Contents

1. Nakima (Tupistranutans Wall)- An Indegenous Underutilised Vegetable Crop Grown in Hills of West Bengal
   Safal Raj, Ujjal Roy, and Ram Krishna Sarkar .......... 4

2. Low Cost Storage Structures for Fruits and Vegetables
   Gargi Gautami and Subhalaxmi Mishra ............... 6

3. Pomegranate (Punica Granatum) : Medicinal Properties and Health Benefits
   Chamling, Bidyarani and Parameshwar ............... 8

4. Mahua- The Valuable Flower for Tribes
   Pavithra, Kavana and Vidya .......................... 9

5. Role of Growth Hormones in Fruit Crops
   Chamling, Bidyarani and Parameshwar ............... 11

6. Strategies to Improve Phosphorus Availability in Agricultural System
   Kiran Doodhwal ........................................ 13

7. Herbicide Resistance
   Chogatpur, Kalaghatagi and Gunabhagya ............ 16

8. DNA Microarray
   Ashwini and Vijayalakshmi ...................... 18

9. Garden Liquid Fertilizers for Sustainable Farming
   Raghu R.S. ........................................... 20

10. Egg Amino Acid and Fish Amino Acid: A Novel Organic Liquid Manure for Increasing Crop Productivity
    Varshini, Srinivasan and Sapthagiri .......... 22

11. Coconut: Value Added Products
    Praveen Gidagiri.................................. 24

12. Nano Agents in Food Industries
    Jinnamu Aresh and Nagarathna S.B. ............. 25

13. Medicinal Properties Associated with Honey Bee
    Mawtham, Chinndurai and Elakkya ................ 27

14. Recent Advances in Biological Control
    Achanta and Venugopal ............................ 30

15. Exploitation of Behaviour Modifying Chemicals in Pest Management
    Venugopal and Achanta ............................ 32

16. Mechanism of K Solubilizing Bacteria for Potassium use Efficiency in Agriculture Soil
    Ramesh Kanna ........................................ 34
17. Rivina humilis, an Invasive Weed Identified in Tree Shades of Coimbatore.............
   K. Kalaichelvi and J. Prabhaharan.......................... 36

18. Shankapushpi- Indian Traditional Ayurvedic Medicine
   Kavana, Pavithra and Vidya........................................ 37

19. Chia Seed- A Nutrient Enrich Capsule of Food
   Shweta, Shaik Jakir and Pande Shilpa.......................... 40

20. Alternative Technology of Frying
   Nagarathna and Jinnamu......................................... 41

21. Watershed Management through Modeling
   M. Angaleeswari and E. Sujitha.................................. 43

22. Ornamental Plants as a Source of Antioxidants
   Anamika Gurung....................................................... 44

23. PCR- A Strong Tool for Plant Disease Diagnosis
   Boda Praveen and Korla Saratababi.............................. 47

24. Biofuel Crops: Need of the Hour
   Chogatpur, Gunabhagya and Geeta............................... 48

25. Trees Our Treasure
   Darthiya and Mude Ashok....................................... 50

26. Role of Forensic Entomology for Solving Crime Investigation
   R. Naveena and A. Vasudha........................................ 52

27. The Future of Creation
   Afna Mol and Nithis Babu........................................ 54

28. Accelerating Crop Research Through Speed Breeding
   Sonu Get.................................................................... 55

29. Evolution of Sex Dimorphism in the Lepidoptera
   Sandeep, Kuldeep and Niranjan.................................. 58

30. Phalsa- A Nutritive Fruit of India
   A.D. Ashok, K. Kayalvizhi and J. Ravivarman................. 61

31. Impact of Agrochemicals Used on Soil Quality
   Prashant H. Rathod ................................................... 63

32. PUSA Hydrole: Boon for Farmers
   Narayan Prasad Verma and Dhanni Devi......................... 64

1. \textbf{HORTICULTURE}

\textbf{Nakima (Tupistranutans Wall) – An Indigenous Underutilised Vegetable Crop Grown in Hills of West Bengal}

