-of-a-kind beverage that blended Tamarind essence with the craft of winemaking. Made by fermenting Tamarind pulp, sugar, and water, it offers a delightful combination of sweet and tangy flavors. In essence, Tamarind wine is afascinating and fresh addition to the world of beverages, making it a delightful choice for those seeking a unique and versatile flavor experience (Mbaeyi-Nwaoha and Ajumobi 2015)

Conclusion

In conclusion, Tamarind cultivation greatly supports farmers by offering income diversification, particularly in arid regions. It generates employment opportunities within local communities and international markets and enhancing their income prospects. For consumers, Tamarind and its value-added products provide a treasure of nutritional benefits. They are rich in essential minerals and vitamins, while their unique sweet and tangy flavors enhance culinary diversity. The convenience and extended shelf life of these products make them easily accessible and versatile in a variety of dishes, from traditional favorites to innovative creations. In essence, Tamarind acts as a vital link, connecting farmers and consumers. Farmers find economic stability, while consumers relish the nutritious and flavorful additions to their diet.

Acknowledgement

The authors are thankful to the CAMPA Authority, Ministry of Environment Forest and Climate Change, and Government of India for providing funding under All India Co-ordinate Research Project on Tamarind and The Director, Institute of Forest Genetics and Tree Breeding, Coimbatore.

Reference

De Caluwe, E., K. Halamova, and P. Van Damme. 2009. Tamarind (*Tamarindus indica*L.): a review of traditional uses, phytochemistry and pharmacology. Pp. 85–110 in H. R. Juliani, J. E. Simon and C. Ho, eds. African natural plant products. American Chemical Society, Washington.

Emmy De Caluwe, Katerina Halamova, Patrick Van Damme. *Tamarindus indica* L. – A review of traditional uses, phytochemistry and pharmacology. Afrika focus 2010;23 (1):53-83.

Jimoh, S.O. and Onabanjo, O.O., 2012. Potentials of *Tamarindus indica* (Linn) in jam production. *Journal of Agriculture and Social Research (JASR)*, *12*(2), pp.29-43.

Kotecha PM and Kadam SS, Preparation of ready-to-serve beverage, syrup and concentrate from Tamarind, J Food Sci Technol, Mysore, 2003, 40, 76-79.

Mani A, Prasanna VSSV, Praveena J, Yadav A. Importance, Cultivation and Value-Added Products of Tamarind: A Wondrous Tree Legume. International Journal of Agriculture Sciences, 2020; 12(9):9789-9793.

Mani, A., Kuchi, V.S., Mitra, S., Banik, A.K., Chakraborty, I. and Das, F.B.S., 2020. Recipe standardization for preparation of Tamarind candy. *The Pharma Innovation Journal*, *9*(5), pp.166-170.

Manjula, B., Aruna, R., Prasanna, N. S., and Ramana, C. (2017). Studies on physical and bio-chemical analysis of value-added products developed from Tamarind pulp. International Journal of Processing and Post-Harvest Technology, 8(2), 99-103.

Mbaeyi-Nwaoha, I.E. and Ajumobi, C.N., 2015. Production and microbial evaluation of table wine from tamarind (*Tamarindus indica*) and soursop (*Annona muricata*). *Journal of Food Science and Technology*, *52*, pp.105-116.

Narina SS, Catanzaro CJ. Tamarind (*Tamarindus indica* L.): An underutilized fruit crop with potential nutritional value for cultivation in the United states of America. Asian Food Science Journal 2018;5:1-5.

Priyadarshi.S.,Chetana., and Madhava Naidu.M (2019). Technological Interventions For Tamarind Processing and Its Value Addition. _Spice India_Vol-32 (4)

Rana, M., Sharma, P., Mahima, R.C. and Sharma, P., 2018. Proximate and phytochemical screening of the seed and pulp of Tamarind indica. *Journal of Medicinal Plants*, *6*(2), pp.111-115.

Singh, D., Wangchu, L. and Moond, S.K., 2007. Processed products of tamarind.

Sunil kumar, 2020. Tamarind: Value Added Products and its Health Benefits. Agriculture &Food_Vol 2:Issue 5

Volume: 03 Issue No: 11

THE FUTURE OF RENEWABLE ENERGY: BIOGAS PRODUCTION TECHNOLOGY

Article ID: AG-VO3-I11-101

[1]S. Santhosh Kumar and [2] Er. K. Sureshkumar*

[1] UG Scholar, J.K.K. Munirajah College of Agricultural Science, T. N. Palayam, Gobi, Erode 638 506, Tamil Nadu

[2] Assistant Professor, J.K.K. Munirajah College of Agricultural Science, T. N. Palayam, Gobi, Erode 638 506, Tamil Nadu

*Corresponding Author Email ID: suresharavind1406@gmail.com

Introduction

Biogas is a valuable source of renewable energy that holds immense potential for a sustainable future. It is a mixture of primarily methane and carbon dioxide, produced through the anaerobic digestion of organic materials such as agricultural residues, energy crops, and organic wastes.In the face of growing concerns about climate change and the depletion of fossil fuel reserves, renewable energy sources have gained significant importance. Biogas, being a clean and sustainable energy solution, offers a promising alternative to traditional forms of energy.

The potential of India:

Biogas plant potential in India -50 Lakhs Installed as per 2022(Agri stat).

Anaerobic Digestion:

Anaerobic digestion is also called Biomethanization

Dry Digestion:

- Feed is added directly into the digester without any treatment.
- Mixing of feed is difficult.

Wet Digestion:

- Feed is added in the form of slurry.
- The slurry is made up of Biomass and Water in a 1:1 ratio.
- Mixing is easy.

Anaerobic Digestion:

Biochemical conversion of biomass into liquid & gas by Anaerobic digestion in the absence of oxygen.

- Digester diameter – 1m3 to 100 – 1000 m3.
- Digestion may be Continuous or Batch digestion plant.
- The combined action of 4 groups of bacteria helps in anaerobic digestion.
- Bacterial action itself generates heat in small amounts. But in cooler conditions, we want to provide external heat to maintain temperature.
- The ideal temperature is 30-35*c - Mesophilic digestion.
- 55* - Thermophilic Digestion.
- Thermophiles – Faster output of Biogas yield.
- Psychrophiles – Organisms adapted to lower temperatures would reduce the need for digester heating in cold climates.
- Products of Anaerobic Digestion are Biogas and biodigested Slurry.

.

Anaerobic digestion includes pre-processing & post-processing of feedstocks.

- pre-processing of feedstocks to increase their biogas yield.
- Post-processing of digestate helps to increase its value i.e. Separation of different properties of Nutrients.

The combined action of 4 groups of bacteria helps in anaerobic digestion.

First stage: Hydrolysis

- Breakdown of high molecular weight substances like carbohydrates, Protein, and Lipids into smaller molecular weight substances like sugars, amino acids, and Fatty acids.

- The hydrolytic group of Bacteria helps to break down substances.

Second stage: Acidogenesis

- The end product of the first stage – Hydrolysis is converted into Acetic acid, Hydrogen, and CO2.
- Acetic acid is made up by utilizing dissolved oxygen in a slurry by the endergonic process.
- Acid-producing bacteria involved this this stage.
- They reduce the component I to low molecular weight – Alcohol and organic acid.

Third stage: Acetogenesis.

- Here end product of Acidogenesis i.e. Acetic acid is converted into Acetate and hydrogen.
- Acetogeneic group of bacteria helps to convert acetic acid into acetate
- Hemoacetogens convert hydrogen and simple carbon compounds into acetate

Fourth stage: Methanogenesis

- The methanogenic group of bacteria helps to convert degraded slurry into Methane

Growth Factors:

When there are unfavorable conditions bacteria will suffer to grow faster, so we need to add growth factor nutrients like Vitamins, Amino acids, Fatty acids, and Sterols. It must be added externally if necessary.

Properties of Biogas:

- Calorific Value of Biogas: 3500 – 4800Kcal/m3Methane is a colourless, Odourless Tasteless gas
- Liquefication of Biogas requires nearly 5000psi
- Density – 0.94kg/m3
- Ignition Temperature of Biogas - 650-750 °C
- Energy content 6.0 – 6.5 kW/m3
- Octane number of Biogas – 115-135

Physical properties		Biogas components				Biogas ($60\% CH_4$; $40\% CO_2$)
		CH_4	CO_2	H_2	H_2S	
volume fraction	%	55-70	27-44	1	3	100
calorific value	MJ/m^3	35,8	-	10,8	22,3	21,5
flash-point	°C	650-750	-	583	-	650-750
critical pressure	Mpa	4,7	7,5	1,3	89	7,5-8,9
critical temperature	°C	-82,5	31	-	100	-82,5
normal density	g/cm^3	0,72	1,98	0,09	1,54	1,2
critical density	g/cm^3	162	468	31	349	320
density ratio of air density	[-]	0,55	2,5	0,07	1,2	0,83

Composition of Biogas:

Component	Agricultural waste
Methane CH_4	50–80
Carbon dioxide CO_2	30–50
Hydrogen sulphide H_2S	0.70
Hydrogen H_2	0–2
Nitrogen N_2	0–1
Oxygen O_2	0–1
Carbon monoxide CO	0–1
Ammonia NH_3	Traces
Siloxanes	Traces
Water H_2O	Saturation

Factors involved in biogas production

C: N Ratio

- The optimum condition for anaerobic digestion to take place ranges from 20 to 30:1.
- if there is too much nitrogen, the carbon soon becomes exhausted and fermentation stops.
- The nitrogen left over will combine with hydrogen to form ammonia. This can kill or inhibit the growth of bacteria, especially methane producers.

Temperature

- The methanogenic group of bacteria works well in 35-38*c

- Higher temperature leads to better gas production.
- Gas production falls at 20*c and stops at 10*c.

pH or hydrogen ion concentration

- The pH is maintained between 6.5 and 7.5. In this pH range, the microorganisms will be very active and digestion will be very efficient

Total solid content

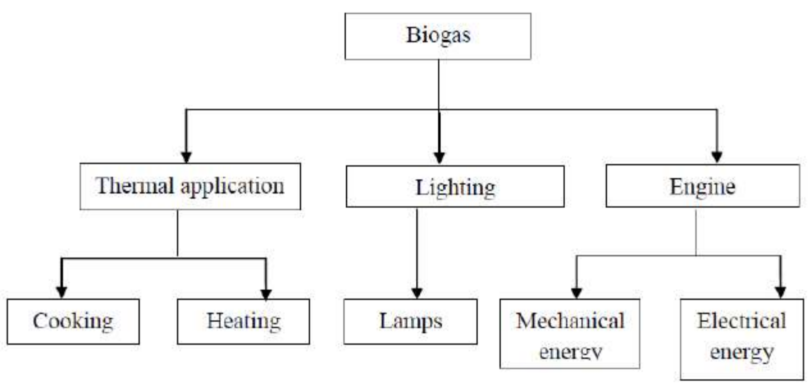
- The raw cow dung contains 80-82% of moisture. The balance of 18-20% is termed as total solids.
- The cow dung is mixed usually in the proportion of 1:1 to bring the total solid content to 8-10%.

Mixing

It is necessary that the slurry is properly mixed and bacteria get their food supply. It is found that slight mixing improves digestion.

Uses of biogas

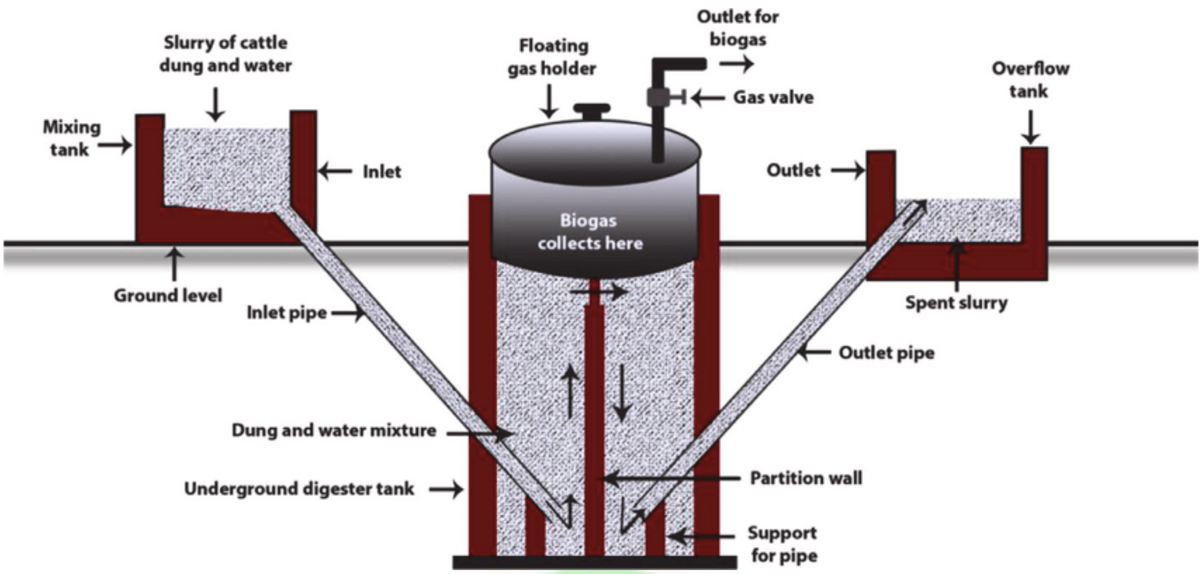
Biogas serves as a suitable alternate fuel for satisfying the energy needs of human society. It can be used for the production of power, for cooking, lighting, etc.



TYPES OF BIOGAS PLANT

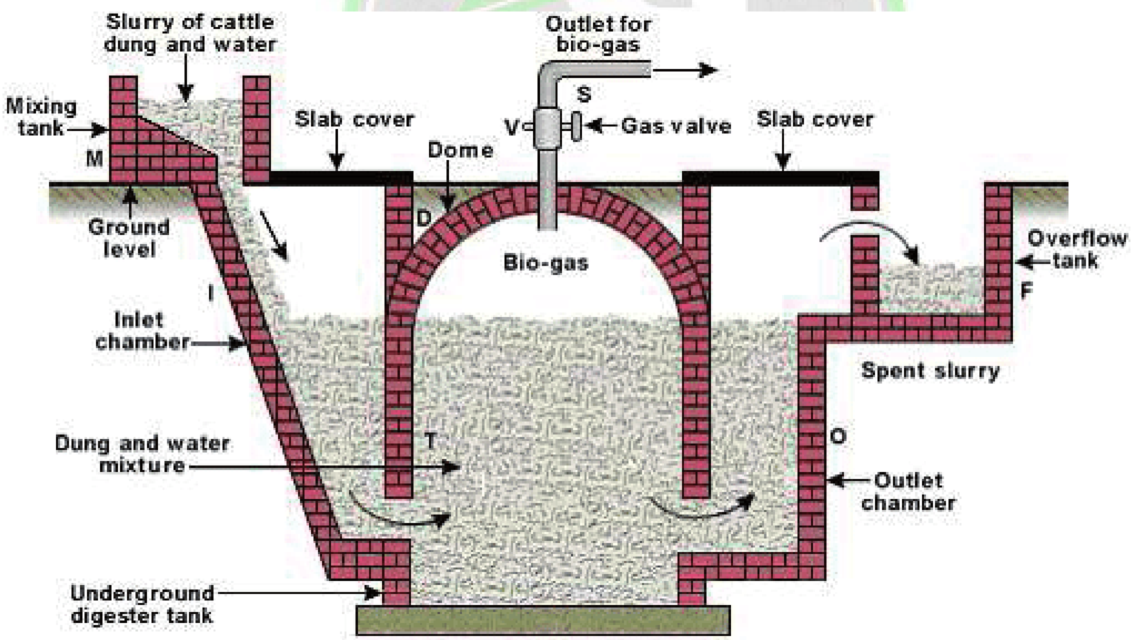
Floating drum type (Constant pressure)

Digester is made of bricks and is circular. It is constructed typically underground to lessen the heat loss from the plant. A separate gasholder is fixed to store the gas produced during digestion



Fixed dome biogas plants (Constant volume)

Fixed dome plants in which the dome acts as a gasholder in place of a high-cost drum. The gasholder and digester are constructed as a single unit. Both are made up of masonry work.



Conclusion:

Biogas production technology holds significant promise for the future of renewable energy. By harnessing organic materials through the anaerobic digestion process, biogas offers a clean and sustainable energy solution.

Feedstock selection, anaerobic digestion optimization, and gas purification are key considerations for efficient biogas production. Advances in automation, integration with other energy sources, and the creation of biomethane further enhance its potential.

References:

S.Pugalendhi, R.Shalini, J.Gitanjali, P.Subramanian - 2019 – Introduction to Renewable sources of energy – Tamilnadu agricultural university, Coimbatore.

Er. Sanjay Kumar – 2019 – Renewable energy – Kalyani publishers. Pg no: 122.

Gofrey Boyle. 2014. Renewable Energy Power For A Sustainable Future. Oxford University press.

Volume: 03 Issue No: 11

UNDERUTILIZED TROPICAL AND SUBTROPICAL FRUITS OF ASIA

Article ID: AG-VO3-I11-102

***Rutuja Narendra Deshmukh[1], Pramod Mahadev Lalge[2] Siddharth Kumar[3] and [4]Shashwat P. Mahalle**

Ph.D. Scholar[1&2], M.Sc Scholar[4], Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, India

Ph.D. Scholar[3], Department of Fruit Science, College of Horticulture, University of Agriculture and Technology, Banda, India

*Corresponding Author Email ID: deshmukhrutuja701@gmail.com

siddharthhort20@gmail.com

Introduction

The fundamental source of food, housing, medicine, and many other goods and methods that make life on Earth feasible and enjoyable is plant biodiversity (WCMC, 1992; UNEP 1995). Just one-third of the plant species used by humans worldwide are those that have been utilized for specific purposes by generations of varied cultures. Today, the majority of widely cultivated species' centers of diversification are identified. (Zeven and de Wet, 1982), However, little is still known about the distribution of genetic diversity and usage patterns for many other locally significant species. The food basket that humanity has been depending on for generations has shrunk as a result of increased reliance on main food crops. (Prescott-Allen and Prescott-Allen, 1990). The agricultural "simplification" process, which favored some crops over others due to their relative advantages for growing in a wider range of habitats, their simple cultivation requirements, their easier processing and storability, their nutritional qualities, taste, etc., is the source of this nutritional paradox. Of over 600 species of major and minor agricultural plants now in use, about 10 species of plants fulfill the food (calorie) requirements. (Paroda and Bhag Mal, 1993).

There are just 20 crops on the short list of the most widely utilized food plants, which is even smaller (Wilkes, 1984). The other underutilized crops, which are often used in less common farming conditions and are part of the subsistence farming done by impoverished farming households, may also play a significant role as new promising crops. If the endeavor of methodical gathering to preserve the genetic resources of staple crops occurred in the 20th century (Pistorius, 1997), The understanding of the need to salvage and enhance the use of crops abandoned by study, technology, marketing strategies, and conservation activities has marked the beginning of the twenty-first century. After successfully piqueing the interest of decision makers, these underutilized crops-also known by terms like minor, orphan, neglected, underutilized, underexploited, underdeveloped, lost, new, novel, promising, alternative, local, traditional, niche crops-have been included in global action plans.

The development of underused fruits has the potential to increase nutrition, farm incomes, crop diversity, and employment opportunities on the land, as well as through valuable exports and postharvest processing and marketing. The term "underutilized" has the following definition. (i) locally grown but underutilized crops; (ii) commonly grown crops for which new uses can be found (value-added products, for example); (iii) crops not currently grown in a particular nation or region but whose worth has been demonstrated elsewhere under similar climatic conditions; and (iv) species that are taken from the wild.. What is deemed underutilized in one place could not be in another, hence the definition of underutilized varies depending on the nation or region. Some significant tropical and subtropical fruits from Asia that are now underutilized and waiting to be explored are listed below.

Longan (*Dimocarpus longan*)

A fruit of the Sapindaceae family, longan is a subtropical fruit. In Asia, this arilloid fruit species is highly valued. Regarding the precise origins of the longan, opinions differ greatly. It is thought to have originated in the hilly regions of China, either between southwest India and Sri Lanka, or from Myanmar through southern China. With a few tiny plantations in Vietnam, Cambodia, Laos, Queensland, Australia, and Florida, the United States, the crop is primarily grown in southern China, Taiwan, and Thailand (Mitra and Pan, 2018). Fresh longan, dried longan, or frozen longan can all be eaten.

The fruit can be canned, peeled, and pitted. Most cultivars have juice that is sweet enough to process without the need for added sugar. One of Thailand's biggest exports is dried longan. In southern China, there are between 300 and 400 different longan cultivars; of these, 30 to 40 are grown for profit. The significant longan cultivars that are grown in China, Thailand, and Taiwan are Chuliang, Wu Yuan, Fu Yan, Biew Kiew, Chompoo, and Yang Tao Ye.

The first longan variety, "Gandaki Longan 1," was released by the National Research Center for Litchi, Bihar, and is advised for growing in India (Nath *et.al*., 2018). marcottage is the vegetative propagation method most commonly used in Thailand.

Rambutan (*Nephelium lappaccum*)

The juicy and flavorful rambutan, also known as hairy litchi, is a fruit of average quality. The fruit's edible meat is the white, translucent, subacid, sweet-flavored aril. It is native to Malayarchipelago and a member of the Sapindaceae family. From Malaysia, the industrial hub, it extended westward to nations including Thailand, Myanmar, Sri Lanka, India, eastern Vietnam, the Philippines, Indonesia, and Hawaii (Mitra, 2017). The major uses for rambutan are as a fresh fruit, in deserts combined with other fruits, in canning, or in the preparation of fruit syrup. Its seed oil is utilized to make soap. While the tannin it contains is used to make dyes, the root itself has medical properties. In the tropical region of southeast Asia, rambutan has numerous identified varieties. Seematjan, Lebakboeloos, Si Chomphee, Rong Rian, Si Thong, Seekonto, Rongrien, Seenjonja, and other notable cultivars are a few examples. ICAR-CHES selected CHES-14, CHES-27, and CHES-31 for use in India (Karunakaran *et.al.,* 2016). Rambutan trees can reproduce asexually by patch, forkert, and inarching budding. Planting distances for rambutan are typically 8 m × 8 m or 6 m × 6 m (with frequent pruning). It is recommended to plant a variety of cultivars in an orchard to improve pollination.

Bael (*Aegle marmelos*)

Bael is a plant that belongs to the Rutaceae family and genus Aegle. It has 2-3species, only one of which is cultivated. It grows wild in most of Southeast Asia, including Bangladesh, Sri

Lanka, Pakistan, central India, and most of the countries in the sub-Himalayan region. Bael is renowned for its potent medicinal and dietary qualities. The bael tree is utilized in almost its whole. The fruit has a high sugar, mineral, and riboflavin (Vitamin B2) content. Ripe fruit is laxative, restorative, tonic, and beneficial to the brain and heart. The mature fruit is often prescribed for dysentery and diarrhea because it is stomachic, astringent, and digestive. Ripe fruits can be used to make toffees and drinks (such as squash, ready-to-serve and nectar).

Preserves, candies, and dry products (powder) are frequently made from immature fruits. Depending on the variety and genotype, bael fruit skin can make up anywhere from 20 to 25 percent of the fruit's overall weight. Animals dislike the peel because it is so hard. Animals can, however, be given it in ground form. Cattle enjoy the ground form mixed with concentrate (Kaushik and Dhawan, 1996). There is a lot of heterogeneity because most bael trees that are accessible in India are of the seedling variety. A few selections have been made in Uttar Pradesh, Bihar and West Bengal (Srivastava *et al.*, 1998) and Gujarat (Singh *et al.*, 2023). The important selections are Thar Divya, Thar Neelkanth, Thar Srishti, Thar Prakriti, Thar Shivangi, CISHB-1 and 2, Pant Aparna, Pant Sujata, Pant Urvashi, Goma Yashi, and Narendra Bael-5,7,9,16, and 17.

Ber (*Ziziphus muritiana*)

Ber is the perfect fruit tree for tropical and subtropical dry and semi-arid areas, where most fruit products cannot be cultivated because of poor soil quality, unfavorable weather, or a lack of irrigation resources. Ber is thought to have originated in Central Asia, which included parts of Tajikistan, Uzbekistan, China, Afghanistan, and northwest India. China, Taiwan, India, and several other Central Asian nations are the primary growing regions for it.

Ziziphus is a genus in the Rhamnaceae family. *Z. mauritiana* fruits are high in vitamin C and minerals. Although the fruits are primarily consumed in their fresh state, they can also be processed and utilized in other ways, such as dried, candied, pickled, or as juice or squash or as ber butter. In arid areas, the leaves serve as fodder, and the tree serves as a host plant for lac insects (Lacciferlacca).

Carambola (*Averrhoa carambola*)

The carambola, a member of the Oxalidaceae family, is indigenous to Indonesia's Indochinese region, which is where most cultivated plants originate. The tropical and subtropical regions between latitudes 0° and 30° North and South are currently home to carambola plants. Malaysia, Taiwan, Australia, India, southern China, Thailand, Florida, Hawaii, and Brazil are among the significant nations. The carambola fruit has minimal commercial value when consumed raw due to its high oxalic acid concentration and sour flavuor.

New cultivars with pleasant flavors and low oxalic acid levels, however, are gaining popularity quickly. Minerals like potassium, iron, calcium, salt, and phosphorus are abundant in fruits. The sweet carambola are best eaten fresh, whereas the acid varieties should only be eaten after cooking. A common practice in restaurants is vacuum-packing fresh carambola slices. When 50–70% of the fruit's surface is colored (coluor varies depending on cultivar), the fruit is harvested.

The ideal temperature range for carambola storage is 5-10 ^{0}C. Store the CVs Arkin and Golden Star between 85 and 90 percent relative humidity and 5 degrees Celsius for a maximum of 44 days. A healthy tree that was five or six years old yielded 400–500 kg of fruit a year.

Durian (*Durio zibethinus*)

One of Southeast Asia's most well-liked seasonal fruits is durian. Its powerful scent and flavor make it well-liked. Although the fruit is typically eaten raw, it can be processed into a paste, or the flesh can be frozen, ground into a powder, or mixed with other foods like ice cream, cakes, and candies. It can also be roasted and used as a topping for roasted seeds. The Malvales order of the Bombaceae family includes the tropical fruit tree species known as durian. Its center of diversity is thought to be Borneo, from which it has expanded throughout China, Thailand, Malaysia, Brunei, Indonesia, and the Philippines.

The fruit is high in vitamins, minerals, protein, fat, and carbs. Fruits are picked from the tree by either climbing on it or letting it fall naturally and gathering it. A tree that was 8–12 years old would typically yield 150–300 fruits annually, each weighing between 0.5

and 1.5 kg. Once durian begins to ripen, it becomes challenging to store. Even on the tree, the fruits at maturity displayed a greater respiration rate. Nonetheless, ripe fruits might be kept in storage at 4–6 °C and 85–90% relative humidity for 6–8 weeks.

Table 1. Nutritive values of fruit (values per 100 g edible portion)

Fruit	**Moisture (%)**	**Protein (g)**	**Fat (g)**	**Carbohydrates (g)**	**Energy (g)**	**Minerals**			**Vitamin-C**
						Ca (mg)	**P (mg)**	**Fe (mg)**	
Bael	61.5	1.8	0.3	31.8	137	85	50	0.6	8
Carambola	91.9	0.7	0.1	6.1	28	4	11	1.0	50
Longan	72.9	1.0	0.5	25.2	61	2	6	0.3	8
Rambutan	82.9	0.9	0.1	14.5	64	3	6	1.8	31
Durian	68.0	2.5	2.5	28.8	144	20	63	1.2	46
Ber	81.0	0.95	1.2	15.5	63	0.04	0.02	0.5	110

Conclusion

Asia's tropical and subtropical climates are blessed with a great diversity of minor/underutilized fruits that grow untended, semi-wild, or wild and are generally underappreciated. Since the majority of these species are highly tolerant and versatile, they can survive in a variety of challenging environments. Even though Asia has a wealth of germplasm, breeding or conservation initiatives have not yet been implemented in a significant manner for the majority of the underused fruits. Numerous of these fruits have a high nutritional content and significant therapeutic significance. Because they increase their income with the least amount of risk, these fruits represent great potential for sustainable agriculture, especially for small farmers. Our immediate goals would be to create/select an appropriate variety/genotype, standardize manufacturing procedures, and increase consumer awareness of these fruits.

References

Karunakaran, G., Tripathi, P.C., Sakthivel, T., Ravishankar, H., Sankar, V.(2016) Rambutan is a potential future frui. *Indian Hort*., **61**(2): 3-5.

Kaushik, R.A. and Dhawan, S.S. (1996). Popularizing nutritive potential of bael. *Indian Hort*., **41**(3):56.

Mitra, S.K. (2017) Genetic resources of jackfruit and rambutan. Acta Hort. 1186: 15-22.

Mitra, S.K. and Pan, J. (2018) Litchi and longan production and trade in the world. *Acta Hort*., 1293:1-6.

Mitra, S.K. and Rajendran, P. (2018). Fruits and Hidden Hunger. In: Zero Hunger India: Policies and perspectives (ed.K.V.Peter) Brillion Publishing, New Delhi. Pp. 259-276.

Nath, V., Gupta, A.K., Marboh, E.S., Srivastava, K., Kumar, v. and Singh, M. (2018). Gandaki Longan 1 : first longan variety. Indian Hort., **63**(1):3-4.

Paroda, R.S. and Bhag Mal. (1993). Developing a National Programme for Research on Underutlized crops in India. Proceedings of the First International Crop Science Congress, Ames Iowa, USA 14-22 July 1992.

Pistorius, R. (1997). Scientists, Plants and Politics – A history of the Plant Genetic Resources Movement. International Plant Genetic Resources Institute, Rome, Italy.134 pp.

Prescott-Allen and Prescott Allen. (1990). How many plants feed the world? *Conserv. Biol.* 4: 365-374.

Singh, A.K., Singh, S., Singh, R.S., Sharma, B.D. and Saroj, P.L. (2023). New bael varieties for dryland. *Indian Hort*., **68**(1):3-6.

Srivastava, A.K., Singh, H.K. and Singh, I.S. (1998). Bael (Aegle marmelos). *Indian Hort*., **42**(4): Cover-II.

UNEP. (1995). Global Biodiversity Assessment. United Nations Environment Programme University Press, Cambridge, UK.

WCMC. (1992). Global Biodiversity: Status of the Earth' Living Resources–World Conservation Monitoring Center, Chapman & Hall, London, New York. 5494 pp.

Wilkes, G. (1984). Germplasm conservation towards the year 2000. In: Plant Genetic Resources: A conservation imperative. (eds. C. Yeatman, D. Kefton and G. Wilkes). American Association for the Advancement of Science, Washington, DC. USA.

Zeven, A.C. and de Wet, J.M.J. (1982). Dictionary of cultivated plants and their regions of diversity excluding most ornamentals forest trees and lower plants. 2nd Ed. Pudoc, Wageningen.

Volume: 03 Issue No: 11

ADVANTAGES OF VERMI COMPOST IN AGRICULTURE

Article ID: AG-VO3-I11-103

Anita Bhawariya*

Research scholar, University of Rajasthan, India

*Corresponding Author Email ID: anitabhawariya662@gmail.com

Abstract

Vermicomposting is a biological technique of converting organic wastes in to a rich soil amendment. In this paper a thorough literature is done regarding the impacting factors for a vermicomposting unit followed by design of pit for a vermicomposting and the number of earthworms required for the obtained amount waste. This is further continued with selecting of optimum range for parameters such as Temperature, Potential Hydrogen, Moisture content, TAN.

Introduction

Vermicomposting or worm composting is a simple technology for converting biodegradable waste into organic manure with the help of earthworms. Earthworms are valued by farmers because, in addition to aerating the soil, they digest organic matter and produce castings that are a valuable source of humus.

Vermicompost is a type of Organic Fertilizer. It is derived by composting organic waste by using various species of earthworms. It is a mixture of decomposing vegetable or food waste, bedding materials, and most importantly worm castings. This process of producing Vermicompost is called Vermicomposting. vermicomposting time ranges from 100 days repectively. Vermicompost can be stored for one year without loss of its quality, if the moisture is maintained at 40% level.

Vermicomposting is an organic and biological process in which earthworm species are primarily used to convert organic matter or biodegradable wastes into manure. The produced vermicomposts are rich in nutrition and thus, they are widely used as bio fertilisers in organic farming and sewage treatment plants.

Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes and also contain 'plant growth hormones & enzymes'. It is scientifically proving as 'miracle growth promoter & also plant protector' from pests and diseases.

Advantages of vermi compost

- Develops roots of the plants: Vermicompost has a profound effect on plants. It boosts the nutrients available to plants, helping seeds to germinate more quickly, grow faster, develop better root systems and produce higher yields. That means more flowers or fresh fruits and vegetables.
- Improves the physical structure of the soil.
- Vermicomposting increases the fertility and water-resistance of the soil.
- Helps in germination, plant growth, and crop yield.
- Nurtures soil with plant growth hormones such as auxins, gibberellic acid, etc.

Vermi composting materials

Decomposable organic wastes such as animal excreta, kitchen waste, farm residues and forest litter are commonly used as composting materials. In general, animal dung mostly cow dung and dried chopped crop residues are the key raw materials.

pH of vermicompost

6–7

Earthworm is best for vermicompost

Among the epigeic earthworms, Eisenia andrei and Eisenia fetida are the species most widely used in vermicomposting and vermiculture facilities worldwide.

Process of vermi compost

Selection of site

- The site selected for the pit should be easily approachable for inspection.
- Pit should be at a comparatively higher level so that neither rain water gets into nor the water table rises and causes water stagnation in the pit during monsoon.

- It should be near the cattle shed and the source of water supply.
- It is a common site in the country that farm waste & cow dung are piled by the side of the road. Automobile exhausts containing lead get deposited in such compost. Hence compost pit should be located at a distance from the road or else compost containing toxic metal lead contaminates even food grain, affecting health of animals & human beings.

Construction of Tanks

With the help of bricks cemented tanks are constructed on the soil surface. These tanks should be located near cattle shed or on easily approachable farm sites. Size of the tank should be 10'X6'X3' with 9" inch thick brick wall. For circulation of air, proper holes of 7" inches (preferably) are left on all the four sides of the tank wall. Plastering of inner-outer wall & floor of the tank should be done by dung and mud mixture.

Materials required

- Farm residues, refuses like weeds, grasses, leaves, sugarcane trash, stubbles and aal kind of wastes, stalks, roots, stems, prunings, stalk of green manuring crops, etc. 1400 to 1500kg.
- Cattle dung 90 to 100 kg (8-10 baskets) ϖ Dry sieved-soil 1750 kg (120 baskets) (urinated earth is more effective)
- Water –according to season (less during rains and in abundance during dry spells) 1500 to 2000 litres.

Method of filling

The tank Before filling the tank, slurry made of cow dung and water should be sprinkled on the floor and the wall

First layer: Plant residues available on the farm are spread evenly in layers to a thickness of 6 inches (100 to 110kg)

Second layer: Cattle dung or Gobargas-slurry, 4 to 5 kg in 125 to 150 litres of water on the first layer of the trash.

Third layer It consists of clean dry sieved soil (keeping apart stones, pebbles, glass plastic etc.) Then 50 to 60 kg (4 to 5 baskets) of soil are spread on moist layer of farm refuses sprinkling of water is repeated. The tank is filled in this way layer by layer and it is filled till the materials is 1½ ft. above the brick level. A hut like shape may be given at the top. The whole tank is to be filled within 1 or 2 days. Eleven to twelve layers are required for filling the tank to its capacity. In case cattle dung is not available in desired quantity, collection of same is done for 8-10 days under a shade by covering it with a light layer of soil. As an alternative practice, tank can be filled 1/3 or ½ of its capacity in parts.

Full tank should be covered and sealed by 3 inch layer of soil (300 to 400 kg). It should be pasted with a mixture of dung and soil. Cracks should not be allowed to develop on the heaps, to check gas leakages, for that the pasting can be repeated.

Second filling After 15 to 20 days the fresh contracts and becomes more compact and goes down in the tank by 8-9 inches. The procedure described in the first filling is repeated and again sealed and pasted with mud and dung. It takes about 3 to 4 months in compost making by NADEP method. In order to maintain 15 to 20 % moisture, the compost is sprinkled with cattle dung and water. This helps in conservation of the nutrients.

Conclusion

Vermi composting a biological process which involves the interaction between earthworms and micro-organisms leading to the formation of earthworm biomass and the vermicompost. In this paper a thorough research is conducted which involves the entire parameters required for vermicomposting, the design consideration which involves the surface area of the pit required and the type of earthworms required, their criteria for selection and the number of worms required are all included in this paper. This paper provides the basis for the process of vermicomposting.

References

Eghball B, Power JF, Gilley JE and Doran JW, Nutrient, carbon, and mass loss duringcomposting of beef cattle feedlot manure, Journal of Environmental Quality, 1997, 26,189–193.2.

Gandhi M, Sangwan V, Kapoor KK and Dilbaghi N, Composting of household wasteswith and without earthworms,Environment and Ecology, 1997, 15(2), 432–434.3.

Tara Crescent, Vermicomposting. Development Alternatives (DA) SustainableLivelihoods, (http:// www.dainet.org/livelihoods/default.htm), 2003.4.

Garg P, Gupta A and Satya S, Vermicomposting of different types of waste using

Eisenia foetida: A comparative study,Bioresource Technology, 2006, 97, 391-395.

AgriGate- An International Multidisciplinary e-Magazine

Volume: 03 Issue No: 11

WATER - ENERGY - FOOD NEXUS

Article ID: AG-VO3-I11-104

Bharathi M*, Ashok Kumar M and Dharmadurai C

1. *PG Scholar Department of Soil Science and Agricultural Chemistry, Directorate of Natural Resource Management, Tamil Nadu Agricultural University, Coimbatore, 641 003

2. Assistant Professor, Department of Soil Science and Agricultural Chemistry, Natural Resource Management, Adhiyamaan College of Agriculture and Research, Athimugam, Shoolagiri, Krishnagiri– 635 105, Tamil Nadu, India

3. Assistant Professor, Department of Agricultural Microbiology, Natural Resource Management, Adhiyamaan College of Agriculture and Research, Athimugam, Shoolagiri, Krishnagiri– 635 105

*Corresponding Author Email ID: bharathidass2001@gmail.com

Introduction

With a view to drawing attention to the interrelated nature of global resource systems, FAO is exploring how the water–energy–food nexus can support food security and sustainable agriculture worldwide. Population growth, rapid urbanization, changing diets and economic development are just some of the factors driving increased demand for water, energy and food. Agriculture is the largest consumer of the world's freshwater resources, and more than one-quarter of the energy used globally is expended on food production and supply. Feeding a global population expected to reach 9 billion people by 2050 will require a 60 percent increase in food production.

"The water–energy–food nexus is about understanding and managing often-competing interests while ensuring the integrity of ecosystems"

Developing a conceptual approach

The first challenge in dealing with the water–energy–food nexus is to understand it. At its 24th session, the Committee on Agriculture (FAO's main technical advisory committee) approved FAO's "Water Governance for Agriculture and Food Security" programme, specifically mentioning the water–energy–food nexus. With this mandate, FAO embarked on a process to define what the nexus means for the food and agriculture sector.

The result of that process is a conceptual approach that revolves around the complex and interlinked uses of water, energy and food. The approach distinguishes between natural resources on the one hand and, on the other, the various goals and interests to be achieved with the same (limited) resources. The water–energy–food nexus is about understanding and managing these often-competing interests while also ensuring the integrity of ecosystems. FAO has identified four areas of work through which it can help manage the nexus:

- by providing evidence
- by developing scenarios
- by designing and appraising response options and
- by supporting multistakeholder dialogue.

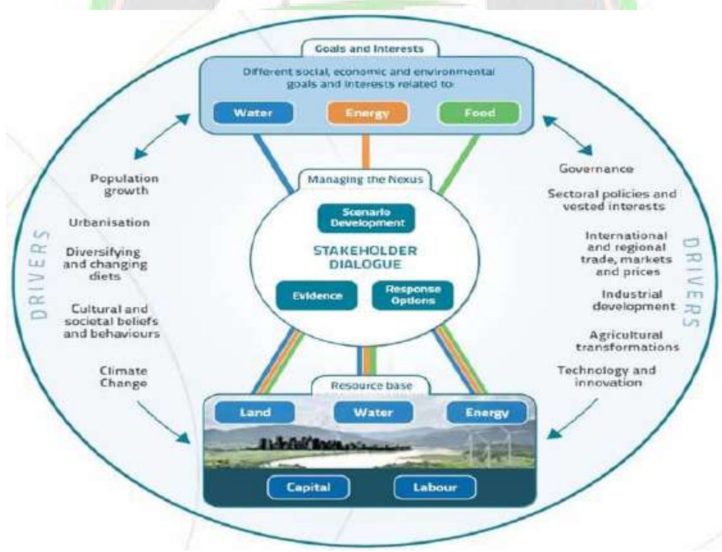


Fig: 1 Conceptual Approach (Source: FAO)

The Nexus-approach

How to deliver water, energy and food for all in a sustainable and equitable way, while preserving the health of natural ecosystems that form the basis of any economic activity? The Nexus approach moves beyond traditional sectoral thinking in order to achieve overall security and sustainability of all resources.

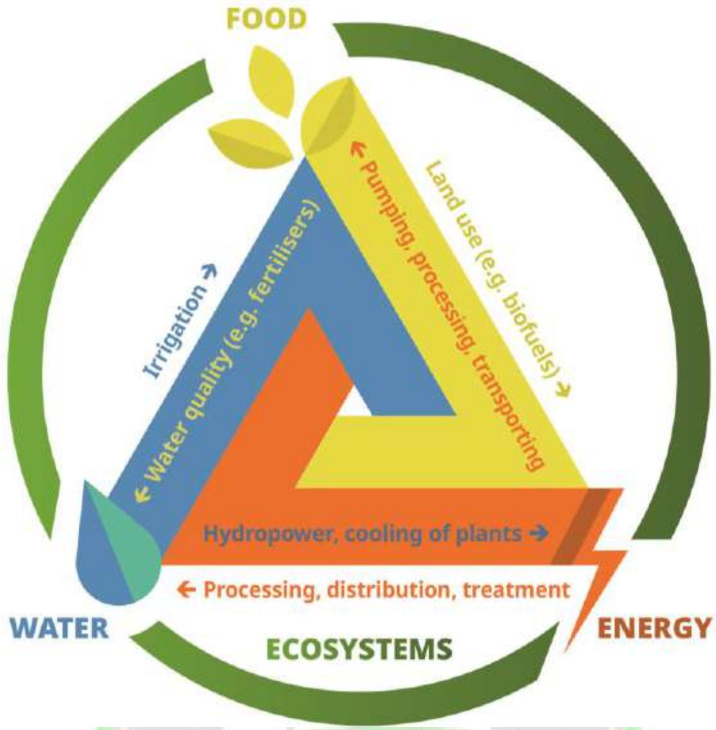


Fig 2: The Nexus - approach

Source: GWP-Mediterranean

Interlinkages between water-energy-food-ecosystems

The Nexus approach stems from the realization that water, energy, agriculture and natural ecosystems exhibit strong interlinkages (see Table 1), and that under a traditional sectoral approach, attempting to achieve resource security independently often endangers sustainability and security in one or more of the other sectors. Under the Nexus approach, interlinkages, synergies and trade-offs are analysed, with the aim of identifying solutions, fostering water-food-energy security and efficiency, and reducing impacts and risks on water-dependent ecosystems.

Table 1: Multi-dimensional interlinkages between water, energy, food and ecosystems

Water <-> Energy: Water plays a key role in energy production, e.g. in hydroelectric plants, for cooling thermal (fossil-fuel or nuclear) plants and in growing plants for biofuels. Conversely, energy is required to process and distribute water, to treat wastewater, to pump groundwater and to desalinate seawater.

Water <-> Food: Water is the keystone for the entire agro-food supply chain. Conversely, agricultural intensification impacts water quality.