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\textbf{Introduction}

The hilly region of West Bengal is one of the biodiversity rich parts of India with profusion of endemic flora and fauna. The diverse communities inhabiting in this area have been utilizing different endemic flora as food with high degree of acceptance, one of which is Nakima (\textit{Tupistranutans Wall}). It is a perennial underutilised indigenous vegetable crop grown commonly in hills of West Bengal i.e. Darjeeling and Kalimpong district of West Bengal and other hilly neighbouring states such as Sikkim (Khatoon et al., 2018) and Meghalaya (Roy et al., 2017). It is generally known by the name of Nakima (local name) in the hills of West Bengal. It belongs to family Asparagaceae (Liliaceae) and prefers cool climatic conditions for its proper growth and inflorescence development. As being wild underutilised vegetable crop it is also found in different forest areas of the regions from which the local peoples usually collects the inflorescence after proper maturity for their consumption. Nakima is generally propagated through suckers (Gurung et al., 2018) and mainly preferred for planting during rainy season. Besides being wild and found in forest it is nowadays widely cultivated in different parts of the region due to its nutritional and medicinal assets.

\textbf{General Plant Botany}

Plants are perennial in nature with long strap shaped leaves (1-2 metre in length) borne on a rosette from stout rhizome. Flowers are of short duration usually fleshy in nature. It bears a special type of inflorescence with fresh buds and flowers of attractive colour, shape, size that can be used as a vegetable in the form of curry and pickle.
Nutritional composition of Nakima (Tupistranutans Wall)

Nutritional composition of Nakima includes moisture (91.5%), Ash (1.1%), Fat (2.9%), Protein (2.4%), Carbohydrate (2.1%), Sodium (3.1%), Potassium (292 mg/100g), Calcium (200.6mg/100g) and 44.0 kcal/100g overall nutritive value (Rai et al., 2005).

Medicinal significance of Nakima (Tupistranutans Wall)

The plant exhibit a wide spectrum of folk and indigenous medical uses. The powdered root and flower decoction is helpful to control diabetes (Hussain and Hore, 2007; Shankar et al., 2016). Similarly, dry powder of inflorescence is consumed to treat diabetes and as tonic to relieve body pains (Idrisi et al., 2010). It is also reported to control high blood pressure and blood sugar level (Bhujelet et al., 2018).

Present scenario of Nakima (Tupistranutans Wall) in Hills of West Bengal

With respect to increasing human population demands for different agricultural and horticultural outputs are also increasing hastily. Innumerable horticultural crops are cultivated in various parts of the nation to overcome such demand of need. In such situation, various underutilized crops have a great scope to exploit in various ways to a maximum extent. Similarly, nakima (Tupistranutans Wall) is one of the underutilised vegetable crops grown in hills of West Bengal. In past years, it was not that widely used by the farmers and the local people of the region except as for medicinal purpose but nowadays it is commercially grown by the local farmers and people in different parts of the region as a source of nutritive vegetable to meet the demand of local market and to fetch maximum price during inadequacy of vegetables in the market.

Importance of Tupistranutans Wall in the livelihood of local province

As being one of the nutritive vegetable grown in hilly region of West Bengal it plays a vital role in maintaining the vegetable demand of the local market during its season of production thereby providing a good amount of money to the growers. Discussion with the growers and local retailers revealed that the market value of nakima during 2019 was around Rs. 200/kg in hills of West Bengal which was a bright site for the growers and such amount are utilised to tackle the upcoming production needs favouring the economical balance of the local farmers and curiosity of cultivation among others.

Nakima usually takes its place in the local market during September – October which is usually a peak time of the year for well-known Dasai (dusheera) and tihar (deepawali) festival in hills and during such time, nakima holds its importance in preparation of various traditional dishes. In addition, it also possesses various medicinal properties for treating various human illness which are being followed from long time and thus again grasps its importance in local province.