Food <-> Energy: Energy is an essential input throughout the entire agro-food supply chain, from pumping water to processing, transporting and refrigerating food. Conflicts around land use for food production may arise in the case of biofuels or extended solar installations.

Healthy ecosystems are an essential requirement for the sustainability of all the above and are negatively affected if water, energy or food are used in an unsustainable way.

Benefits of the Nexus approach

The application of a Nexus approach can lead to multiple and cross-sectoral benefits including:

- **Economic benefits,** such as increased mid- and long-term viability of economic activities, resilience in the face of climate change, reduced risks and associated costs from floods and droughts, greater value added in the agriculture and tourism sectors, increased efficiencies in the consumption of resources and use of infrastructure, and optimized trade and innovation.
- **Social and environmental benefits,** such as the promotion of the Sustainable Development Agenda 2030, improved public health, employment creation, improved water and sanitation services, improved conservation and the recovery of ecosystems and habitats.
- **Regional cooperation and geopolitical benefits,** such as enhanced cooperation in the management of shared resources, including the adoption of new cross-border agreements, common regulations and protocols, development of regional markets for goods, services and labour and increased cross-border investments.

The Water-Energy Nexus: Challenges and Opportunities

Present day water and energy systems are interdependent. Water is used in all phases of energy production and electricity generation. Energy is required to extract, convey, and deliver water of appropriate quality for diverse human uses, and then again to treat wastewaters prior to their return to the environment. Historically, interactions between energy and water have been considered on a regional or technology-by technology basis. At the national and international levels, energy and water systems have been developed, managed, and regulated independently.

Six Strategic Pillars to Address the Water-Energy Nexus

1. Optimize the freshwater efficiency of energy production, electricity generation, and end use systems.
2. Optimize the energy efficiency of water management, treatment, distribution, and end use systems.
3. Enhance the reliability and resilience of energy and water systems.
4. Increase safe and productive use of nontraditional water sources.
5. Promote responsible energy operations with respect to water quality, ecosystem, and seismic impacts.
6. Exploit productive synergies among water and energy systems.

Technology Research and Development Opportunities

Opportunities exist throughout the stages of technology research, development, demonstration, and deployment:

- Recovery of dissipated energy
- Advances in cooling systems
- Alternatives to freshwater in unconventional oil and gas
- Desalination and nontraditional waters
- Net-zero wastewater treatment
- Efficient equipment and appliances Improvements in sensors, data collection, analysis, and reporting will yield benefits to multiple decisionmakers. Addressing energy and water systems as an integrated whole can stimulate additional innovations.

Data, Modeling, and Analysis Context and Needs

- The water-energy nexus is affected by many moving parts including supplies, demands, land use and land cover, population/migration, technologies, policies, regional economics, weather extremes, and climate.
- Improved integration of models spanning these domains can better reflect the dynamics of interactions and interdependencies among complex systems.

- Available data and information needs span a wide range of spatial and temporal scales, necessitating improved capacity for "telescopic resolution."
- Layered data-knowledge built around DOE data and other observation, model-generated, and reported data sets can lead to emergent insights and broadly accessible toolkits supporting energy and coupled water-energy system resilience.
- Stakeholder decision-making needs extend beyond these more integrative modelling frameworks and data-knowledge systems and must target:
  - ✓ Qualitative and quantitative scenarios
  - ✓ Probabilistic approaches
  - ✓ Insights into system shocks and extremes
  - ✓ Improved characterization of uncertainties
  - ✓ The food-energy-water nexus, with some of the links between each feature identified and explained.

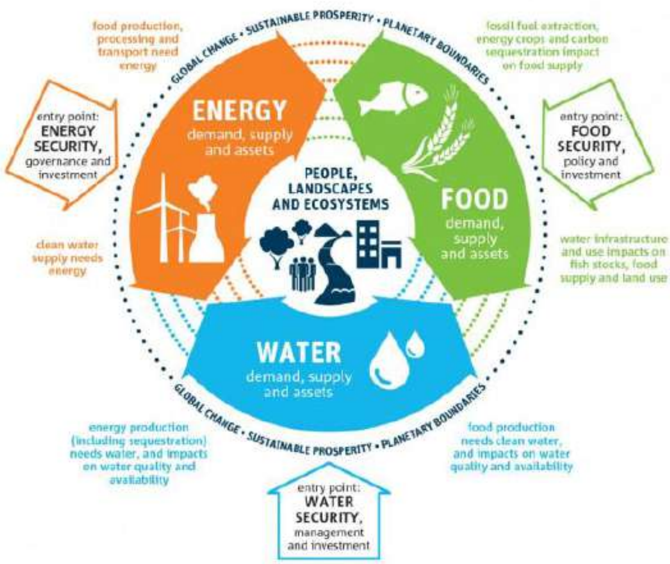


Fig:3 Source: IWA, 2018. Sustainable Development: The Water-Energy-Food Nexus.

Conclusion

Effective adoption of the Nexus approach is also a promising instrument for promoting social cross-cutting issues, such as gender empowerment, stakeholder engagement, human rights and combatting poverty, by safeguarding the rights of socially and economically vulnerable groups. These groups are affected the most by resource insecurity, as they depend the most -and spend the largest share of their income- on basic needs in the form of water, food and energy.

References:

1. https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/Programmes-per-theme/Water-Food-Energy-Nexus/the-nexus-approach-an-introduction/#:~:text=Typical%20examples%20include%3A%20the%20potential,renewable%20energy%20for%20desalination%20plants.
2. https://www.energy.gov/sites/default/files/2014/07/f17/Water%20Energy%20Nexus%20Executive%20Summary%20July%202014.pdf
3. https://cwee.ucdavis.edu/about/water-energy-nexus/#:~:text=The%20water%E2%80%93energy%20nexus%20is,and%20treating%20wastewater%E2%80%94consumes%20energy.
4. https://www.fao.org/land-water/water/watergovernance/waterfoodenergynexus/en/

Volume: 03 Issue No: 11

WILD GENETIC RESOURCES IN SUGARCANE

Article ID: AG-VO3-I11-105

[1]Lakshmipriya, S., [2*]V. Krishnan*, [1]K. Preetha, [1]FS. Aparna, [1]J. Arathi, [1]Praveen, R., and [2]M. Tamilzharasi

[1]PG Scholar & [2]Faculty, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal 609603, U. T. of Puducherry, India

*Corresponding Author Email ID: anurathakrishnan66@gmail.com

Introduction

The term genetic resources refers to any biological material that contains genes or metabolic material that may be derived from genes. It is also called gene pool/ genetic stock/ germplasm or the sum total of genes in crop species. Sugarcane is the most important cash crop in India. It is a giant tropical grass from the family Gramineae and botanical genus *Saccharum*, whose stalk has the capacity to store a crystallizable sugar, sucrose. It originated in Papua New Guinea. The six species of *Saccharum* and the related genera comprising *Erianthus*, *Miscanthus*, *Narenga* and *Sclerostachya* form the basic genetic resources of sugarcane. They form a closely related interbreeding group involved in the evolution of the cultivated sugarcanes referred to as the '*Saccharum* Complex' (Mukherjee 1957, Daniels et al. 1975). It comprises three sugar-bearing species – *S. officinarum*, known as "Noble cane", *S. sinense* and *S. barberi* and three non-sugar-bearing species – *S. robustum*, *S. spontaneum* and *S. edule*. The world collection of sugarcane genetic resources is maintained by the US Department of Agriculture- Agricultural Research Service (USDA- ARS), in Miami, Florida (USA), with a duplicate set at ICAR Sugarcane Breeding Institute (SBI) in Coimbatore (India).

HISTORY OF GERMPLASM COLLECTION:

Sugarcane improvement programmes worldwide are closely linked with the exploration, collection and utilization of sugarcane genetic resources.

Attempts to collect *Saccharum* germplasm from the areas of diversity began in the later part of the 19th century. Collections were made from New Guinea in 1892, 1895, 1921, 1928, 1951, 1957 and 1977. Indonesia was explored for *Saccharum* germplasm collection in 1976 and 1984. (Nair, N. V, 2012) Besides these major explorations, efforts were also made to collect germplasm from Thailand (1982 and 1983), Taiwan (1957-1958, 1966), Philippines (1984, 1985). *Saccharum* germplasm has also been collected from China and Japan over a while. The history of sugarcane germplasm collection in India dates back to 1912 following the establishment of the Sugarcane Breeding Station at Coimbatore initiated by **C.A. Barber**. (Amalraj, V. A & Balasundaram, S, 2006) The earlier explorations focused on collecting *S. officinarum* clones for introduction as cultivars whereas explorations conducted after 1921 endeavored to collect both cultivated and wild species of *Saccharum*. The **'Spontaneum Expedition Scheme**' was launched in 1947 by the Sugarcane Breeding Institute for the collection of *Saccharum* germplasm from India and other Asian countries. During 1947-56, over 500 clones were collected from the distributional areas of India under this scheme. Efforts were renewed during 1981-1990 to collect *Saccharum* germplasm from North East India. During this period, six explorations were organized and over 800 clones were collected. Collection efforts were revived in 1999 and nearly 750 clones were collected from the states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Arunachal Pradesh, Orissa, Mizoram, Tripura, Rajasthan, Himachal Pradesh, West Bengal and the Andaman Nicobar Islands. These explorations resulted in the collection of a large number of accessions representing the wide range of variability for *Saccharum* and related genera present in the country.

***SACCHARUM* COMPLEX:**

The sugarcane genetics resources of immediate value to sugarcane breeders are those taxa of the '*Saccharum* Complex'. The '*Saccharum* Complex' represents a hypothetical collective of species that were supposedly responsible through interbreeding for the origins of sugarcane. This informal taxonomic group includes five genera:

- *Erianthus*
- *Miscanthus*
- *Narenga*
- *Sclerostachya*
- *Saccharum*

a.

b.

c.

d.

e.

f.

Fig 1. ***Saccharum* spp**. a. *Saccharum officinarum* b. *Saccharum spontaneum* c. *Saccharum robustum* d. *Saccharum barberi* e. *Saccharum sinense* f. *Saccharum edule*

Erianthus: Genus *Erianthus* includes both old world and new world species. The predominant species occurring in India is *Erianthus arundinaceus*, which is found in the southern peninsula, east coast and in some of the Northeastern states. This is the only cane-forming type among *Erianthus* and is viewed as a donor for important agronomic traits and adaptability. Other species found in the country include *E. bengalense, E. procerus, E. ravennae* and *E. rufipilus*, which are largely confined to the North Eastern States.

Miscanthus*: Miscanthus*, has a high degree of chilling tolerance, including exceptional photosynthetic capacity at low temperatures, compared to other.

Narenga and ***Sclerostachya*** are the two primitive genera in the *Saccharum* complex, the latter reported to be a source for waterlogging resistance.

Out of these *Erianthus, Sclerostachya* and *Narenga* occur in India while *Miscanthus* is endemic to North India.

The following are the six species constituting the genus ***Saccharum***

1. ***Saccharum officinarum*** (2n=80): denominated as "**Noble cane**" due to its thick stems, high sucrose content, low fiber and starch contents.
2. ***Saccharum spontaneum*** (2n=40-128): a wild species with high ploidy levels ranging from 8 to 12, low sucrose content, resistance to pests and diseases, ability to regrow stems, high vigor and great adaptability
3. ***Saccharum robustum*** (2n=60, 80): characterized by a lack of rhizomes, larger inflorescences and thicker and taller stems than those of *S. spontaneum*.
4. ***Saccharum barb*****eri** (2n= 111-124): characterized by short and thin internodes.
5. ***Saccharum sinense*** (2n-=81-124): believed to be derived from natural hybridization between *S. officinarum* and *S. spontaneum*. They are distinguished from *S. officinar*um by their floral characteristics, high fiber content and tolerance to abiotic stresses.
6. ***Saccharum edule*** (2n= 60-80): a small group with sterile plants that probably originated from *S. robustum.*

Modern sugarcane cultivars originated from successive natural and artificial hybridizations between species of the genus *Saccharum*. The suggestion is, that all the genera (*Erianthus, Miscanthus, Narenga* and *Sclerostachya*) are closely allied to *Saccharum* and were involved in the evolution of sugarcane ancestors. But the delimitation of these genera (*Erianthus,* *Miscanthus*, *Narenga* and *Sclerostachya*) is contentious and largely unresolved, with most species recognized under *Saccharum*.

ROLE OF INSTITUTES IN GERMPLASM CONSERVATION:

Consequent to the sustained efforts by several National Agencies and the ISSCT **(International Society of Sugar Cane and Technologists)** a large collection of sugarcane germplasm is available today representing the native variability available in the *Saccharum* Complex. These collections have been conserved in the two world collections in the USA and India. The USDA **(United States Department of Agriculture)** world collection of sugarcane germplasm is maintained at the Subtropical Horticulture Research Station in Miami, Florida (USA). On the other hand SBI **(Sugarcane Breeding Institute)** with one of the longest active breeding programs in the world. A major part of the sugarcane germplasm *Saccharum officinarum*, *S. barberi*, *S. robustum* and *S. edule* is being maintained at the SBI research center, Kannur, Kerala. While wild species such as *S. spontaneum* and *Erianthus* spp and the related genera are maintained at Coimbatore (India). Some of the clones collected from high altitude viz. Arunachal Pradesh and Meghalaya could not establish and flowered at Coimbatore. So *S. spontaneum* clones from Arunachal Pradesh *Erianthus fulvus* and *Miscanthus nepalensis* collected from Meghalaya are maintained at the IARI **(Indian Agricultural Research Institute)** regional station, Wellington.

Sugarcane Breeding Institute is a designated center for NAGS **(National Active Germplasm Site)** for sugarcane under the National Plant Biodiversity Conservation Network of NBPGR.

Table 1. Germplasm holdings maintained by Sugarcane Breeding Institute at various places

Location	Species/ Genera	Indian accessions	ISSCT accessions
SBI, Coimbatore	*S. spontaneum*	878	Nil
	Erianthus spp	313	Nil
	Allied genera	41	Nil
SBI, Kannur	*S. officinarum*	Nil	757
	S. robustum	Nil	145
	S. barberi	Nil	30

	S. Spontaneum	305	79
	Erianthus spp	Nil	132
	Allied genera	88	20
SBI, Agali	*S. officinarum*	130	Nil
SBI, Wellington	*S. spontaneum*	47	Nil
	Erianthus rufipilus	5	Nil
	Miscanthus nepalensis	3	Nil

"Conservation of genetic diversity is a long-term commitment: more than any of us will live for"

Conclusion

Genetic diversity present in the sugarcane germplasm, among different Saccharum species and related taxa, represents a large reservoir of genes to develop new varieties and hybrids for any character or ecosystem. Every country engaged in sugarcane improvement retains a collection of sugarcane clones, which evolves over time with new additions. It is obvious that the genetic resources have been utilized to a considerable extent by different workers, although success in terms of released varieties has been limited to a handful of ancestor clones from *S. officinarum*, *S. spontaneum* and *S. barberi*. The genetic diversity available in the germplasm offers opportunities to design and develop sugarcane varieties by using nowadays technologies.

References:

Amalraj, V. A & Balasundaram, S. (2006). Status of Sugar-cane Genetic Resources in India, *Plant Genetic Resources Newsletter*,148, 26-31.

Barber, C. A. (1961). The classification of Indigenous Canes, *Agricultural Journal of India*,11, 371-376

Daniels, J. (1972). Descriptors of Sugarcane Clones, *Agricultural description Proceedings IISCT*, 14, 112-119

Daniels, J., Smith, P., Paton, N., & Williams, C.A. (1975). The Origin of the Genus Saccharum, *International Society of Sugarcane Technologists. Sugarcane Breed Newsletter*,36, 24-39.

Genetic Resources.(n.d.). https://sugarcane.icar.gov.in/index.php/genetic-resources

Mukherjee, S. K. (1957). Origin and distribution of *Saccharum*, *Botanical Gazette*, 119, 55-61.

Nair, N. V. (2012). Sugarcane genetic resources - status, potential and role in sugarcane improvement, *Journal of Sugarcane Research*, 2(2), 1-8

Recent achievements in germplasm collection and exploration.(n.d.). https://sugarcane.icar.gov.in/index.php/recent-achievements-germplasm

Volume: 03 Issue No: 11

PHYSICAL CARE AND MANAGEMENT OF RACE HORSES

Article ID: AG-VO3-I11-106

***Dr.S.Usha,**
Assistant Professor, Department of Livestock Production Management,
Madras Veterinary College, TANUVAS, Chennai- 600 007, Tamil Nadu
*Corresponding Author Email ID: drushavet@gmail.com

Introduction

A racehorse's body obviously undergoes incredible stress over the course of a race, which could lead to injuries. For example, horses can develop fractures that are affected by numerous factors, such as the strength of their bones, the bones involved, as well as the size or age of the horse. One particularly common type of fracture in racehorses is a chip fracture, where tiny pieces of bone break off, particularly in the horses' joints. Considering the massive impact an injury could have on a horse, it's unsurprising that many racehorse owners spare no expense in ensuring that a horse receives regular physical assessments to ensure it's healthy.

In fact, this is usually done every day by the horse's caretaker or trainer, who'll perform a basic physical examination to check for things like swollen muscles in the legs, whether the horse has its usual appetite or any other unusual changes in the horse's physical condition that could be a sign of a bigger problem. This helps identify any problems early on so the horse can receive the necessary treatment, should it turn out to be an ailment such as a respiratory infection or another issue.

Hoof care

While a racehorse's hooves are assessed as part of daily grooming, a horse's hooves have their own care routine that is strictly followed to not only ensure a horse is able to run as fast as it can but that it can do so without any risk of injury. This is particularly important as Thoroughbreds are known to struggle with weaker hoofs than other breeds. To ensure a racehorse isn‘t put at risk, a number of different care practices are performed, such as:

- Trimming to ensure the hoofs are at the correct length and angle
- Horseshoes correctly fitted and in good condition
- Hoof conditioner applied to ensure optimal hoof health
- Supplements provided to encourage keratin growth

Feed

We are what we eat, and the same concept is applied to racehorses, whose diets are strictly controlled to ensure they are as fit as possible. Most racehorses are fed a combination of hay, which provides them with the necessary roughage they need

and concentrated feeds, including grains such as oats, corn or barley, provide them with the carbohydrates they need to keep their energy levels up.

Even though racehorses generally have access to hay at any time of the day, the timing of their carbohydrate-filled meals is also important to ensure the horses are not training on a full stomach.

Stabling

Modern stables for racehorses are regularly cleaned, suitably warm, ventilated and have adequate drainage and bedding. This not only helps the horse avoid any mild or serious illnesses but ensures they don‘t need to spend any excess energy maintaining a healthy body temperature.

Mental health care

Stress, anxiety, depression, and other mental health issues can be very detrimental to any creature, but as you‘d expect, it can be particularly damaging to a racehorse, which is expected to be able to give its best on a race day.

Respiratory Health

Well-functioning airways and lungs are as essential to racehorses as to any athletic horse, enabling peak performance. Complicating this picture of respiratory health in all racehorse breeds is exercise-induced pulmonary hemorrhage (EIPH, commonly called bleeding), which Arthur calls a ―virtually normal physiological response‖ to strenuous exercise.How much these horses exercise each day impacts the development of their lung capacity. While the occasional fast workout can sharpen a horse‘s speed, regular long gallops can increase lung capacity.

The Basics of Equine Behavior

Ten Natural Survival Traits

- The horse, a prey animal, depends on flight as its primary means of survival. Its natural predators are large animals such as cougars, wolves, or bears, so its ability to outrun these predators is critical. As humans, we need to understand their natural flightiness in order to fully understand horses.
- The horse has a very fast response time. A prey animal must react instantly to a perceived predator to be able to survive.
- Horses can be desensitized from frightening stimuli. They need to learn quickly what is harmful (e.g., lion, cougar, etc.) and what is harmless (e.g., tumbleweeds, birds, a discolored rock, etc.), so they do not spend their whole lives running away.
- Horses forgive, but do not forget. They especially remember bad situations! This is why it is critical to make the horse‘s first training experience a positiveone.
- Horses categorize most experiences in one of two ways: a) something not to fear, so ignore or explore it, and b) something to fear, so flee. Therefore, when presenting anything new, the horse needs to be shown that ‗a‘ is the case. Again, it is important to make all training experiences positive.
- Horses are easily dominated. The horse is a herd animal where a dominance hierarchy is always established. If done correctly, human dominance can easily be established during training without causing the horse to become excessively fearful.
- Horses exert dominance by controlling the movement of their peers. Horses accept dominance when: a) we or another animal cause them to move when they prefer not to, and b) we or another animal inhibit movement when they want to flee. Examples include using a round pen, longe line, or hobbles; or the more dominant horse in the field chasing the less dominant one away.
- The body language of a horse is unique to the equine species. As a highly social animal, the horse communicates its emotions and intents to its herd mates through both vocalization and body language. A person handling horses needs to be able to read the horse‘s body language to be an effective trainer.
- Horses are one of the most perceptive of all domestic animals. Since they are a prey

species, they must be able to detect predators. A stimulus unnoticed by humans is often cause for alarm for horses; as riders and trainers we commonly mistake this reaction for –spookiness‖ or bad behavior.

- The horse is a precocial species, meaning that the newborn foals are neurologically mature at birth. They are most vulnerable immediately after birth so they must be able to identify danger and flee if necessary.

Volume: 03 Issue No: 11

MANAGEMENT OF SEED BORNE DISEASES OF SAFFLOWER

Article ID: AG-VO3-I11-107

***Dr. N. A. Musmade, Dr S. R. Zanjare, Dr. V. R. Shelar, Dr. A. V. Suryawanshi, Dr. D. S. Sarnobat, Prof R.S. Bhoge and Dr A. V. Karjule**

1 Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth Rahuri 413 722 (Dist. Ahmednagar) (Maharashtra State)

*Corresponding Author Email ID: musmadenarayan@gmail.com

Introduction

Safflower is a cultivated annual oilseed crop that belongs to the tribe *Cardueae* (thistles), family *Asteraceae* (Compositae), and subtribe *Centaureinae* (Berville *et al*., 2005). The *Asteraceae* family, which includes annual herbs and woody shrubs, is acknowledged as the biggest group of flowering plants. It has more than 1500 genera and 22,000 species. There are numerous more names for safflower, including kusum, kasunmba, kusumbo, kusubi, kabri, ma, sufir, kar/karar, sendurgam, agnisikha, hebu, su, and suban. In addition to affore, asfiore, asfrole, astifore, asfiori, zaffrole or zaffrone, saffiore, and finally, safflower, it is also known as hung-hua or "red flower" in the People's Republic of China (hereinafter referred to as "China"), as well as by numerous other names throughout the world as compiled by Smith (1996).

Safflower is one of the oldest crops grown by humans, yet it is still a small crop in comparison to other oilseeds (FAOSTAT, 2019). Vegetable oil is now the primary reason that safflower is grown (Kumar *et al*., 2015). According to Kumar and Kumari (2011), safflower is an annual plant that is upright, herbaceous, densely branched, prickly, and thistle-like and can reach heights of 30 to 150 cm. Young safflower plants form a rosette and remain in this vegetative state for several weeks, throughout the course of which leaves and a sizable taproot system emerge. Due to its extensive taproot system and numerous thin horizontal roots, this plant is able to access deeper soil strata for water and nutrients than a number of agricultural plants

(GRDC, 2017). After the rosette stage, the stem quickly lengthens, there is significant branching, and then there is flowering with leaves grouped on both sides of the stem (Singh and Nimbkar, 2006). Typically, farmed safflower has beautiful orange flowers. The size of a leaf varies depending on the variety and where it is located on the plant, but average leaves are 2.5–5 cm wide and 10-15 cm long. According to Teotia *et al*. (2017), the ovate-lanceolate, alternating, sessile leaf shape. Lower leaves typically lack spines, but those higher up the stem frequently grow stiff spines. While these spines make the crop challenging to traverse, they serve as a barrier to larger animals like pigs and kangaroos (GRDC, 2010). Growing older makes plants stiffer and more resistant to environmental stressors like wind and hail.

According to Pearl *et al*. (2014), the domestication of the ancient crop known as safflower dates back to the Fertile Crescent around 4,000 years ago. According to Chapman *et al.* (2010), this area stretches from western Iraq to southern Israel. Safflower has been grown for many years in northern Africa, China, and India.

Although safflower is a dryland oilseed crop, it has historically been grown throughout southern and central Asia as well as the Mediterranean to extract colours for textiles and food (Zohary *et al*., 2012; Li and Mundel, 1996). Safflower is now grown in arid and semi-arid regions wherever the plants have developed a tolerance for heat and dryness. Figure 1 shows the variety of safflower cultivars.

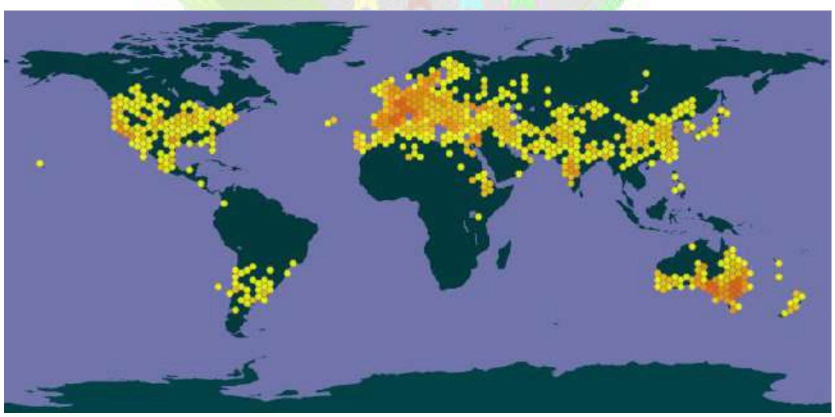


Figure 1: The cultivated safflower (*Carthamus tinctorius* L.) is found across the world. Georeferenced occurrences are indicated by yellow (or light grey) dots.

Source: GBIF Backbone Taxonomy (2023).

2. Seed-associated pathogens of safflower

Pathogen cause	**Disease**	**Yield losses**	**References**
Fungi			
Alternaria carthami	*Alternaria* leaf spot	25–60%	Borkar and Shinde (1989); Awadhiya (1991); Singh and Prasad (2005); Prasad *et al*., (2008)
Fusarium oxysporum f. sp. *carthami*	Fusarium wilt	40–80%	Awadhiya (1991); Kalpana Sastry (1996); Kalpana Sastry and Chattopadhyay (2003); Rao *et al*., (2014)
A. nigar, *A. flavus*, *Chaetomium* sps., *Rhizopus* sps *Curvularia*sps, *Macrophomina phaseolina* and *Fusarium* sps	Fusarium wilt, Macrophomina root rot, Leaf spot	40–80%, 1%–10%	Padaganur and Anil kumar (1976); Raghuwanshi *et al*., (2002); Rajendraprasad *et al*, (2021)
M. phaseolina	Macrophomina root rot	1%–10%	Awadhiya (1991); Prasad and Suresh (2012), Rajeswari *et al*., (2012)
Bacteria			
Pseudomonas syringae	Bacterial Leaf Spot and Stem Blight		Jacobs (1982)
Viruses			
Cucumber Mosaic Virus (CMV)	Cucumber Mosaic Disease		Klisiewiez (1965), Tomas (1981); Milosevic *et al* (2020)

2.1 Seed-Associated Mycoflora of Safflower

Safflower seed mycoflora was researched by Padaganur and Anil Kumar in 1976, who observed *Curvularia* sp., *Alternaria* sp., *A. flavus*, *A. niger*, and *Fusarium* sp. on several seed lots of two kinds. *A. carthami* was isolated from surface-sterilised safflower seeds by Rajagopalan and Shanmugam in 1983. They noted that the infection is outwardly seed borne and rarely transported within. *Alternaria carthami* was also carried in the pericarp of safflower together with *A. alternata* (Zazzerini *et al*. 1985). Prasad (1985) used the standard blotter method to evaluate 35 different safflower types for the presence of *A. carthami*. 27 cultivars were shown to have a 4-42 per cent association with the fungus, which led to pre- and post-emergence seedling mortality. Raghuwanshi *et al*., (2002) investigated seed mycoflora of safflower cultivars and observed that the seed germination and vigour were negatively impacted by Alternaria, Fusarium, *Aspergillus* sp. in varieties *viz*., A-1, Manjira, APRR-3, CO-1, Bhima, HUS-305, A-300, S-144, K-1, JSF-1, NRS-209 and Gima. Singh *et al*. (1987) examined seed mycoflora linked to 13 cultivars of safflower and documented 11 species of fungi linked with the seeds. *Rhizoctonia* spp. and *Alternaria* spp. were observed to be prevalent among the species discovered, with occurrence rates of 40% and 30%, respectively.

3. Measurement of diseases

3.1 Fusarium wilt and leaf spot disease severity scale.

***Fusarium* wilt**		**Leaf spot diseases**	
Disease scale	**Leaf/Stem symptoms**	**Disease scale**	**Leaf symptoms**
0	No yellowing/stem discolouration	0	No discolouration
1	Yellowing of leaf with slight necrosis (10–20%)/reddish-brown discolouration of the stem	1	Small irregular spots covering <10% of leaf area
2	Leaf with >50% necrotic areas/stem decay and stunted plant.	2	Lesions coalesce to form larger spots with 50% of the plant infected with the disease
3	Leaf/plant dead	3	Lesions are observed up to bracts with infected seeds

* Based on lower stem vascular discoloration and leaf symptoms, a disease rating methodology for wilt (0–3) was developed (adapted from Thies, 2000).

*Leaf spot malady scale of assessment adapted from Gud *et al*. 2008.

According to Borkar and Shinde (1989), *A. carthamii* in safflower, which is externally seed-borne, not only causes seed rot, which lowers seed quality but also seedling degradation and pre- and post-emergence mortality of seedlings. The findings showed that 48 to 100% of safflower seeds had externally transmitted *A. carthami* infection. *A. carthami* was identified to be prevalent (100%) in Awadhiya's study of the seed mycoflora linked with fifty types of safflower in 1991. She also noted the presence of *Fusarium* and *Macrophomina* sp. using the component plating technique, Prasad *et al*. (2008) investigated the seed-borne nature of *A. carthami* in safflower. *A. carthami* infection was highest in the seed coat (76.6%), endosperm (38.3%), and embryo (20.4%). *A. carthami*, *A. alternata*, *M. phaseolina*, *F. oxysporum*, *A. flavus*, *A. niger*, *Curvularia lunata*, and *Rhizopus* sp. were all noted as being present.

3.2 Scale for assessing the severity of Macrophomina disease.

***Macrophomina* disease**

Disease scale	**Leaf/Stem symptoms**	**Disease scale**	**Leaf symptoms**
0	No symptoms on the leaf	7	Lesions coalescing to form irregular brown patches with concentric rings. Covering 26-50 per cent of the leaf area. The lesion is also on the stem and petioles.
1	Small, irregular brown spots covering 1 per cent or less of the leaf area.		
3	Small, irregular, brown spots with concentric rings covering 1-10 per cent of the leaf area.	9	Lesions coalescing to form irregular, dark brown patches with concentric rings covering 51 per cent or more of the leaf area. Lesions on stem and petioles.
5	Lesions enlarging, irregular, brown with concentric rings covering 11-25 per cent of the leaf area.		

*Standard 0-9 grade disease ratting scale (Mayee and Datar, 1986)

4. Important seed-borne diseases

4. 1 Leaf spot/ blight disease

4.1. 1 Geographical Distribution, Economic Importance, and Losses

The Alternaria leaf blight on safflowers was initially identified in India by Chowdhury (1944). Kenya, Argentina, Portugal, Australia, Israel, Italy, Pakistan, Russia, Spain, Tanzania, the US, Ethiopia and Zambia are safflower-growing nations that have all recently reported occurrences of the illness. The northern Great Plains region of the US as well as the Indian states of Bihar and Madhya Pradesh are both believed to be experiencing exceptionally severe illness consequences, as reported by Bergman and Jacobsen (2005). There have been reports of serious disease harm to experimental safflower crops from Kenya and Tanzania in East Africa. During flowering but before maturity, a week of humid conditions can reduce safflower yields by 50% to 90% in cultivars that are especially sensitive to the disease. There is a considerable negative correlation between the severity of the disease and yield (Chattopadhyay 2001). Seeds from affected plants become discoloured, contain less oil, and have a noticeable increase in the quantity of free fatty acids, all of which are detrimental to seed germination.

4.1.2 Symptomatology

According to Chowdhury (1944), *A. carthami* originally generated little brown patches with concentric rings that eventually grew larger and consolidated. Additionally, he noted markings on the stem and petiole. According to Krishna Prasad and Basuchaudhary (1989), *A. carthami* caused a small, dispersed leaf spot with an uneven form, a yellowed halo without a target board appearance, and a light brown dot in the spot's middle. *A. carthami* previously caused similar symptoms in safflower, which were described by numerous researchers (Prabhakar *et al*., 2012; Taware *et al*., 2014 and Gholve *et al.*, 2015). Small, isolated, light brown to dark brown circular spots (1-2 mm dia.) first formed on the bottom leaves of seedlings (30 days old) before spreading to the top leaves. These patches grew larger and merged into larger spots and/or leaf blight as the virus spread. In rare instances, a brown dot encircled by numerous dark, alternating concentric rings also emerged in the core of these areas. Shot holes typically emerged in the diseased area in mature locations.

Under field conditions, the disease often began to manifest in November and reached its peak prevalence by the middle of February. In the sensitive safflower kinds, the disease propagated quickly; as a result, plants that were harshly infected became dark and dried out without producing any seeds. Other safflower cultivars showed indications of the malady on the upper leaves and also on the lower leaves that covered the lower side of the stem. In some instances, the symptoms also manifested themselves as elongated, dark brown to black discolourations on the stem, which led to the spliting of the infected stems. On floral portions, the infected capitula stayed closed, shrivelled, and dried out (Wagh *et al*., 2020). The symptoms were little dark brown spots that appeared first at the base of the involucral bracteoles and later grew larger and spread to other areas of the capitulum (Plate 1).

4.1.3 Pathogen- *Alternaria carthami*

The mycelium has small constrictions at the septa and is septate both intracellularly and between cells. When young, it has a subhyaline colour, but as it ages, it takes on a black hue. The conidiophores are thick, erect, inflexible, unbranched, septate, straight or flexuous, occasionally geniculate, brown or olivaceous brown, paler near the apex, and they can appear alone or in groups through the stomata or epidermis. The conidiophores are 15–85 min long and 6–10 min wide, with the base occasionally enlarged. The conidia are solitary or found in extremely short chains and are carried on conidiophores. They have a large beak and are smooth, straight or curved, obclavate, light brown and translucent in colour. Constrictions at the septa of the conidia can occasionally be seen. They are 12-28 millimetres wide and 36-171 millimetres long (with a beak) and 36-99 millimetres long (without a beak). The spores have up to 7 longitudinal or oblique septa and 3-11 transverse septa. The spores' beaks range in length from 25 to 160 m, are 4-6 m thick at the base, tapering to 2-3 m, and have up to 5 transverse septa. Near the base, the beak turns light brown, becoming practically hyaline at the tip. It's possible to view some spores without beaks. In culture, conidial beaks can produce chlamydospores. The ideal temperature range for the fungus to grow is between 25°C and 30°C. Additionally, it can endure a wide pH range; however, development is greatest around pH 6.0 (Choudhary, 1944). There was olivaceous brown-coloured septate mycelium present in the temporary mounts made from *Alternaria*-afflicted safflower leaf tissues and pure culture of *A. carthami*.

4.1.4 Epidemiology Role and Disease Cycle

According to Prasad *et al*. (2009) and Gayathri and Madhuri (2014), the disease can persist through seeds as well as alive conidia of *A. carthami* on detritus on naturally infected sensitive safflower cultivars. With the aid of relatively easy procedures, *A. carthami* is easily separated from seeds. The isolation procedures employed in conjunction with seed planting to assess seedling health appear to be the most effective method for detecting the existence of *A. carthami* in seeds (Awadhiya 2000). The primary infection is seen in the seeds collected from infected plants. On the leaf margin, the infectious agent infects the spines (Borkar 1997). Each spine's apex needs to have an entrance with a diameter of 120 m for infection to pass through. By altering the location of the spine on the outer edge of the leaf and the connection among the positions of the spines on the leaf margin, it is possible to assess the amount of infection by measuring the diameter of the holes at the spine apex. Because spores are released on lesions that emerge on plants grown by contaminated seeds, the disease harms the crop all during the growing season. Two macrolide antibiotics from *A. carthami*, brefeldin A (BFA) and 7-dehydrobrefeldin A (7-oxo-BFA), have been discovered as phytotoxins and pathogenicity elements; the toxins are known to impede endoplasmic reticulum-Golgi flow as well as processing (Kneusel 1994; Driouich *et al*. 1997). Rains, elevated relative humidity above 80%, irrigated temperatures around 21°C and 32°C, severe fog or regular showers, cyclonic storms, particularly during the seedling and grain production stages, and rain are all risk factors for the disease (Sastry and Chattopadhyay 2005; Murumkar *et al*. 2008a).

In the sensitive safflower cv. Manjira, the incubation duration was altered. Based on the incubation time (day from the first symptom's expression) (Wagh *et al*., 2020).

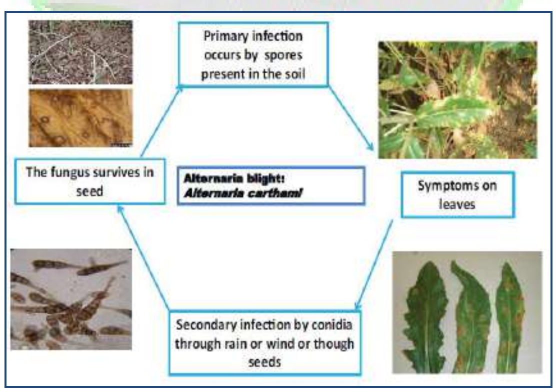


Fig 1. Disease cycle of *Alternaria* leaf spot disease

4.1.5 Management

4.1.5.1 Cultural practices

The Spread of the disease can be stopped by using disease-free seeds. Such seeds can come via prior-planted dry land crops instead of from irrigated areas. Fungicides may also be utilised to treat the diseased seeds, as was previously described. Rotating crops and maintaining strict cleanliness standards for agricultural detritus are efficient ways to control the disease. By adding KCl to the soil at a rate of 67 kg/ha, safflower seed production is improved and disease severity is significantly decreased (Chattopadhyay 2001). This practice can be paired with the spraying of effective fungicides and the use of the right planting dates for improved disease management.

4.1.5.2 Fungicides

The initial cause can be reduced by treating seeds with mefenoxam + thiram or difenoconazole + mefenoxam (Jacobsen *et al*. 2008). Spraying the crop with any foliar fungicide, such as mancozeb at 0.25%, difenoconazole at 0.5%, AAF (carbendazim 12% + mancozeb 63%) at 0.2% (Sumitha and Nimbkar 2009), or fosetyl at 0.1% (Bramhankar *et al.* 2001), can be utilised to prevent secondary infection. For efficient and cost-effective disease management, carbendazim at a concentration of 0.1% should be applied as soon as the disease manifests (typically at the rosette stage, or 25 days after sowing), followed by need-based second and third applications at intervals of 15 days and during the flowering and seed-setting stages, accordingly (Murumkar *et al*. 2008a, 2009a). The combination seed treatment and foliar spray of *T. viride* ST @ 10 g/kg + Garlic clove extract ST @ 10 ml/kg + Hexaconazole FS @ 0.1% resulted in the lowest average disease intensity (14.34%) and the largest decrease (74.36%) (Wagh *et al*, 2020). Treatment with *Trichoderma harzianum* Th4d sc at 2 ml/kg resulted in low disease incidence and severity measurements of 41.66% in *Fusarium* sp, 08.33% in *Rhizoctonia* sp, 06.66% in *Phytophthora* sp, 04.33% in *Alternaria* leaf spot, and 03.33% in *Cercospora* leaf spot (Pawar *et al.*, 2013). The highest percentage of seedling vigour was found in Thirum + Mancozeb (16%), and there was no seedling mortality found in 24 or 48 hr against *A. carthami* (Gholve *et al.*, 2017).

4.1.5.3 Bioagents

After 9 days of incubation, the *Trichoderma viride* was particularly efficient against *A. carthami* and *F. oxysporium* f.sp. *carthami* (Shinde and Hallale, 2013).

The *T. harzianum* was discovered to be the best efficient, and it considerably inhibited *A. carthami* and *A. alternata* mycelial growth by about 81.48% and 83.70%, respectively (Zanjare *et al*., 2020).

4.1.5.4 Botanicals

Eucalyptus, nerium, onion bulb, garlic bulb, lantana, datura, neem, and ocimum species extracts have been shown to have antifungal properties against *A. carthami*, which can be further exploited for effective disease management (Shinde *et al*. 2008, Ranaware *et al*. 2010, Taware *et al*. 2014). At both 15% and 25% concentrations, a combination of neem, chilli, garlic, eucalyptus, and menthol extracts was identified to be extremely efficient against pathogens; at the latter concentration, mycelial inhibition was found at 62.16% (Upadhyay *et al*., 2019).

4.1.5.5 Resistance sources

A variety of safflower cultivars respond to *A. carthami* infection in different ways (Munoz-Valenzuela *et al*. 2007, Thomas *et al*. 2008). Some genotypes such as EC 32012, NS 133, CTS-7218, HUS 524, and CTV 251 (Desai 1998); GMV 1175, GMV-1199, and GMV-1585 (Indi *et al*. 2004); GMV-5097, GMV-5133, and GMV-7017 (Murumkar *et al*. 2009a); and Ellite Line 21-33. The most intriguing genotypes to be employed in the programme of breeding for incorporating resistance to the Safflower genotypes that vary from partially spiny to non-spiny have been found to display different levels of tolerance to A. carthami infection indicating an elevated level of tolerance to A. carthami under excessive disease pressure (Pawar *et al*. 2013).

High yield and elevated levels of disease tolerance are compatible (Mundel and Chang 2003; Harish Babu *et al*. 2005). According to laboratory and field testing, four wild *C. Carthamus* species, palaestinus, *C. lanatus*, *C. creticus*, and *C. turkestanicus*—are resistant to Alternaria leaf spot. The crossings between *C. tinctorius*, *C. creticus*, *C. oxyacantha*, *C. tinctorius*, *C. turkestanicus*, *C. tinctorius*, *C. lanatus*, *C. palaestinus*, and *C. oxyacantha* resulted in twenty-four F1s. *A. carthami* infection (immunity) has not been found in *C. tinctorius* after screening. These disease-resistant lines would be utilised as the starting point for disease-resistance breeding to molecularly tag the resistant genes for marker-assisted field selections for *Alternaria* blight resistance (Prasad and Anjani 2008a).

Safflower genotypes are reported to have monogenic recessive seedling resistance to *A. carthami*, however, adult plant resistance is under the control of two duplicate loci, with at least one locus conferring adult plant resistance under homozygous recessive conditions (Gadekar & Jambhale 2002a). The development of plants resistant to *A. carthami via* organogenesis and somatic embryogenesis as well as molecular breeding have made it possible to breed safflower for resistance to *Alternaria* blight through the use of transgenic safflower plants. The basis for the development of transgenic safflower plants is the cloned esterase gene that breaks down the BFA (phytotoxin and pathogenic factor) (Kneusel *et al*. 1994).