Future Prospects: India has a wide agroclimatic region which includes hilly regions of different states and even in such regions nakima has a great opportunity to flourish thereby improving the production as well as economic benefit to the nation. Some other important prospects include:

- Collection and conservation of related germplasm.
- Identification of an elite species.
- Multiplication and standardization of cultivation practices.
- Nutritional and biochemical profiling of crop.
- Awareness about the benefits of the crop among the consumers and growers.
- Standardization of postharvest processes for maintaining the freshness and reducing the spoilage.
- Regularization of proper marketing channel.
Conclusion

Most of the homestead gardens in the hills of West Bengal often cultivate Nakima (Tupistranutans Wall) due to its easy management and cultivation. Further, survey carried out also revealed the preference of this vegetable over other by the consumers despite its higher price in market. Though it is popular in few patches within the country it still is underutilised as a vegetable crop nationwide. Local folklore, several articles and research has been proof enough that Nakima (Tupistranutans Wall) has a potential to emerge as a high value crop (HVC) due to its consumer preference, season bound availability, higher price and therapeutical values. Therefore proper exploitation, further research work and awareness are necessary for popularizing the crop.

References


2. HORTICULTURE

Low Cost Storage Structures for Fruits and Vegetables

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Harvested fruits and vegetables are living tissues with continuing metabolism after harvest. They are subjected to respiration, water loss and cell softening throughout the post-harvest system. Owing to improper post-harvest operations, 30-40% of fruits and vegetables produced in the country are lost resulting in poor returns to farmers and high cost to consumers. The indigenous low cost methods for storage of horticultural crops are designed to check microbial, enzymatic and oxidative spoilage in the stored materials. These produces can be stored safely up to a few months without excessive spoilage. In order to certify appropriate storage conditions, various types of storage structures and techniques have evolved with time.

Some low cost storage structures for fruits and vegetables are –

- Clamps
- Cellars
- Ventilated storage structures
- Evaporative cool chambers
  - Pot-in-pot
  - Charcoal cooler
Clamps: Tropical roots and tuber crops must be stored at temperatures that will provide protection against chilling which causes internal browning, surface pitting and increased susceptibility to decay. A field storage clamp is a simple and low cost technology that can be designed using locally available materials for ventilation and insulation to avoid these conditions. Clamps are usually used in temperate regions but are also effective at higher elevations and in warmer climates. In tropical climates, extra straw casing is made to give extra ventilation instead of soil. A second layer of straw and soil can be added in cold climates where as in hot regions, chimney type air outlets can be made at the top of clamp. During rainy weathers clamp can be constructed under the tree or roof to protect from rain.

Cellars: These are the underground or partially underground structures that are used to store vegetables, fruits, nuts etc. Cellars keep fruits and vegetables at lower temperature and steady humidity conditions. The structure helps in keeping the produce safe, from freezing, during winters and keeps cool during summers. These structures can be built in cold as well as hot climatic regions. A root cellar can be constructed by digging out a pit to a depth of about 2 meters (7 to 8 feet) and framing the sides with wooden planks.

Ventilated storage structures: Naturally ventilated structures can be used for the storage of fruits and vegetables such as roots and tubers, pumpkins, onions and hard white cabbage. Any type of building that allows free circulation of air through the structure and its contents can be used. This type of storage structure is commonly used in India for the bulk storage of onion and garlic.

Evaporative cool chambers: Cooling by evaporation is an age old practice and is known in every part of the world. Evaporative cooling is one of the methods to cool the environment where the temperature drops and humidity increases considerably to a suitable level for on-farm storage short-term of perishables (Jha and Kudas 2006). Different types of evaporative cool chambers with varied size, capacity, volume have been developed in various parts of the world.