Table 2: Reactions of safflower cultivars, germplasm lines against *Alternaria* blight disease

Cultivar/germplasm line	Reaction	References
HUS-305, DSH-242 (IHT), A-1	Tolerant	Wagh *et al*, 2020
PBNS-125, SSF-1109, PBNS-124, DSI-116, DSI-114, SSF-1201, ASF-1302, AKS-326, NARI-95, DSH-250, NARI-H-15, DSH-249, PBNS-12 and PBNS-120	Susceptible	
JSI-120, NARI-198, PBNS-12, DSI-118, AKS/GMU-4576, JSI-118, SSF-1102, DSI-117, NARI-97, ASF-1301, JSI-119, PBNS-123, SSF-1215, NARI-96, AKS-327, DSI-115, PBNS-122, DSI-113 and JSI-117	Highly susceptible	
Nari-P-26, W-521-3, Nari-P-22, Nari-P-25, GMU-7396, Nari-P-27, Nari-P-24, SAF-15-21, Nari-P-21, DSI-116,Nari-P-23, GMU-3705/6, GMU-3705/6 (12)	Tolerant	Pawar *et al*, 2017
Nari-P-28, SAF-15-07 (02)	Susceptible	
GMU-3705, DSI-108 (02)	Highly susceptible	

4.2 *Fusarium* Wilt

4.2.1 Economic Importance, geographical distribution and Losses

Safflower fusarium wilt was first noted in India in 1975 (Singh *et al*. 1975) and the Sacramento Valley of California, USA, in 1962 (Klisiewiez and Houston 1962). Egypt has also been reported to have the disease (Zayed *et al*. 1980). In all of India's safflower-growing regions, it is now recognised as the most dangerous disease (Murumkar and Deshpande 2009). Rarely can plants developed from contaminated seed make it past the seedling stage, suggesting that crop losses in the stand may occur when the infected seed is sown. According to reports, disease incidence ranges from 10% to 20% in the majority of fields and can reach 50% in a few. If vulnerable varieties are cultivated in fields with a history of severe Fusarium wilt, yield losses may reach 100% (Sastry and Chattopadhyay, 2005). Safflower production in India has come under great threat from it, with up to 25% of plants being destroyed, leading to significant yield loss in the Gangetic Valley. According to reports, infected safflower seeds in storage are producing enough fusarium mycotoxins, including diacetoxyscirpenol, T-2 toxin, and 12,13-epoxytrichothecene, to be able to cause mycotoxicosis.

4.2.2 Symptomatology

The condition shows symptoms at every stage of development. Cotyledonary leaves may develop little dark spots, either randomly or in a ring, on the inner surface of the leaf during the seedling stage. They may also become shrivelled, and brittle, and occasionally tend to roll and curve. When the seeds germinate, the seedlings that survived the fungus attack regain their health during the first phases of blooming and recur as a disease. The symptoms start to become very obvious when plants are approximately 15 cm and 20 cm in height and in the sixth to tenth leaf stage. Knowing four essential characteristics of the symptoms at this phase may help identify the disease. These include golden-yellow leaf discoloration accompanied by dying, epinasty, as well as unilateral infection on branches and leaves. Vascular browning that only manifests on one side of the stems and roots of plants with unilateral top symptoms is another example. The symptoms rapidly develop one after another. The reddish-brown vascular discoloration of the root, stem, and petiole flesh of plants infected will vary significantly in intensity depending on the variety's response, the level of infection, and the environment. When a plant is more developed, the disease can only start to harm the lower branches on a single side of the plant, leaving the other parts of the plant intact. These kinds of plants may partially recover between bud development and early flowering, though the symptoms may subsequently reappear. Plants that were severely afflicted generate little, partially opened flower heads. Many ovaries are incapable of producing seeds, or when they do, they may be black, small, malformed, chaffy, or abortive.

4.2.3 Pathogen-*Fusarium oxysporum*

F. oxysporum Schlecht, f. sp. *carthami* Klisiewicz, and Houston are the pathogen. On potato dextrose agar (PDA), the fungus is easily isolated from damaged plant sections. Mycelium can range from being sparse to being numerous, branching, and septate. It is typically white with a purple tint or a delicate pink colour. Microconidia are plentiful, oval to elliptical, one-celled, and slightly curved, measuring 5-16. 2.2-3.5 m, and they are carried on simple phialids emerging laterally on the hypha or short, sparsely branched conidiophores. The macroconidia are hyaline, can have up to five septa but typically have only three, are constricted at the septa, are borne in sporodochia, can be straight or curved, frequently have a point at the tip with a rounded base, and measure 10-36. 3-6 m mostly 28. 4-5 m. One-celled, smooth, subduedly coloured chlamydospores range in size from 5 to 10 microns. They are both terminal and intercalary, frequently solitary but occasionally could form in chains, and they are abundantly created (Sastry and Chattopadhyay 2005).

4.2.4 Epidemiology Role and Disease Cycle

The fungus reproduces both through soil and seed. Although hyphae have also been found to be present in the parenchymatous cells of the seed coat of the infected seed, mycelium and spores still pollute the seed surface. The primary means by which the fungus survives in the soil is through chlamydospores found in plant waste. When the plants are in the seedling stage and the tissues are soft, the pathogen can more easily penetrate the host cells through mechanical mechanisms. When plants are afflicted, cortical cells start to shrink. Production of the enzymes polygalacturonase, pectin methyl esterase, cellulase, and protease appears to aid in the spread of the infection. Safflower plants with the illness have been found to contain the mycotoxins diacetoxyscirpenol and T-2. Additionally, the pathogen is said to release T-2 toxin, fusaric acid, diacetoxyscirpenol, and lycomarasmin in culture filtrate. However, as mentioned previously, the precise function of either enzymes or toxins is poorly understood or unknown. However, it has been claimed that the quantity of fusaric acid produced by *F. oxysporum* f. sp. *carthami* strongly correlates with its virulence..

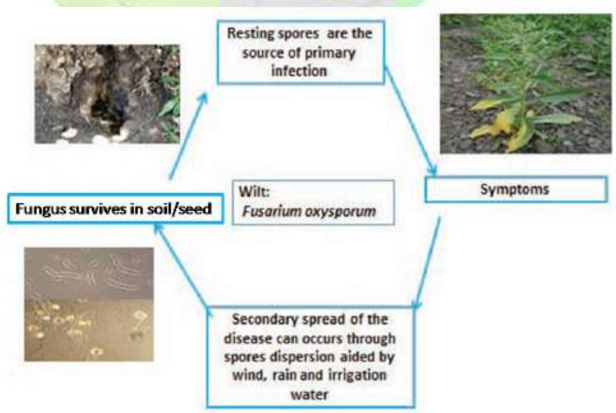


Fig 2. Disease cycle of *Fusarium oxysporum* disease

It has also been asserted that the pathogenicity is removed by preventing the production of fusaric acid. The quantity of infected seeds per head may be constrained by the extent of fungus distribution in the vascular tissue of the stem or side branch and seed cap. It is believed that the fungus reaches the seed by the vascular thread that extend from the pericarp to the receptacle junction. The pericarp and seed-coating tissue are affected by intra- and intercellular fungus. Different isolates of *F. oxysporum* f. sp. *carthami* have been reported to exhibit different morphology, culture traits, and pathogenicity (Sastry and Chattopadhyay 2003; Murumkar and Deshpande 2009; Raghuwanshi and Dake 2009; Somwanshi *et al.* 2009).

High nitrogen levels and warm, humid weather are also favourable to the sickness. According to reports, the wilt is less severe where paddy or millets are grown before safflower on fallow land. The incidence of the disease is said to be low in uplands with neutral to alkaline, clay-like soil (Kolte, 1985). Stress from high temperatures, poor drainage, and compacted soil all contribute to disease severity. The plant is more vulnerable to Fusarium wilt due to any cause that slows down root growth. The dense planting also makes plants more stressed and makes infections more likely. The impact of F. oxysporum f. sp. carthami tends to be apparent in flowering, as crops including their ability to produce are most susceptible to stress. The disease intensity decreases as the temperature drops (from 21°C to 15°C) between the last weekend of December to the beginning of February, while under Indian conditions, it may increase as the temperature rises (23.6°C). Depending on the variety and inoculum density, seedlings grow less prone to disease as they mature (Sastry and Chattopadhyay 1999a).

4.2.5 Management

4.2.5.1 Resistance sources

Numerous safflower genotypes have been tested for resistance utilising the water culture approach employing pathogen culture filtrate at a concentration of 3.5% (Shinde and Hallale 2009; Waghmare and Datar 2010). Thus, the causes of Fusarium wilt disease resistance in natural and domesticated *Carthamus* species have been discovered. *C. oxyacantha*, *C. lanatus*, *C. glaucus*, *C. creticus* and *C. turkestanicus* are examples of wild safflower species that are resistant to wilt.

By selecting and reselecting from superior lines of breeding developed from crossings of C. tinctorius, C. oxyacantha and *C. turkestanicus* resistant cultivars are being produced. The likely-to-succeed safflower genotypes with the greatest wilt resistance are GMU-1553 (Gadekar and Jambhale 2002b); 86-93-36A, 237550, VI-92-4-2, and II-13-2A (Sastry and Chattopadhyay 2003); GMU-1702, GMU-1706, and GMU1818 (Chavan *et al.* 2004); 96-508-2-90 (Anjani *et al.*

2005); HUS 305 (Sastry and Chattopadhyay 2003, Raghuwanshi *et al*. 2008, Singh *et al*. 2008b); WR-11-4-6, WR-8-24-12, WR8-19-10, WR-46- 5, WR-5-20-10, and WR-8-17-9 (Singh *et al*. 2008b); released hybrids DSH-129, NARI-NH-1, and NARI-H-15; and released cultivars A-1, PBNS-40, and NARI-6 (Murumkar *et al*. 2008b, 2009b, Prasad and Suresh 2012). Sehgal and Raina (2005) and Johnson *et al*. (2007) both produced information on the utilised of molecular markers for safflower germplasm characterization and for genotyping safflower cultivars. High levels of disease resistance can be identified in *C. lanatus* (2n = 22) and the alloploid that results from treating seedlings from a hybrid between *C. lanatus* and *C. tinctorius* (2n = 24) with colchicine. The dominant genes provided by the *C. lanatus* genome appear to minimize the malady resistance in the alloploid. It has been found that the accumulation of the antifungal chemical carthamidin (4, 5, 7, 8-tetrahydoxy flavone) in sick plants is what makes the plants resistant to infection.

Two dominant genes with complementary forms of gene action control some genotypes resistance to *F. oxysporum* f. sp. *carthami*, whereas inhibitory types of gene action control other genotypes' resistance (Shivani *et al*. 2011). And in yet other cases, resistance in seedlings is found to be straightforwardly monogenic dominant, whereas resistance in adult plants is discovered to be regulated by epistatic nonallelic interactions (Gadekar and Jambhale 2002b). However, the emergence of novel races in the *F. oxysporum* f. sp. *carthami* natural population may hinder the development of long-lasting wilt-resistant cultivars (Kolte 1985).

4.2.5.2 Chemical Control

Seed therapy with fungicides such as captan; carboxin, thiram, or a combination of carboxin + thiram; benomyl; and carbendazim + mancozeb @ 0.1% or 0.2% can reduce infection of the outermost layer by *F. oxysporum* f. sp. *carthami* as well as becomes effective at eliminating the fungus within the seed, but each of these is more effective if utilised with wilt-tolerant cultivars or cultural techniques (Sastry and Jayashree 1993, Govindappa *et al*. 2011b).

4.2.5.3 Cultural Control

In India, nonhost plants that are typically grown in succession with safflower, such as lentil, chickpea pea, and wheat, have been found to increase safflower yield and decrease the occurrence of wilt by secreting compounds that prevent the pathogen from growing (Kolte 1985; Sastry and Chattopadhyay 1999a; Sastry *et al.* 1993). Wheat and chickpea both increase the amount of antagonistic microorganisms in the rhizosphere, which significantly reduces the pathogen's ability to develop. Through exudates and extractives, the root system of *Ruellia tuberosa* L. displays potent therapeutic and protective benefits against the safflower wilt. The aerial fungicide potential of the root extractive is revealed. *R. tuberosa* is believed to have an inhibitory effect on *F. oxysporum* f. sp. *carthami* due to the quantities of 2,6-dimethoxy quinone, acacetin, and C16-quinone in the root exudates and extractives. *R. tuberosa*, a typical weed prevalent in India, is said to be able to grow in safflower farms to avoid wilt (Kolte 1985).

4.2.5.4 Biological Control

Trichoderma viride (Patibanda and Prasad 2004, Singh Saroj *et al*. 2006), *A. fumigatus* (Gaikwad and Behere 2001) and *Bacillus subtilis* have all been found to be antagonistic against *F. oxysporum* f. sp. *carthami*, showing their possible benefit for the managing of the malady. More encouraging findings are seen in local isolates of *Trichoderma* species (Waghmare and Kurundkar 2011). The employment of various disease control strategies in conjunction with integrated disease management has always been beneficial (Sastry *et al*. 2002). For instance, combining the use of NSKE at 5% and *T. harzianum* or *T. viride* at 4–10 g/kg seed on the moderately susceptible safflower variety A-1 or both (Prasad and Anjani 2008b) leads to substantial suppression of the infection along with the boost in safflower yield (Singh Saroj *et al*. 2006).

4.2.5.5 Botanicals

It has been identified that several plants extracts of leaf, including *Parthenium hysterophorus*, *Leucaena leucocephala*, *Vinca rosea*, *Gliricidia maculata*, *Ocimum basilicum*, *Eucalyptus globulus*, *Azardica indica*, *Datura metel*, and *Bougainvillaea spectabilis* can suppress the mycelial growth of *F. oxysporum* f. sp. However, when it comes to lowering the per cent wilt incidence of safflower, all of the examined leaf extracts fall short of Thiram (Kolase *et al*. 2000).

4.3 RUST

4.3.1 Economic Importance, geographical distribution and Losses

Rust, which is brought on by *Puccinia carthami* is the most prevalent disease affecting safflower. In Bohemia in 1840, Corda for the first time described it while he was battling *C. tinctorius* L. (Arthur and Mains 1922). This malady has been identified in all is growing regions of safflower and is widespread throughout the plant's native range (Kolte 1985). Recent reports of it include Oman (Deadman *et al*. 2005), China's snow lotus (Saussurea involucrata (Kar. & Kir.) (Zhao *et al*. 2007), and cross-border regional areas between Romania and Bulgaria

(Anonymous 2014). In nations where the crop is farmed year after year, the malady is more severe. Safflower monoculture is so prohibited. Severe epiphytotic's of this rust were noted there following the arrival of the safflower crop in 1949 and 1950 (Schuster and Christiansen 1952). Because it now happens too late in the cultivating season to affect yields in the Great Plains of the United States, it is rarely a concern there (Lyon *et al*. 2007). Before 1990, the sickness appears to have caused large yield losses in India, but over the last 10 to 15 years, it has not been acknowledged as having a significant impact in diminishing safflower production (Prasad *et al*. 2006; Singh and Prasad 2007). However, it is also believed that seed and seedling contamination is economically significant because it is the origin of inoculum for beginning leaf infection. Furthermore, heavily polluted seeds won't grow well if they are saved for future plantings (Lyon *et al*. 2007). The mean yearly loss from safflower rust in the US is estimated to be roughly 5% and costs about $1 million, based on calculations by Kolte (1985). Safflower rust's primary loss is the reduction in stand caused by sowing untreated teliospore-infested seed or seed where there are still viable soil-borne teliospores present. Only about 20% stand loss has been documented when using naturally rust-infected seed, compared to 98% stand loss when using artificially contaminated seed. Rust-infected yet rust-resistant safflower kinds display a stand loss of 26%, according to field tests with rust-resistant and rust-susceptible cultivars. But because these resistant kinds of surviving plants have the capacity for growth compensation, any yield loss is insignificant in comparison to the stand losses of susceptible types that range from 55% to 97% despite their substantially lower yield.

4.3.2 Symptomatology

Safflower rust has two distinct pathological phases: (1) root and foot maladies, which appear as rust signs on cotyledons, hypocotyls, etc.; and (2) leaf phase illness, which appears as rust indications on the leaves, blossoms, fruits, etc. later in the plant's development. The primary cause of rust in the seedling phase is the infection of developing seedlings by basidiospores brought on by the germination of soil- or seed-borne teliospores. Pycnia, which are initially represented as orange-yellow spots on cotyledons, may also cause the seedlings to droop and wilt. These patches later produce primary uredia, a uredinoid aecidia, which causes colour shifts. Many of these uredia become pustules, and subsequent pustules join together to form enormous rust pustules. Taproots and lateral root systems are examples of subterranean structures that have rust pustules. The epidermal and cortical layers of the affected area frequently display longitudinal cracking, as described by Schuster and Christiansen (1952). The primary cause of part of the cracks is the accidental roots that are distributed at the infection sites. Wilted plants may be able to survive thanks to their roots. Seedlings that are 8 to 10 weeks old may have an infected stem and develop orange-yellow pycnia. Girdling of the invaded area as a result of tissue collapse is a particularly distinctive sign on comparatively older plants. Due to their sturdy stems, these plants can stand upright, but their leaves are typically wilted. Due to wind or rain, these kinds of plants frequently break where they are girdled. The disease's foliar phase is indicated by uredial pustules that develop on flowers, leaves, and fruits. On the leaves, the chestnut-brown uredia remains scattered and wilted. Teleutospores develop in the uredopustules as the safflower plant matures, giving the corroded parts of the plant a dark-brownish tint.

4.3.3 Pathogen- *Puccinia carthami*

P. carthami (Hutz.) Corda is the pathogen. *P. carthami* is an obligate pathogen that lives on the Carthamus species and has an autoecious life cycle. Since real aeciospores are inadvertently left out of the life cycle of macrocyclic rust, the rust is said to be of the brachy-form type. The uredosori are sporadic and are typically located close to the pycnia on both sides of the leaves. Uredia can occasionally occur between two pycnia that are quite close to one another. Many globoids or broadly ellipsoid uredospores ranging 21-27. 21-24 m in size are seen in uredosori. The spore wall is 1.5–2.0 m thick. The uredospores are light chestnut brown, echinulate, and have three to four equatorial germ pores. Uredosori produce teleutosori. The teliospores are bicelled, ellipsoid, 36–44, 24–30 m, slightly or not constricted at septa, chestnut-brown, rounded or slightly obtuse at both ends, coarsely verrucose, 2.5–3.5 m thick at the side, and the spores are typically depressed from the apical position. The teliospores have a 10 lx-long pedicel, and are hyaline, delicate, and mainly deciduous. Pycnia are subepidermal, flask-shaped or spherical, and typically occur in groups. They have a diameter of 80–100 min. Numerous flexuous hyphae are visible sticking out, and the ostiole is filled with a lot of pycniospores.

4.3.4 Epidemiology Role and Disease Cycle

P. carthami is mostly kept alive during the uncropped season by teleutospores that lazily hang to seeds or hidden crop waste. Two categories have been established for teliospores. One of the two types is known to have a rapid germination ability, while the other shows a 5- to 6-week duration of dormancy. In the outdoors, teliospores—which signal dormancy—can survive for 12 months, yet only for 21. It was found that the contaminated safflower straw still had live teliospores despite 45 months of retention at these temperatures. Uredospores are unable to survive in the wild. They can, however, reportedly endure for more than a year in dry conditions at 8°C–10°C. After three weeks at room temperature, the uredospores become inactive. On infected plants, uredospores can survive for three weeks at 30°C to 31°C and for three days at 52°C to 55°C. Intriguingly, rust likes to directly form teliospores at temperatures above 40°C (Kolte 1985). Numerous wild species of Carthamus act as collateral hosts for P. carthami for it to survive (Sastry and Chattopadhyay, 2005). In India, the wild C. oxyacantha variety of safflower is frequently infected with this rust, and it seems that this host develops an infection one month sooner than the farmed type. Additionally, during the off-season, live teliospores were observed on this wild safflower, suggesting a potential source for the pathogen's survival. Other Carthamus species, such as C. glaucus MB, C. lanatus L, C. syriacus (Boiss) Dinsm., and C. tenuis (Boiss) Bornm., also seem to be collateral hosts for P. carthami. The resting teliospore, which is one of two types of teliospores, overwinters and is still viable the following season, claim Prasad and Chothia (1950). However, it's possible that the first disease in the safflower plant was brought on by teliospores generated by native safflower species, especially those that don't need a dormant period after production. These may attack the wild variety first and create uredospores, which are then blown into the farmed safflower to begin the infection process. Alternatively, they may infect the safflower crop. Based on reports, the polyacetylenes in particular, found in crop residue from safflower, help teliospores germinate. Between 12 and 18 degrees Celsius is the optimum temperature range for teliospore germination. During typical germination, teliospores generate a four-celled promycelium containing a cell containing a tiny sterigma and a kidney-like sporidium. Infected roots and feet originate from this gametophytic reproduction, which appears as the formation of sporidia and occurs while seedlings are buried during the germination of the seeds period and before to plant emergence. While a temperature around 30°C and 35°C prevents such an infection, a lower temperature range of 5°C–15°C encourages a greater number of seedlings showing the root and foot stage of the disease. Changes in soil moisture from 35% and 80% of its capacity for holding water have not been shown to affect seedling rust infection. The elongation and hypertrophy of the afflicted seedlings are one of the key signs of *P. carthami* infection in seedlings. Orange patches made up of spermogonia occur on cotyledons a week after the main infection by sporidia, and primary uredosori form around them after 2 or 3 days. These infect the earliest leaves, causing the first foci of infection. Late in the growing season, secondary uredospores, the fungus's sporophytic generation, attack leaves. Uredospores can form a germ canal at temperatures ranging from 8°C to 35°C, however 18°C and 20°C are optimum. The germ tube develops an appressorium in the substomatal vesicle to aid in the penetration of leaf tissues through the stomata.

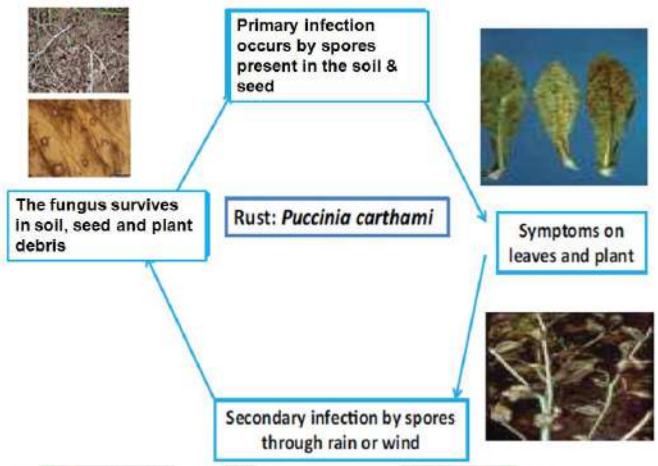


Fig 3. Disease cycle of *Puccinia carthami* disease

The infection benefits from high humidity levels and a chilly environment. Depending on the temperature, the incubation time is said to span 10 to 14 days. At the optimal temperature range of 18°C to 20°C, the incubation period is 10 days; however, beyond 35°C, the rust uredospores might a little germinate and the infection may not appear. At 40°C, the uredospores do not even begin to germinate. When applied artificially to leaves, uredospore inoculation on seed only results in the production of uredo- and teliospores of *P. carthami*, not the infection of seedlings. Since *P. carthami* is an autoecious macrocyclic rust which rapidly completes the sexual cycle, the potential for recombination is greatest. Numerous rust races were found in the United States. Numerous rust gradient hosts have been developed in the US to differentiate the races (Kolte 1985).

4.3.5 Management

4.3.5.1 Host Plant Resistance

Safflower resistance to *P. carthami* has been measured by the response of infected hypocotyls to rust. However, the resistant seedlings do not exhibit hypocotyl extension; sporulation only takes place on the cotyledons, and the seedlings are not destroyed. The very susceptible seedlings exhibit extensive sporulation on the hypocotyl, and they do not survive.

Most of the time, it appears that foliage rust resistance and seedling rust resistance are physiologically and genetically connected. The disease seedling phase is likewise resistant to lines that have resistance to the leaf phase. Less than 5% of seedlings die from the rust's seedling phase in plants with a high level of leaf resistance. An effective way to screen for foliar rust resistance is closely correlated with the seedling rust resistance test. Thus, it is argued that the seedling test can be a useful tool for identifying foliar rust resistance. A large number of genotypes can be screened for resistance using the microliter drop method (with a known number of teliospores suspended in 1 mL) (Bruckart 1999). Researchers have examined how different safflower introductions and selections for rust resistance respond (Zimmer and Leininger 1965; Kalafat *et al*. 2009). Some safflower varieties have reportedly shown resistance to both the seedling and leaf stages of the disease. PI 170274-100, 193764-66, 19988282, 220647-98, 220647-55, 250601-109, 250721-93, 253759-62, 253911-25, 253912-9, 253913-5-72, 253914-5-108, 253914-7-9, and 257291-68 are among them. Other genotypes, including No. 1 and Tayan No. 1 in China and No. 30 and No. 26 in Turkey (Kalafat *et al*. 2009), are rust-resistant (Liu *et al*. 2009).

The safflower line N-l-1-5 has been discovered to be incredibly resistant to the rust's seedling phase, despite being just somewhat vulnerable to the disease leaf stage. PCA, PI 195895, and 6458-5 are further such lines that have a high level of seedling resistance. One dominant gene (N) controls the N-l-1-5 seedling resistance. This source should occasionally be given top priority when breeding for resistance to seedling rust. The elimination of an alternate host may theoretically have the same effect on the development of races in a heteroecious species of the same genus as the use of seedling rust resistance on *P. carthami*. The use of seedling rust-resistant varieties would decrease the amount of primary inoculum, which would reduce the possibility for new pathogenic strains to emerge from vegetative recombination. Seedling infection is the main source of primary infection in the foliage phase.

4.3.5.2 Chemical Control

It has been reported that seed dressing with fungicides such as maneb, mancozeb, captafol, and thiram (each at 0.2%–0.3% concentration) can prevent safflower rust infection in seedlings. Systemic fungicides, such as oxycarboxin seed treatment, have been proven to be most successful at preventing the germination of disease-causing spores and managing the condition when treated at a rate of 24-48 ounces per 100 kg of seeds. To manage the foliar phase of the rust on safflower, two treatments of systemic fungicides, such as calnexin at 0.05% spaced 15 days apart, are helpful (Prasad and Suresh 2012; Varaprasad 2012).

4.3.5.3 Cultural Control

Safflower rust can be managed through cultural practices including avoiding low-lying locations for safflower cultivation, avoiding monocropping safflower, and delaying irrigation until the crop shows symptoms of moisture stress (Varaprasad 2012).

4.4 *Cercospora* Leaf Spot

4.4.1 Economic Importance, geographical distribution and losses

Cercospora sp caused safflower leaf spots to be widespread throughout the world, particularly when safflower is grown extensively as a single crop. It reportedly also occurs in Ethiopia, India, Iran, Israel, Kenya, the Philippines, and the former Soviet Union, in addition to the western Great Plains and Northern Plains of the United States (Mundel and Huang 2003). The epiphytotic incidence of the disease was recorded in the Coimbatore region of southern India in 1921, 1924, and 1925. Still, there is not much data on the stated monetary losses caused by the disease.

Observations made in Montana, USA, in 2006–2007 demonstrate that safflower serves as an additional host for the sugar beetroot disease, C*ercospora beticola*. This could lead to new potential disease risks for both crops if they are produced within 4 years of one another (Lyon *et al*. 2007). This provides additional evidence that safflower functions as *C. beticola* secondary host. This is crucial since irrigated safflower is increasingly being researched for rotation with sugar beetroot in Montana, USA, where two crops are occasionally grown adjacent to one another (Lartey *et al*. 2005, 2007).

4.4.2 Symptomatology

Safflower plants are affected a few weeks after planting or when they are in the blossoming stage. On leaves, symptoms take the form of 3 to 10-mm diameter circular to irregular brown sunken spots. The symptoms begin to show up on the lower leaves before gradually moving up to the middle and top leaves. Patches occasionally have zoning and have a golden colour to their boundary. The leaves may become curled and black with internal necrosis as the disease advances. When the patches are damp, the sporulation of the fungus gives them a velvety greyish-white appearance. A tiny black fructification of the pathogen may be seen on both the top and lower sides of the spots on the affected leaves. Stems and nodes could also be harmed. If the disease is extremely bad, the bracts are also affected and show the presence of reddish-brown spots. Flower buds that are affected perish and turn brown. Without seed growth, the capitulum as a whole could also be harmed.

4.4.3 Pathogen-*Cercospora carthami*

The pathogen is *C. carthami* (H. and P. Sydow) Sundararaman and Ramakrishnan. Mycelium that is hyaline, smoky brown, septate, and branching collects in the stomatal areas where stromata are produced. Conidiophores can develop singly or as fascicles (tufts of 12–20 conidiophores) on both leaf surfaces. They immediately emerge from the epidermis in moist situations (Kolte 1985). The conidiophores are simple, septate, erect, and occasionally branched, and they range in size from 104.74 to 209.56. The characteristics of the conidia include hyaline, linear, 2-20 septate, and borne acrogeneously on the conidiophores. They are broad at the base and taper in a whip-like fashion towards the end, measuring 2.5–5.5–300 m. according to the length of the conidia, the amount of septavary, and the prevailing environmental conditions. In water, the conidia readily germinate and produce growth tubes on both the ends and sides. Each cell can produce a germ tube (Sastry and Chattopadhyay, 2005).

4.4.4 Epidemiology Role and Disease Cycle

C. carthami has a small host range and solely infects *Carthamus* sp., according to reports. The pathogen reproduces by embedding living stromata in agricultural waste and employing a vegetative saprobic mycelium. The pathogen's stromata, which are microscopic black specks organised in concentric rings, are visible on ill leaves.

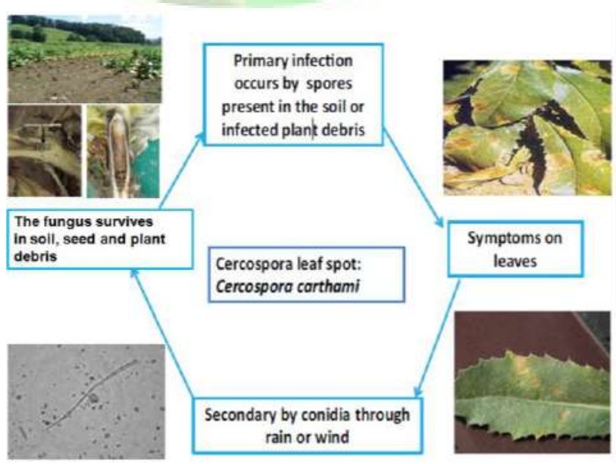


Fig 4. Disease cycle of *Cercospora carthami*

The disease cycle is started by wind- or water-blown conidia that land on safflower and germinate when there is free moisture. The fungus infects plant parts through direct penetration, natural holes or wounds, or both. The disease is most severe in warm, muggy conditions, and infection requires heavy, persistent early morning dew or other free moisture. The *Cercospora* leaf spot pathogen can spread via wind, water splashing, and movement of infected plant material (Lyon *et al*. 2007)

4.4.5 Management

4.4.5.1 Host Plant Resistance

Despite the high level of host plant resistance sources that are known, only five genotypes namely, 8-12-1, SSF-650, 2-10-2, 4-13-1, and 2-11-2—are resistant to both *Cercospora* leaf spot and aphid attack (Akashe *et al*. 2004). Spraying a 1% Bordeaux mixture on the diseased region will help manage it. Dithiocarbamate fungicides (0.25%) and copper oxychloride (0.3%), according to Prasad and Suresh (2012), may also be helpful in the treatment of the condition.

4.4.5.1 Chemical control

The management of the disease may benefit from a seed treatment with thiram 3 g/kg and spraying with mancozeb 2.5 g or carbendazim 1 g/L of water. When micro mobilized with safflower seeds, four rhizobacterial strains (GBO-3, INR937a, INR937b, and IPC11) were discovered to be inducers of systemic resistance in safflower, avoiding infection caused by *C. carthami* (Govindappa *et al*. 2013). For the *Cercospora* leaf spot, few specialised cultural management methods have been discovered. The incidence and severity of *Cercospora* leaf spot will probably decrease with crop rotations of three years or longer to non-host crops (small grains or maize), the incorporation of crop debris, and avoiding overhead watering and excessive irrigation (Lyon *et al*. 2007).

4.5 *Macrophomina* Root Rot – *M. phaseolina*

4.5.1 Economic Importance, geographical distribution and losses

The disease has, however, become widely prevalent in warm temperate and tropical regions of the world as a result of recent climate change. The illness is typically regarded as being of less importance during the regular crop-producing season in the winter months. According to Mahdizadeh *et al*. (2011) and Lotfalinezhad *et al*. (2013), it considerably lowers yields in Iran, especially during the dry seasons. According to Prasad and Suresh (2012), India often experiences yield losses of 1%–10% due to the sporadic *Rhizoctonia* disease phase. The production and height of the crop are inversely correlated with disease incidence, claim Chattopadhyay *et al*. (2003).

4.5.2 Symptomatology

Dark-brown to black lesions first form on the roots. Infected plants may eventually display a unique silvery colouring (ashy stem and root) in the epidermal and subepidermal layers at the base of the stem and the root. As the fungus advances up to the vascular and pith tissues of the stem, the infected tissues turn greyish-black and eventually form numerous tiny sclerotia that resemble finely ground charcoal (charcoal rot). Around the pith cavity and along the vascular components are sclerotia. Affected plants grow stunted and ripen too early. A novel sort of distinct stem-split symptom on 30-day-old safflower plants has recently been observed as microscopic cracks 2-3 cm above the soil surface that extend in both upward and downward directions, creating a large split. A white to grey fungal mycelia mat develops inside the broken part, which turns brown and hollow (Govindappa *et al*. 2005). Such plants are not resilient.

4.5.3 Pathogen- *M. phaseolina* (Tassi) Goid

M. phaseolina (Tassi) Goid is the name of the pathogen, which is *R. bataticola* (Taub) Butler in its pycnidial stage. The details of the pathogen's characteristics and the disease cycle have been described under the titles of peanut and sunflower diseases. Using RAPD markers and UPGMA cluster analysis, the genetic diversity of isolates common in safflower-growing regions may be classified into two major types. There are various levels of genetic similarity, ranging from 50% to 55%, according to the dendrogram created by cluster analysis (Prasad *et al*. 2011, Navgire *et al*. 2014).

4.5.5 Management

4.5.5.1 Host Plant Resistance

The Indian Institute of Oilseeds in Hyderabad, India, has devised methodologies for seed germination utilising towel paper and infected soil cups to test safflower germplasm lines for disease resistance (Prasad and Navneetha 2010). However, neither in cultivated nor in wild safflower have sources of resistance been identified. The length and width of the necrotic lesion on the stem of safflower have been observed to positively and significantly correlate with the diameter of the lower stem (DLS) of safflower; as a result, the DLS trait needs to be utilised as an indication for the indirect selection of resistant genotypes in safflower (Pahlavani *et al*. 2007).

IUT-k 115, GUA-va 16, CW-74, AC-Stirling, AKS-152, AKS-68, NARI-6, SSF-658, A-2, PBNS 12, and PBNS 40 are a few of the disease-tolerant genotypes (Pahlavani *et al*. 2007, Ingle *et al*. 2004, Prasad and Suresh 2012). Three genotypes, GMU-3265, GMU-3285, and GMU-3297, are found to be resistant with only up to 1–10 per cent seedling mortality, while four genotypes, GMU-3259, GMU-3262, GMU-3306, and GMU-3316, are identified as being extremely resistant with no seedling infection (Salunkhe 2014). These can be incorporated into breeding programmes to increase safflower resistance to *M. phaseolin*a-caused root rot and charcoal rot.

4.5.5.2 Chemical Control

No cost-effective, practically beneficial chemical treatment for the condition is advised. However, by treating the safflower seed with thiram or carbendazim (Subeej25 DS) at 2 g/kg seed for the control of the disease and better plant stand establishment in the field (Prashanti *et al*. 2000a, Prasad and Suresh 2012), the seed-borne inoculum of the pathogen can be reduced.

4.5.5.3 Cultural Control

As cultural practises for the control of disease, Prasad and Suresh (2012) suggested the use of clean seed, the application of organic matter, lengthy rotations with non-host crops, avoiding overly dense plant populations, and sanitation, including the burial of debris by hand or by plough during the summer.

4.5.5.4 Biological Control

Safflower rhizosphere soil-derived biocontrol agents like *Trichoderma harzianum*, fluorescent Pseudomonads (*P. fluorescens*), and *Bacillus subtilis* are utilised as seed treatments before being manufactured as talc-based formulations. In addition to controlling the disease, these biocontrol agents at 10 g/kg also demonstrate their efficacy in inducing systemic resistance by activating defence-related enzymes engaged in phenylpropanoid pathways. High activity of peroxidase, PAL, chitinase, polyphenol oxidase and beta-1,3-glucanase could be observed in *P. fluorescens* and *T. harzianum* treated safflower plants after challenge inoculation with *M. phaseolina* (Prashanti *et al*. 2000b, Kaswate *et al*. 2003, Singh *et al*. 2008a, Govindappa *et al*. 2010, 2011a). The lowest preemergence mortality caused by *M. phaseolina* is shown when a seed is treated with *T. harzianum* at a rate of 4 g/kg seed and sawdust + soil is added to the soil at a ratio of 1:10 (Deshmukh *et al*. 2003).

Refrances

Agrios GN (1978) Plant Pathology 2nd Ed, Academic PressInc., New York, New York. 703 p.

Akashe VB, Patil AJ, Indi DV and Mummkar DR (2004.) Response of different genotypes of safflower to major insect pests and leaf spot diseases. Sesame Safflower Newsl. 19: unpaginated.

Alosi MC, Hildebrand DC. and Schroth MN (1978) Entrapment of bacteria in bean leaves by films formed at air-water interfaces. (Abstr.) Phytopathol. News 12:197.

Anjani K, Singh H and Prasad RD (2005) Performance of multiple resistant line of safflower (*Carthamus tinctorius*). Indian J. Agric. Sci. 75: 178–179.

Anonymous (2014) Romania-Bulgaria, Safflower (*Carthamus tinctorius* L.). Cross-Border Cooperation Program-European Regional Development Fund, Bucharest, Romania.

Arthur JC and Mains EB (1922) Bullaria. N. Am. Flora 7: 482.

Awadhiya GK (1992) Seed borne pathogenic mycoflora of safflower. Crop Research 5(2):344-347.

Awadhiya GK (2000) Study of detection methods and location of *Alternaria carthami* Chowdhury in safflower seed. Gujarat Agric. Univ. Res. J. 26: 67–68.

Bar-Tal A, Landau S, Li-Xin Z, Markovitz T, Keinan M, Dvash L, Brener S and Weinberg ZG (2008) Fodder quality of safflower across an irrigation gradient and with varied nitrogen rates. Agronomy Journal, 100: 1499-1505.

Bergman JW and Jacobsen BJ (2005) Control of Alternaria blight (*Alternaria carthami* Choud.) of safflower (*Carthamus tinctorius* L.) in the United States Northern Great Plains region. In: Proceedings of the Sixth International Safflower Conference—SAFFLOWER: A Unique Crop for Oil Spices and Health Consequently, a Better Life for You, Istanbul, Turkey, June 6–10, pp. 215–221.

Berville A, Breton C, Cunliffe K, Darmency H, Good AG, Gressel J, HallLM, McPherson MA, Medail F, Pinatel C, Vaughan DA and Warwick SI (2005) Issues of ferality or potential ferality in oats, olives, the pigeon–peagroup, ryegrass species, safflower, and sugarcane. In: Gressel J (Editor)–Crop ferality and volunteerism: a threat to food security in the transgenicera? Taylor and Francis Books, CRC Press, Boca Raton, pp. 231–255.

Borkar SG, Shinde R (1988). Alternaria leaf spot of safflower. Seed Res. 16:126-127

Borkar, SG (1997) Spines, a new avenue for infection by *Alternaria carthami* on safflower. J. Mycol. Plant Pathol. 27: 311–316.

Bramhankar SB, Asalmol MN, Pardey VP and Ingle YV (2002) Effect of foliar spray of different fungicides on transmission of *Alternaria carthami* (Chowdhury) from plant to seed and seed to plant. Ann. Plant Physiol. 16: 112–114.

Bramhankar SB, Asalmol MN, Pardey VP, Ingle YV and Burgoni EB (2001) Efficacy of fungicides against Alternaria leaf blight of safflower. PKV Res. J. 25: 99–101.

Bruckart WL (1999) A simple quantitative procedure for inoculation of safflower with teliospores of the rust fungus, *Puccinia carthami*. Plant Dis. 83: 181.

Carson ET, Richardson PE, Essenberg JK, Brinder-hoff LA, Johnson WM and Venere RJ (1978) Ultrastructural cell wall alterations in immune cotton leaves inoculated with *Xanthomonas malvacearum*. Phytopathol. 68:1015- 1021.

Chand JN and Walker JC (1964) Inheritance of resistance to angular leafspot of cucumber. Phytopathol, 54:51-53.

Chapman MA, John Hvala, Jason Strever and John M. Burke (2010) Population genetic analysis of safflower (*Carthamus tinctorius*; Asteraceae) reveals a Near Eastern origin and five centers of diversity", American Journal of Botany, Vol. 97, pp. 831-840

Chattopadhyay C (2001) Yield losses attributable to Alternaria blight of safflower (*Carthamus tinctorius* L.) and some effective control measures. J. Mycol. Plant Pathol. 31: 298–392.

Chattopadhyay C, Meena PD, Sastryand RK, and Meena RL (2003) Relationship among pathological and agronomic attributes for soilborne diseases of three oilseed crops. Indian J. Plant Prot. 31: 127–128.

Chauhan LS and Singh DR (1979) Occurrence of mosaic on safflower in northern India. Indian Phytopathology, 32: 301-302.

Chavan RA, Bharose AA, Pawar RB and Patil VD (2004) Screening of safflower germplasm lines and penetration mechanism of *T. viride* against Fusarium wilt. J. Soils Crops 14: 79–82.

Chen G (2009) Induced resistance in safflower against safflower rust disease by exogenous chemicas. Master’s dissertation, Sichuan Agricultural University, Ya’an, China.

Chenulu VV, Sachchidanandaand J and Prakash N (1971) Safflower mosaic. Phytopathology, 71: 129-134. https://doi.org/10.1111/j.1439-0434.1971.tb03148.x

Chowdhury S (1944) An Alternaria disease of safflower. J Indian Bot. Sci. 23:59-65.

Crosse JE and Garrett CME (1963) Studies on the bacteriology of Pseudomonas mors-prunorum, *P. syringae*, and related organisms. J. Appl. Bact. 26:159-177.

Dajue L and Mundel HH (1996) Safflower (*Carthamus tinctorius* L.). Promoting the conservation and use of underutilized and neglected crops. 7. International Plant

Darrel Lee Jacobs (1982) Bacterial leaf and stem blight of safflower in Montana: its epidemiology, sources of resistance and inheritance of resistance. Master of Science in Plant Pathology, Montana State University.

Daub ME and Hagedorn DJ (1980) Growth kinetics and interactions of *Pseudomonas syringae* with susceptible and resistant bean tissues. Phytopathol. 70:429-436.

Deadman ML, Al-Sadi AM, and Al-Jahdhami S (2005) First report of rust caused by *Puccinia carthami* on safflower in Oman. Plant Dis. 89: 208.

Desai SA (1998.) A note on the preliminary screening of safflower genotypes against Alternaria leaf spot in northern Karnataka. Karnataka J. Agric. Sci. 11: 824.

Deshmukh VV, Chore NS and Jiotode DJ (2003) Effect of soil amendments with saw dust and viability of Trichoderma harzianum in different carriers. Crop Res. (Hisar) 26: 508–511.

Dordas C (2008) Role of nutrients in controlling plant diseases in sustainable agriculture: A review. Agron. Sustain. Dev. 28: 33–46. doi:10.1051/agro.2007051

Doudoroff M and Palleroni NJ 1974) Genus Pseudomonas. Pages 217-243 in: R.E. Buchanan and N.E'. Gibbons, eds.

Driouich A, Jauneau A, and Staehelin LA (1997) 7-Dehydrobrefelin A, a naturally occurring brefeldin A derivative, inhibits secretion and causes a cis-to-trans breakdown of Golgi Stocks in plant cells. Plant Physiol. 113: 487–492.

Dubey V, Aminuddin K and Singh VP (2010) Molecular characterization of Cucumber mosaic virus infecting Gladiolus, revealing its phylogeny distinct from the Indian isolate and alike the Fny strain of CMV. Virus Genes, 41: 126-134. DOI: 10.1007/s11262-010-0483-6

Dwivedi A (2005) Handbook of Research on Information Technology Management and Clinical Data Administration Health Care. Meical Information Science Reference, Hershey-NewYork, 1027p.

Dye DW, Bradbury JF, Dickey RS, Goto M, Hale CN, Hayward AC, Kelman A, Lelliott RA, Patel PN, Sands DC, Schroth MN, Watson DRW and Young JM (1975) Proposals for a reappraisal of the status of the names of plant pathogenic Pseudomonas species. Int. J. Syst. Bact. 25:252-257.

Emongor VE (2010) Safflower (*Carthamus tinctorius* L.) the underutilized and neglected crop: A review. Asian Journal of Plant Sciences, 9 (6): 299- 306

English H and Davis JR (1960) The source of inoculum for bacterial canker and blast of stone fruit-trees. Phyto- pathol. 50:634 (Abstr.).

Ercolani GL (1969) Epiphytic survival of Pseudomonas mors-prunorum Wormald from cherry and *P. syringae* van Hall from pear on the host and on the non-host plant. Phytopathol. Mediterr. 8:197-206.

Erwin DC, Starr MP and Desjardins PR (1964) Bacterial leaf spot and stem blight of safflower caused by *Pseudomonas syringae*. Phytopathol. 54:1247-1250.

FAOSTAT (2019) Crop production data, Food and Agriculture Organization of the United Nations, Statistics Division online database, http:/www.fao.org/faostat/

Fletcher JD (2001) New hosts of Alfalfa mosaic virus, Cucumber mosaic virus, Potato virus Y, Soybean dwarf virus, and Tomato spotted wilt virus in New Zealand. New Zealand Journal of Crop and Horticultural Science 3: 213-217. DOI: 10.1080/01140671.2001.9514180

Gadekar DA and Jambhale ND (2002a) Inheritance of seedling and adult plant resistance to Alternaria leaf spot in safflower (*Carthamus tinctorius* L.). Indian J. Genet. Plant Breed. 62: 238–239.

Gadekar DA and Jambhale ND (2002b) Genetics of seedlings and adult plants resistant to wilt caused by *Fusarium oxysporum* f. sp. *carthami* in safflower. Sesame Safflower Newsl. 17: 81–84.

Gaikwad SJ and Behere GT (2001) Biocontrol of wilt of safflower caused by *Fusarium oxysporum* f. sp. *carthami*. In: Proceedings of the Fifth International Safflower Conference—Safflower: A Multipurpose Species with Unexploited Potential and World Adaptability, Williston, ND, July 23–27, 2001, pp. 63–66.

Garcia A (2009) Insulin production from transgenic safflower. http://www.sembiosys.ca/.

Garrett CME, Panagopoulos CG and Crosse JE (1966) Comparison of plant pathogenic psuedomonads from fruit trees. J. Appl. Bacteriol. 29:342-356.

Gayathri DA and Madhuri V (2014) Seed mycoflora of safflower and its control by using otanicals, bioagents and fungicides—A review. Int. J. Appl. Biol. Pharm. Technol. 5: 209–215.

GBIF (2023) Global Biodiversity Information Facility, Denmark, https://www.gbif.org/ (accessed 7th April 2023)Genetic Resources Institute, pp.1-83.

Gholve VM, Ghuge SB, Pawar SV and Barde PT (2017) In vitro efficacy ofvarious seed dresser on seed mycoflora of safflower. Agric. Update, 12(TECHSEAR-5): 1440-1445;

Gholve VM, Taware MR, Wagh SS. (2015) Symptomatology, isolation, identification and pathogenicity test of Alternaria blight of safflower. Trends Biosci. 8(1):57-60.

Gnanamanickam SS and Kandaswamy TK (1978) Bacterial leaf spot and stem blight - A new disease of safflower in India caused By *Pseudomonas syringae*. Current Sci. 47: 506-508.

Govindappa M, Lokesh S, and Rai VR (2005) A new stem-splitting symptom in safflower caused by *Macrophomina phaseolina*. J. Phytopathol. 153: 560–561.

Govindappa M, Lokesh S, Rai VR, Naik VR, and Raju SG (2010) Induction of systemic resistance and management of safflower Macrophomina phaseolina root-rot disease by biocontrol agents. Arch. Phytopathol. Plant Prot. 43: 26–40.

Govindappa M, Rai VR and Lokesh S (2011a) Screening of *Pseudomonas fluorescens* isolates for biological control of *Macrophomina phaseolina* root-rot of safflower. Afr. J. Agric. Res. 6: 6256–6266.

Govindappa M, Rai VR and Lokesh S (2011b) *In vitro* and *in vivo* responses of different treating agents against wilt disease of safflower. J. Cereals Oilseeds 2: 16–25.

Govindappa M, Rai VR, and Lokesh S (2013) Induction of resistance against Cercospora leaf spot in safflower by seed treatment with plant growth-promoting rhizobacteria. Arch. Phytopathol. Plant Prot. 36: 1–14. doi:10.1080/03235408.2014.880574.

GRDC (2010) Raising the bar with better safflower agronomy, ACT, Australia, Grains Research and Development Corporation.

GRDC (2017) GrowNotes Safflower Northern, Grains Research and Development Corporation, Australia.

Gud MA, Murumkar DR, Shinde SK and Kadam JR (2008) Correlation of weather parameters with development of leaf spot of safflower caused by *Alternaria carthami*. In S. E. Knight and T. D. Potter (Eds.), Safflower: Unexploited potential and world adaptability.

Proceedings of 7th International Safflower Conference, Wagga Wagga, New South Wales, Australia. ISBN: 978-0-646-50329-5.

Harish Babu BN, Naik VR, Hanumantharaya L, Raju SG and Yaragoppa SD (2005) Evaluation of 6 promising breeding lines of safflower for Alternaria tolerance, seed yield and its components. Karnataka J. Agric. Sci. 186: 803–806.

Hildebrand DC (1973) Identification of species within the syringae group of Pseudomonas using nutritional screening. Pages 5-9 in Synopsis. Int. Soc. Plant Pathol. Working Party on Pseudomonas syringae group. Inst. Nat. Rech.Agron, Angers, France, April 1973. 118p.

Hoitink HAJ, Hagedorn DJ and McCoy E (1968) Survival,transmission, and taxonomy of *Pseudomonas syringae* van Hall, the causal organism of bacterial brown spot of bean (*Phaseolus vulgaris* L.). Can. J. Microbiol. 14:437-441.

Indi DV, Murumkar DR, Patil AJ and Akashe VB (2004) Screening of safflower germplasm against Alternaria leaf spot under field conditions. J. Maharashtra Agric. Univ. 29: 344–346.

Ingle VN, Deshmukh VV, Jiotode DJ, Chore NS and Dhawad CS (2004) Screening of safflower varieties against root rot (*Rhizoctonia bataticola*). Res. Crops 5: 113–114.

Jalender P, Bharati NB and Anitha K (2015) Studies on host range of cucumber mosaic virus in Tomato (*Solanum lycopersicum* L.). Ecology, Environment and Conservation, 21. Suppl. Issue; 417-420.

Johnson RC, Kisha TJ and Evans MA (2007) Characterizing safflower germplasm with AFLP molecular markers. Crop Sci. 47: 1728–1736.

Kalafat S, Karakaya A, Kaya MD and Bayramin S (2009) A preliminary study on the reactions of some safflower genotypes to rust disease. Bitki Koruma Bulteni 49: 183–187.

Kalpana Sastry R (1996) Symptoms of wilt disease—clues for use in resistance breeding. In: Hegde DM, Raghavaiah CV, Pati D (Eds.), Proceedings of Training Programme on Breeding Approaches for Improving Productivity of Safflower and Group Meeting on Heterosis Breeding in Safflower. Directorate of Oilseeds Research, Rajendranagar, Hyderabad, pp. 25–32.

Kalpana Sastry R, Chattopadhyay C (2003) Development of Fusarium wilt resistant genotypes in safflower (*Carthamus tinctorius*). Eur. J. Plant Pathol. 109, 147–151. https://doi.org/10.1023/A:1022502618887.

Kaswate NS, Shinde SS and Rathod RR (2003) Effect of biological agents against different isolates of *Rhizoctonia bataticola* (Taub.) Butler in vitro. Ann. Plant Physiol. 17: 167–168.

Kizil S, Cakmak O, Kirici S and Inan M (2008) A comprehensive study on safflower (*Carthamus tinctorius* L.) in semi-arid conditions. Biotechnology and Biotechnological Equation, 22(4): 947-953.

Klement Z and Goodman RN (1967) The hypersensitive re action to infection by bacterial plant pathogens. Ann. Rev. Phytopathol. 17-44.

Klisiewicz JM (1975) Race 4 of *Fusarium oxysporum* f. sp. *carthami*. Plant Dis Rep. 59: 712.

Klisiewicz JM and Houston BR (1962) Fusarium wilt of safflower. Plant Dis. Rep. 46: 748–749.

Klisiewicz JM, Houston BR and Petersen LJ (1963) Bacterial blight of safflower. Plant Pis. Reptr. 47: 964-966.

Kneusel RE, Schiltzg E and Maternhl U (1994) Molecular characterization and cloning of an esterase which inactivates the macrolide toxin brefeldin A*. J. Biol. Chem. 269: 3449–3456.

Kolase SV, Deokar CD and Sawant DM (2000) Effect of plant extracts on the incidence of safflower wilt. Sesame Safflower Newsl. 15: 92–94.

Kolte SJ (1985) Diseases of Annual Edible Oilseed Crops, Vol. III: Sunflower, Safflower and Nigerseed Diseases. CRC Press, Boca Raton, FL.

Krishna Prasad NVK, Basuchaudhary KC (1989) Symptomatology and epidemiology of Alternaria leaf blight of safflower in India. Second Intern. Conf., 9-13 January, ISOR, DOR, Hyderabad. 271-275.

Kulkarni VR and Byadgi AS (2004) Incidence of safflower mosaic disease in North Karnataka. Karnataka Journal of Agricultural Sciences. 17(4): 836-837

Kumar S, Heena Ambreen, Murali TV, Sapinder Bali, Manu Agarwal, Amar Kumar, Shailendra Goel and Arun Jagannath (2015) Assessment of genetic diversity and population structure in a global reference collection of 531 accessions of *Carthamus tinctorius* L. (safflower) using AFLP markers. Plant Molecular Biology Reporter, Vol. 33, pp. 1299-1313.

Lalit Mahatma, Singh SD and Lodha PC (2001) Pathogenic seed mycoflora of Sesame (*Sesamum indicum* L). Journal of Mycology and Plant Pathology. 31(3):377-379.

Lartey RT, Caesar-TonThat TC, Caesar AJ, Shelver WL, Sol NI and Bergman JW (2005) Safflower: A new host of *Cercospora beticola*. Plant Dis. 89: 797–801.

Lartey RT, Lenssen AW, Evans RG and Ghoshroy S (2007) Comparative structural study of leaf spot disease of safflower and sugar beet by *Cercospora beticola*. Plant Pathol. J. (Faisalabad) 6: 37–43.

Latorre BA and Jones AL (1979) Evaluation of weeds and plant refuse as potential sources of inoculum of *Pseudomonas syringae* in bacterial canker of cherry. Phytopathol. 69:1122-1125.

Li D and Mundel HH (1996) Safflower *Carthamus tinctorius* L., Vol. 7, Institute of Plant Genetics and Crop Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome.

Liu TT, Gao F, Ren YZ, Li GY and Tan Y (2009) Identification of safflower varieties rust-resistance. Xinjiang Agric. Sci. 46: 719–723.

Lotfalinezhad E, Mehri Z and Sanei SJ (2013) Temperature response of *Macrophomina phaseolina* isolates from different climatic in Iran. Annu. Rev. Res. Biol. 3(4): 724–734.

Lyon D, Burgener P, Harveson R, Hein G and Hergert G (2007) Growing safflower in Nebraska. NebGiude. University of Nebraska-Lincoln, Extension Institute of Agriculture and Natural Resources, Lincoln, NE.

Madhu MR, Basavarajappa MP, ChidanandLokapur and Anand ID (2018) Efficacy of fungicides in inhibition of *Alternaria carthamic a* using leaf spot of safflower *In vitro*. International Journal of Chemical Studies 2018; 6(1): 1051-1053.

Mahdizadeh V, Safaie N and Goltapeh EM (2011) Diversity of Macrophomina phaseolina based on morphological and genotypic characteristics in Iran. Plant Pathol. J. 27: 128–137.

Manu Upadhyay, Ram Chandra and Ajad Patel (2019) Bio-efficacy of plants extracts against *Alternaria carthmic a* used Alternaria Leaf spot of safflower. Journal of Pharmacognosy and Phytochemistry 2019; 8(2): 1615-1618

Mayee CD, Datar VV (1986) Phytopathometry. Technical Bull-I, MAU, Parbhani. pp. 88-89.

Milosevic D, Ignjatov M, Marjanovic Jeromela A, Nikolic Z, Tamindzic G, Miljakovic D, Stankovic I (2020) Presence and molecular characterization of cucumber mosaic virus on safflower in Serbia. Ratar. Povrt., 57 (2), 49-54.

More SD, Raghavaiah CV, Hangarge DS, Joshi BM and Dhawan A S (2005) In: Esendal, E. (Ed.), VIth International Safflower Conference, Instanbul, Turkey, 6-10th June, pp. 180-186.

Mundel HH and Huang HC (2003) Control of major diseases of safflower by breeding for resistance and using cultural practices. In: Advances in Plant Disease Management, eds., H.C. Huang and S.N. Acharya. Research Signpost, Trivandrum, India, pp. 293–310.

Munoz-Valenzuela S, Musa GLC, Montoya-Coronado L and Rivera-Rojas VM (2007) Evaluation of safflower genotypes in Northwest Mexico. In: New Crops and New Uses, eds., J. Janick and A. Whipkey. ASHS Press, Alexandria, VA, pp. 193–195.

Murumkar DR and Deshpande AN (2009) Variability among isolates of *Fusarium oxysporum* f.sp. *carthami*. J.Maharashtra Agric. Univ. 34:178–180.

Murumkar DR, Gud MA and Deshpande AN (2008b) Screening of released varieties and hybrids of safflower against wilt (*Fusarium oxysporum* f. sp. *carthami*). J. Plant Dis. Sci. 3: 114–115.

Murumkar DR, Indi DV, Akashe VB, Patil AJ and Gud MA (2009b) Multiple resistance sources against major diseases and pests of safflower, *Carthamus tinctorius* L. J. Oilseeds Res. 26: 175–176.

Murumkar DR, Indi DV, Gud MA and Shinde SK (2008a) Field evaluation of some newer fungicides against leaf spot of safflower caused by *Alternaria carthami*. In: Seventh International Safflower Conference—Safflower: Unexploited Potential and World Adaptability, Wagga Wagga, New South Wales, Australia, November 3–6, 2008.

Murumkar DR, Indi DV, Gud MA, Shinde SK and Deshpande AN (2009a) Fungicidal management of leaf spot of safflower caused by *Alternaria carthami*. J. Maharashtra Agric. Univ. 34: 54–56.

Navgire KD, Prasad RD and Wadhave AV (2014) Genetic diversity of *Macrophomina phaseolina* causing root rot of safflower. In: "Abstract-cum-Souvenir" National Symposium on Plant Pathology in Genomic Era, Indian Phytopathological Society, New Delhi, India, May 26–28, 2014, p. 45.

Neergaard P (1977) Seed Pathology, Vol I and II, MacMillan Press, London,U.K, p.1187.

Padaganur GM and Anilkumar TB (1976) seed mycoflora of safflower and its control. Pesticides, 10 (7): 39-41.

Pahlavani MH, Razavi SE, Mirizadeh I and Vakili S (2007) Field screening of safflower genotypes for resistance to charcoal rot disease. Int. J. Plant Prod. 1: 45–52.

Patibanda AK and Prasad RD (2004) Screening Trichoderma isolates against wilt pathogens of safflower, *Carthamus tinctorius* L. J. Biol. Control 18: 103–105.

Pawar SV, Ghuge SB, Gholve VM and Sutar DS (2017) Screening of safflower germplasm/advanced material /parental lines against major disease Alternaria leaf spot. Agric. Update,12(TECHSEAR-5) : 1208-1212; DOI: 10.15740/HAS/AU/12.TECHSEAR(5)2017/1208-1212.

Pawar SV, Utpal Dey, Munde VG,. Sutar DS and Dibakar Pal (2013)Management of seed/soil borne diseases of safflower by chemical and biocontrol agents. African Journal of Microbiology Research

Prabhakar M, Padmavati P, Prasad RD, Prayaga L (2012) Retrieval of biophysical parameters and assessment of Alternaria disease severity in safflower using ground based hyper spectral radiometry. J Oilseeds Res. 29:377-381.

Prasad KVV (1985) Seed borne *Alternaria carthamiin* safflower and its control. Indian Phytopathology. 38:602.

Prasad R and Chothia H (1950) Studies on safflower rust in India. Phytopathology 40: 363.

Prasad RD and Anjani K (2008a) Sources of resistance to Alternaria leaf spot among Carthamus wild species. In: Seventh International Safflower Conference—Safflower: Unexploited Potential and World Adaptability, Wagga Wagga, New South Wales, Australia, November 3–6, 2008, pp. 1–2.

Prasad RD and Anjani K (2008b) Exploiting a combination of host plant resistance and Trichoderma species for the management of safflower wilt caused by *Fusaruim oxysporum* f. sp. *carthami* Klisiewicz and Houston. J. Biol. Control 22: 449–454.

Prasad RD and Navneetha T (2010) Techniques for pathogenicity testing and screening of safflower cultivars against *Macrophomina phaseolina*. J. Oilseeds Res. 27: 199–200.

Prasad RD and Suresh M (2012) Diseases of safflower and their management. In: Safflower Research and Development in the World: Status and Strategies, eds., I.Y.L.N. Murthy, H.

Prasad RD, Navaneetha T and Rao N.N (2011) Cultural, morphological, pathogenic and molecular diversity in *Macrophomina phaseolina* isolates of safflower from southern India. Indian Phytopathol. 64: 247–253.

Prasad RD, Sharma TR and Prameela Devi T (2007) Molecular variability and detection of Fusarium species by PCR based RAPD, ISSR and ITS-RFLP analysis. J. Mol. Plant Pathol. 37: 311–318.

Prasad RD, Sharma TR, Jana TK, Prameela Devi T, Singh NK and Koudal KR (2004) Molecular analysis of genetic variability in Fusarium species using microsatellite markers. Indian Phytopathol. 57: 272–279.

Prasad RD, Singh V and Singh H (2006) Crop protection. In: Research Achievements in Safflower, ed., D.M. Hegde. All India Coordinated Research Project on Safflower, Directorate of Oilseeds Research, Hyderabad, India, pp. 52–77.

Prashanthi SK, Kulkarani S, Sangam VS and Kulkarni MS (2000a) Chemical control of *Rhizoctonia bataticola* (Taub.) Butler, the causal agent of root rot of safflower. Plant Dis. Res. 15: 186–190.

Prashanthi SK, Kulkarni S and Anahosur KH (2000b) Management of safflower root rot caused by *Rhizoctonia bataticola* by antagonistic microorganisms. Plant Dis. Res. 15: 146–150.

Raghuwanshi KS and Dake GN (2009) Fusarium wilt of safflower (*Carthamus tictorius* L.): A review. J. Plant Dis. Sci. 4: 110–117.

Raghuwanshi KS, Dake GN, Mate SN and Naik RM (2008) Pathogenic variations of *Fusarium oxysporum* f. sp. *carthami*. J. Plant Dis. Sci. 3: 241–242.

Raghuwanshi KS, Deokar CD (2002) Studies seed borne mycoflora of safflower. Sesame and safflower newsletter. 17.

Rajagopalan T and Shanmugam N. (1993) Studies on host range and seed borne nature of Alternaria carthemi incitant of leaf spot of safflower. Madras Agriculture Journal. 70: 832.

Rajendraprasad M, B Vidya Sagar, Uma Devi G, Narendra Reddy C and Triveni S (2021) Detection and identification of the seed mycoflora associated with safflower seed samples. The Pharma Innovation Journal; 10(4): 51-56.

Rajeswari B, Keshavulu K, Krishna Rao V. (2012) Management of seed mycoflora of safflower. Journal of Oil Seeds Research, 29:332-335.

Ranaware A, Singh V and Nimbkar N (2010) *In vitro* antifungal study of the efficacy of some plant extracts for inhibition of *Alternaria carthami* fungus. Indian J. Nat. Prod. Resour. 1: 384–386.

Rao VN, Sastry RK, Craufurd P, Meinke H, Parsons D., Rego TJ, Rathore A (2014) Cropping systems strategy for effective management of Fusarium wilt in safflower. Field Crop. Res. 156, 191–198. https://doi.org/10.1016/j. fcr.2013.11.013

Ravinder T, Govinda Rao N and Sastry KS (1992) Effect of homeopathic drugs on Cucumber mosaic virus infection in Safflower. Indian Journal of Virology. 8(1): 40-44.

Saad SM and Hagedorn DJ (1972) Relationship of isolatesource to virulence of *Pseudomonas syringae* on Phaseolus Vulgaris, Phytopathol. 62;678-680.

Salunkhe VN (2014) Screening of safflower germplasm accessions for resistance source against Macrophomina root rot. Bioscan 9: 689–690.

Sands DC, Schroth MN and Hildebrand DC (1970) Taxonomyof phytopathogenic pseudomonads. J. Bacteriol. 10l:9-23.

Sastry KR and Chattopadhyay C (1999a) Influence of non-host crops on the survival of *Fusarium oxysporum* f. sp. *carthami*. J. Mycol. Plant Pathol. 29: 70–74.

Sastry KR and Chattopadhyay C (1999b) Effect of soil solarization on *Fusarium oxysporum* f. sp. *Carthami* population in endemic soils. Indian Phytopathol. 52: 51–55.

Sastry KR and Chattopadhyay C (2005) Diseases of safflower. In: Diseases of Oilseed Crops, eds., Saharan GS, Mehta N and Sangwan MS. Indus Publishing Co., New Delhi, India, pp. 236–267.

Sastry KR and Chattopdhyay C (2001) Effect of soil solarization on wilt incidence and seed yield of safflower (*Carthamus tinctorius* L.). Indian J. Plant Prot. 29: 47–52.

Sastry KR and Jayashree J (1993) Eradication of wilt fungus from heavily infected safflower seed. J. Oilseeds Res. 10: 227–231.

Sastry KR, Rego RTJ and Burford J.R (1993) Effects of cropping systems on wilt of safflower. In: Proceedings of the Third International Safflower Conference, eds., L. Dajue and H. Yunzhou. Beijing, China, June 14–18, 1993, pp. 636–645.

Sastry RK, Chattopadhyay C, Singh V and Hegde DM (2002) Integrated management of safflower wilt using host resistance, cultural and chemical measures. J. Mycol. Plant Pathol. 32: 189–193.

Scharen AL, Bergman JW and Burns EE (1976) Leaf diseases of Winter wheat in Montana and losses from them in 1975. Plant Pis, Reptr9 JO;686-690.

Schneider RW and Grogan RG (1977) Bacterial speck oftomato: sources of inoculum and establishment of a resident population. Phytopatho1. 67:388-3.94.

Schuster ML and Christiansen DW (1952) A foot and root disease of safflower caused by *Puccinia carthami* Cda. Phytopathology 42: 211.

Sehgal D and Raina SN (2005) Genotyping safflower (*Carthamus tinctorius*) cultivars by DNA fingerprints. Euphytica 146: 67–76.

Sequeira L, Gaard G and De Zoeten GA (1977) Interaction of bacteria and host cell wall St its relation to the mechanism of induced resistance. Physiol, Plant Pathol, IQ: 43-50.

Shinde AB and Hallale BV (2009) Standardization of water culture technique for Fusarium wilt of safflower. Int. J. Plant Sci. 4: 248–249.

Shinde AB, Hallale BV and Vaidya AP (2008) Antifungal activity of leaf extracts against Alternaria blight of safflower. Natl. J. Life Sci. 5: 203–206.

Shinde Anjali B and Hallale BV (2013) Biological management of seed pathogen of safflower. Internat. J. Plant Sci., 8 (2): 458-460.

Shivani D, Sreelakshmi C and Kumar CVS (2011) Inheritance of resistance to Fusarium wilt in safflower (*Carthamus tinctorius* L.) genotypes. J. Res. ANGRAU 39: 25–27.

Singh AK, Chakrabarti DK and Basuchaudhary KC (1975) Two new diseases of safflower from India. Curr. Sci. (India) 44: 397.

Singh Saroj, Kumar S and Suryawanshi DS (2006) Evaluation of different treatments for the management of safflower insect pests and diseases under rainfed conditions. Indian J. Entomol. 68: 286–289.

Singh SN, Agarwas SC and Khare MN (1987) Seedborne mycoflora of vand de Faculteit L and bouwwetensxhappen, Universiteit Gen., 57:161-163

Singh V and Nimbkar N (2006) Safflower (*Carthamus tinctorius* L.), in: Genetic Resources, Chromosome Engineering, and Crop Improvement: Oilseed Crops, CRC Press, pp. 167-194.

Singh V and Prasad RD (2007) Integrated management of pests and diseases in safflower. Directorate of Oilseeds Research, Hyderabad, India, p. 49.

Singh V, Prasad RD (2005) Integrated Management of Pests and Diseases in Safflower. Directorate of Oilseeds Research, Hyderabad, India.

Singh V, Ranaware AM and Nimbkar N (2008a) Safflower: Unexploited potential and world adaptability. In: Seventh International Safflower Conference, Wagga Wagga, New South Wales, Australia, November 3–6, 2008, pp. 1–4.

Singh V, Ranaware AM and Nimbkar N (2008b) Breeding for Fusarium wilt resistance in safflower. In: Seventh International Safflower Conference—Safflower: Unexploited Potential and World Adaptability, Wagga Wagga, New South Wales, Australia, November 3–6, 2008, pp. 1–5.

Smith JR (1996) Safflower, Champaign, Illinois, AOCS Press.

Smith JR (1996) Safflower. AOCS Press, Champaign, IL, p. 624.

Somwanshi SD, Deshpande GD and Magar JS (2009) Differential resistance of safflower genotypes to three isolates of *Fusarium oxysporum* f. sp. *carthami* Klisiewicz and Houston. Adv. Plant Sci. 22: 343–346.

Stankovic I (2020) Presence and molecular characterization of cucumber mosaic virus on safflower in Serbia. Ratar. Povrt., 57 (2), 49-54.

Sumitha R and Nimbkar N (2009) Efficacy of fungicides against Alternaria leaf spot disease in safflower. Ann. Plant Prot. Sci. 17: 507–508.

Taware MR, Gholve VM, Utpal Dey (2014) Bio-efficacy of fungicides, bioagents and plant extracts/botanicals against *Alternaria carthami*, the causal agent of Alternaria blight of safflower (*Carthamus tinctorius* L.). Aftrican J Microbio. Res. 2014; 8(13):1400-1412.

Thies JA (2000) Reactions of regional sweet potato breeding clones and standard check cultivars to southern root-knot nematode race 3 and Fusarium Wilt. Biol. Cult. Tests 15, 194.

Thomas BJ (1981) Virology: hardy nursery stock. In: Annual report Glass House Crops Research Institute, Littlehampton, West Sussex, pp 143–146

Thomas V, Norton R and Wachsmann N (2008) Variation in response to *Alternaria carthami* infection by a range of safflower (*Carthamus tinctorius*) varieties. In: Seventh International Safflower Conference— Safflower: Unexploited Potential and World Adaptability, Wagga Wagga, New South Wales, Australia, November 3–6, 2008, pp. 1–3.

Valand GB, Gaikwad NY and Patel AJ (1983).Seed borne fungi of some Sesame varieties. Indian Journal ofMycology and Plant Pathology. 13(3): 363-365.

Valleau WD, Johnson EM and Diachun S (1944) Root infection of crop plants and weeds by tobacco leaf-spot bacteria. Phytopathol. 34:163-174.

Varaprasad KS (2012) Safflower scenario: Status and future strategies. In: Souvenir, Eighth International Safflower Conference, Safflower Research and Development in the World: Status and Strategies. Indian Society of Oilseeds Research, Hyderabad, India, January 19–23, 2012, pp. 1–9.

Wagh SS, Suryawanshi AP, Ambadkar CV and Badgujar SL (2020) Symptomatology and pathogenic variability of *Alternaria carthami* isolates from Maharashtra state infecting safflower crop. International Journal of Chemical Studies 2020; 8(2): 1533-1538

Wagh SS, Suryawanshi AP, Badgujar SL and Ambadkar CV (2020) Integrated management of Alternaria blight of safflower caused by *Alternaria carthami* under field conditions. International Journal of Chemical Studies. 8(2): 1957-1962

Wagh SS, Suryawanshi AP, Badgujar SL and Ambadkar CV (2020) Screening of safflower varieties/cultivars, genotypes and germplasm lines against *Alternaria carthami*. International Journal of Chemical Studies. 8(2): 1929-1931

Waghmare SJ and Datar VV (2010) Studies on seed borne nature of *Fusarium oxysporum* f. sp. *carthami* causing wilt of safflower. J. Maharashtra Agric. Univ. 35: 491–492.

Waghmare SJ and Kurundkar BP (2011) Efficacy of local isolates of Trichoderma spp. against *Fusarium oxysporum* f. sp. *carthami* causing wilt of safflower. Adv. Plant Sci. 24(1): 37–38.

Walker JC and Patel PN (1964) Inheritance of resistanceto halo blight of bean. Phytopathol. 54:952-954.

Weiss EA (1971) Castor, Sesame and Safflower. Barnes and Noble, Inc., New York, pp: 529-744.

Weiss EA (1983) Oilseed crops: Safflower. Longman Group Limited, Longman House, London, UK, pp: 216-281.

Wichman DM (1996). Safflower for forage. In: Mundel HH, Braun J and Daniels C (Eds.). Proceedings of North American Safflower Conference, Great Falls, Montana, Lethbridge, AB, Canada, pp: 56-60.

Wunsch M, Schafer M and Kraft B (2013) Field evaluation of fungicides for management of rust and Alternaria blight on safflower. Carrington Research and Extension Center, North Dakota State University, Carrington, ND.

Zanjare Snehal S, Suryawanshi AV, Zanjare SR and Shelar VR (2020) *In vitro* evaluation of bio control agents against seed borne *Alternaria carthami* and *Alternaria alternate* causing leaf spot disease of safflower. International Journal of Chemical Studies. 8(1): 2994-2997.

Zayed MA, Yehia AH, El-Sebaey MA and Gowily AM (1980) Studies on the host–parasite relationships of safflower root rot disease caused by *Fusarium oxysporum* S Clecht. Egypt. J. Phytopathol.12: 63–70.

Zhao S, Xie GL, Li H and Li C (2007) Occurrence of rust caused by *Puccinia carthami* on snow lotus in China. Plant Dis. 91: 772.

Zimmer DE and Leininger LN (1965) Sources of rust resistance in safflower. Plant Dis. Rep. 49: 440.

Zohary D, Hopf M and Weiss E (2012) "Dye crops", in: Domestication of Plants in the Old World: The origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin, Oxford University Press, pp. 166-168

Volume: 03 Issue No: 11

ENTOMOPATHOGENIC NEMATODES IN THE CONTROL OF INSECT PESTS

Article ID: AG-VO3-I11-108

***Dr. Jancy Rani, K.**

Assistant Professor, Department of Nematology, Division of Plant Protection, Adhiyamaan College of Agriculture and Research, Athimugam, Kirishnagiri (Dist.), Tamil Nadu, India

*Corresponding Author Email ID: jancynematology@gmail.com

Abstract

The entomopathogenic nematodes are parasitize the insect hosts and cause death due to the pathogenicity of the bacteria which is symbiotically associated with these nematodes. *Steinernema*, *Neosteinernema* and *Heterorhabditis* are the most important genera of entomopathogenic nematodes. The third stage infective juveniles of these nematodes will enter through the natural openings of insect host and cause death of the insect by septicemia within 24-48 hours. The *Xenorhabdus (Steinernema)* and *Photorhabdus (Heterorhabditis)* which are the bacteria responsible for the death of targeted insect pests. The soil temperature, moisture and oxygen supply will affect the efficacy of the entomopathogenic nematodes. The application of these nematodes will be safe to the human, plants and environment.

Keywords: entomopathogenic nematodes, *Steinernema*, *Heterorhabditis*, *Xenorhabdus*, *Photorhabdus*, speticemia, infective juvenile, temperature, moisture

Introduction:

The nematodes which are parasitize the insects by its pathogenic effects are known as Entomopathogenic nematodes (EPNs). There are 23 families of entomopathogenic nematodes were described till date (Koppenhöfer, 2007). Among these, Steinernematidae and Heterorhbditidae are the most predominant entomopathogenic nematode families which was used as a biological control of many insect pests (Grewal *et al.*, 2005a). EPNs are naturally occurring in soil ecosystem. These nematodes were non-segmented, colourless, elongated, insect parasitic round worms. The length of the nematodes was 0.4 mm to 1.1 mm, lives in a variety of soil types and infect more than 200 species of insects under laboratory conditions (Hazir *et al.*, 2003). These nematodes are best candidates for integrated pest management and sustainable agriculture. The Steinernematidae family have two genera, *Steinernema* Travassos, 1927 (Poinar, 1990) and *Neosteinernema* (Nugyen and Smart, 1994). *Neosteinernema longicurvicauda* is the only one species of *Neosteinernema* which is isolated from the termite *Reticulitermes flavipes* (Koller). There were many species of *Steinernema* and *Heterorhabditis* species were isolated. These nematodes were associated with symbiotic bacteria *viz., Xenorhabdus (Steinernema)* and *Photorhabdus (Heterorhabditis)* which are responsible for the death of insect hosts directly (Moazami, 2000).

Biology and life cycle of EPNs:

The life cycle of *Steinernema* and *Heterorhabditis* nematodes were similar but the difference between the life cycle of both the nematodes will occur in the first generation. *Steinernema* spp. have reproduce by amphimictic whereas *Heterorhabditis* spp. are hermaphroditic. Both the nematode reproduces amphimictic way in the second generation (Poinar, 1990). The entomopathogenic nematodes will cause disease to the insects by releasing the bacteria in the gut of insects and thus it will be causing the death of the insects. The word 'entomon' means insect and 'pathogenic' means to cause disease. Hence, the term 'entomopathogenic nematodes' refers to 'nematodes that cause disease to insects' (Gordh and Headrick, 2001). The progeny of EPNs will be four juvenile stages to adult stage. It will find their host in response to carbon dioxide, vibration and other chemical cues. The third stage infective stage (J3) of nematodes are the invasive stage in the life cycle of EPNs, is used for biocontrol of insects (Moazai, 2002). The function of the IJ is to locate the insect and infest the host. The symbiotic bacteria which present in EPNs are gram negative and these bacteria cells contained in special vesicles of *Steinernema* and in the intestine of *Heterorhabditis* species (Bird and Akhurst, 1983). A mutualistic association between these bacteria with these nematodes facilitates the transport of the bacteria through the nematodes into the insects which present in soil. The nematodes transfer the bacteria into the haemolymph of an insect and cause pathogenicity of the insect host. After that rapid multiplication of bacterial cells which initiates the nematode development. The toxins will kill the insect host within 24-48 hours by the toxins which produced by the bacterial septicemia (Ehlers, 2007). The insect cadaver becomes red in colour if it was infested with *Heterorhabditis* spp. If the cadaver looks brown or black in colour it was infested with *Steinernema* spp. The color difference of the insect cadaver is indicating the pigments produced by the monoculture of mutualistic bacteria which grows inside the insect hosts (Figure 1).

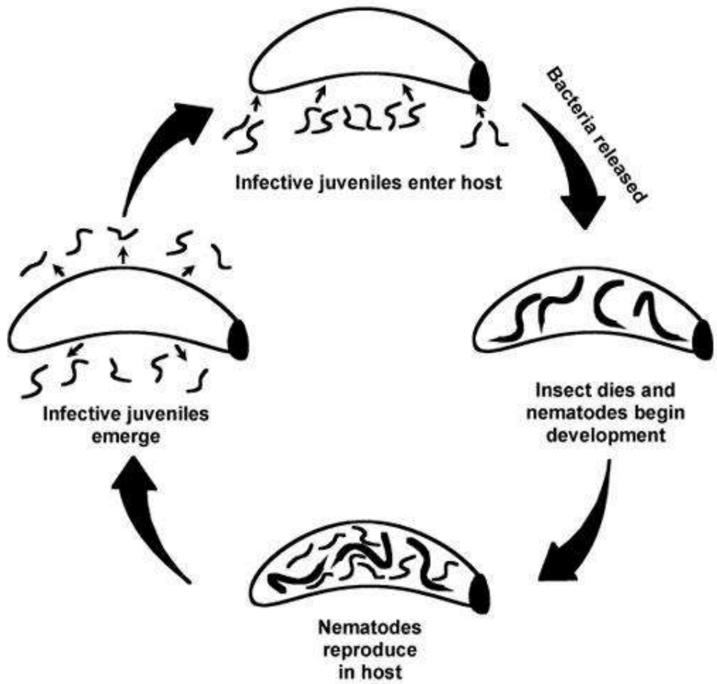


Figure 1. General life cycle of entomopathogenic nematodes

Factors influencing the nematode efficacy:

Temperature, moisture and oxygen supply is the main environmental factors which influence on the efficacy of EPNs. The optimal temperature for excellent efficacy of the EPNs may vary depends on the species. For example, *S. feltiae* performs well at the optimal temperatures below 15°C (Hazir *et al.*, 2001). The optimal temperature for the infectivity of *Heterorhabditis* is 25°C (Mason and Hominick, 1995). Extreme temperatures may lead to desiccation, increased metabolic rate and consequently more rapid use of energy reserves by EPNs. Soil moisture was another important factor which influence the efficacy of entomopathogenic nematodes. The sufficient soil moisture is more important for the movement of nematodes, nematode persistence and pathogenicity in the field conditions (Georgis and Ganugler, 1991). The demand in oxygen supply will lead to the death of nematodes (Lewis and Perez, 2004).

Use of entomopathogenic nematodes

Many worldwide researchers used to EPNs as a biocontrol agent against many insect pests and proved their potentiality for controlling the insects. Most of the works was shown their success of EPNs as a biocontrol against soil-dwelling insects or the insects which lives inside the galleries in the plants where the infective juvenile of nematodes will find its best atmosphere for its survival and protection from the environmental factors. Here is a list of some commercial use of EPNs against some insect pests is furnished below in the Table 1.

Crops	**Pest common Name**	**Pest Scientific name**	**Effective Nematodes**
Banana	Banana root borer	*Cosmopolites sordidus*	*Steinernema carpocapsae, S. feltiae, S. glaseri*
Vegetables	Corn earworm	*Helicoverba zea*	*Steinernema carpocapsae, S. feltiae, S. riobrave*
Grapes	Root Borer	*Vitacea polistiformis*	*Heterorhabditis zealandica, H. bacteriophora*
Sweet potato	Sweet potato weevil	*Cylas formicarius*	*Heterorhabditis bacteriophora, Steinernema carpocapsae, S. feltiae*
Citrus	Citrus root weevil	*Pachnaeus* spp. (Col: Curculionidae)	*Steinernema riobrave, Heterorhabditis bacteriophora*
Iris	Iris borer	*Macronoctua onusta*	*Heterorhabditis bacteriophora, Steinernema carpocapsae*

Table 1. Commercial use of EPNs against insect pests (Entomopathogenic Nematodes in Pest management, pp. 59)

Advantages of entomopathogenic nematodes:

The EPNs have many advantages for the control of insect pests. The most important advantages are: they are safe to humans, plants and environment, they will kill the targeted pest within 24-48 hours, they are easily culturable, live as a infective stage for several weeks upto months, wide host range of insect pests, foliar application was successfully used to control some quarantine leaf eating caterpillers live *Tuta absoluta, Helicoverba armigera, Spodoptera littoralis, Pieris brassicae* on several crops, application of EPNs does not require masks or other safety equipment like chemicals, application of EPNs as biocontrol agent can be able to incorporated with integrated pest management (Boemare *et al.*, 1994; Akhurast and Smith, 2002).

Disadvantages

The limitations or disadvantages of EPNs as biocontrol agents are: cost of production, Limited shelf-life and refrigerated storage is required. The environmental limitations are: require adequate moisture, temperature is required for survival and infectivity, these nematodes are sensitive to UV radiation, high salinity of soil, high or low soil pH, etc. will affect the nematode bio efficacy (Shapiro-Illan *et al.*, 2012).

References

Akhurst, R. and K. Smith. 2002. Regulation and safety. In: Entomopathogenic Nematology. (Eds.) Gaugler, R. Wallingford, UK, CABI Publishing, pp. 311-332.

Boemare, N.E., C. Laumond and H. Mauleon. 1996. The entomopathogenic nematode-bacterium complex: biology, life cycle and vertebrate safety. Biocontrol Science Technology, 6: 333-346.

Georgis, R. and R. Gaugler. 1991. Predictability in biological control using entomopathogenic nematodes. Journal of Economic Entomology, 84: 713-720.

Hazir, S., S.P. Stock, H.K. Kaya, A.M. Koppenhöfer and N. Keskis. 2001. Developmental temperature effects on five geographic isolates of the entomopathogenic nematodes *Steinernema feltiae* (Nematoda: Steinernematidae). Journal of Invertebrate Pathology, 77: 243-250.

Koppenhöfer, A.M. 2007. Nematodes. In: Field manual of techniques in invertebrate pathology: Application and evaluation of pathogens for control of insects and other invertebrate pests. L.A. Lacey and H.K. Kaya (Eds.). pp. 249-264.

Lewis, E.E. and E.E. Perez. 2004. Formulation and storage of entomopathogenic nematodes. International Journal of Nematology, 14: 30-34.

Mason, J.M. and W.M. Hominick. 1995. The effect of temperature on infection, development and reproduction of Heterorhabditis. Journal of Helminthology, 69: 337-345.

Moazami, N. 2002. Biopesticide production. In: Encyclopedia of Life Support System. EoLSS Publishers, Oxford, UK.

Poinar, G.O. 1990. Taxonomy and biology of Steinernematidae and Heterorhabditidae. In: Gaugler, R. and Kaya, H.K. (Eds.). Entomopathogenic Nematodes in Biological Control, Boca Raton (FL): CRC Press, pp. 23-60.

Nugyen, K.B. and G.C. Jr Smart. 1994. *Neosteinernema longicurvicauda* n. gen., n. sp. (Rhabditida:Steinernematidae), a parasite of the termite *Reticultermes flavipes* (Koller). Journal of Nematology, 26: 162-174.

Shapiro-Illan, D.I., D.J. Bruck and L.A. Lacey. 2012. Principles of epizootiology and microbial control. In: Insect pathology. F.E. Vega and H.K. Kaya (Eds.). San Diego: Academic Press, pp. 29-72.

AgriGate Editorial Team

November 2023 | Vol. 3 | Issue No. 11

MOTHER TERESA COLLEGE OF AGRICULTURE

(Affiliated to Tamil Nadu Agricultural University)

ILLUPUR,METTUSALAI PUDHUKOTTAI DT - 622102

Admission opens.!.

ABOUT OUR COLLEGE

Mother Teresa College of Agriculture (MTCA) was established in 2017 to offer the 4-year Degree programme B. Sc. (Hons.) Agriculture and it is one of the affiliated colleges of Tamil Nadu Agricultural University, located in Illuppur near Viralimalai. Bestowed with wet, dry and garden land and orchard in 150 acre, it has state- of – the art infrastructure facilities well equipped laboratories, a well- stocked library, comfortable and coupled with experience faculty.

FACILITIES:

- 40 dedicated faculty members Institute and Industrial visits Etc...
- All India study-tour
- Rural Agricultural Work Experience
- State and Central Agricultural Institute visits
- Farmer students interaction
- Experiential Learning
- Sports (Indoor and Outdoor Track & FieldVolley Ball, Hand Ball, Basket Ball, etc.)

INFRASTRUCTURE

- 150 acre Campus (including, wetlands, dryland, orchard,Etc....
- Girls Hostel with attached bathroom facility
- IFS Model, Sericulture unit Goat rearing unit, Dairy unit Piggery unit, Mushroom unit Poultry broiler & layer units Etc....

For Admission

Contact : 9443372151, 8610141186

website : motherterasaagricollege. com

Email : deanmtca@tnau.ac.in