- **Pot-in-pot:** It is a simple design of evaporative cooler for use at home. The basic design consists of a storage pot placed inside a bigger pot that holds water. The inner pot stores food that is kept cool. One adaptation on the basic pot design is the Janata cooler, developed by the food and nutrition board of India (Roy and Khurdiya 1985).

- **Charcoal cooler:** The charcoal cooler is made from an open timber frame of approximately 50mm × 25mm in section. The door is made by simply hanging one side of the frame. The wooden frame is covered in mesh, inside and out, leaving a 25 mm cavity which is filled with pieces of charcoal. The charcoal is sprayed with water and when wet provides an evaporative cooling. The top is usually solid and thatched, with an overhang to deter flying insects (Odesola and Onyebuchi 2009).

- **Evaporative cool chamber (ECC) or Zero Energy Cool Chamber (ZECC):** It works on the principle of evaporative cooling. IARI, New Delhi developed a cooling chamber that can be built in any part of the country using locally available materials (Roy and Khurdiya 1985). The basic structure of the chamber can be built from bricks and river sand, with a cover made from cane or other plant materials such as straw and sacks or cloth. This structure requires a nearby source of water. Its construction is simple. Floor is built from a single layer of bricks and then a cavity wall is constructed of bricks around the outer edge of the floor with a gap of 75 mm between the inner wall and the outer wall. This cavity is then filled with sand. A covering for the chamber is made with canes covered in sacking all mounted in a bamboo frame. The whole structure should be protected from sunlight by making a roof to provide shade. After construction of the walls and floor, the sand in the cavity is thoroughly saturated with water. Once
the chamber is completely wet, a twice daily sprinkling of water is enough to maintain the moisture and temperature of the chamber. It has been reported that ECC can keep the temperature 10-15°C cooler than the outside temperature and maintain about 90% relative humidity.

References

3. HORTICULTURE: FRUIT SCIENCE

Pomegranate (Punica granatum): Medicinal Properties and Health Benefits
Novin Chamling, Polu Parameshwar and Bidyarani Devi Senjam
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Introduction: Pomegranate (Punica granatum L.) is a valuable fruit crop of arid and semi-arid regions of the world. It is a deciduous shrub native to Asia popularly known as pomegranate (Anar) and belongs to Punicaceae family. Maharashtra is the leading producer of pomegranate in India followed by Karnataka, Gujarat and Andhra Pradesh. Due to its versatile adaptability to a wide range of climatic conditions, hardy nature, less water requirement, good response to hi tech horticultural practices, high yield, better returns on investment compare to other crops of dry regions, nutritional and medicinal values and increasing demand for table and processed products as well as high export potential has made pomegranate a popular fruit of tropical and subtropical regions.

Botanical Description: The fruit is a fleshy berry denominated balausta, thick-skinned, complex, and enclosed by the thallus, with various membranous partitions. The interior is filled with many fleshy seeds, prismatic in shape, with pulpy testa and woody tegmen, very juicy. It is a non-climacteric fruit and should be picked after it has reached optimum maturity. Leaves are entire, smooth, opposed, with no stipule, sometimes verticillate, hairless, oblong, deciduous and has short petioles. The flowers appear singly or in small clusters generally of 2-7 flowers, occasionally at the end of the branch but sometimes on the auxiliary buds. The flowers may be hermaphrodite (normally) and staminated (with no pistil and poorly developed).

Benefits of the fruit
- Rich source of vitamins
- Stimulates blood pressure
- Beneficial for liver
- Anti-proliferative, antioxidant and anti-inflammatory
- Beneficial for all different forms of arthritis
- Reduces heart disease
- Antimicrobial/fungal effect
- Improves digestion and wound healing

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Composition (Per 100gms)</th>
</tr>
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<tbody>
<tr>
<td>Energy</td>
<td>83 kcal</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>18.70g</td>
</tr>
<tr>
<td>Protein</td>
<td>1.67g</td>
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<tr>
<td>Total fat</td>
<td>1.17g</td>
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<tr>
<td>Fibre</td>
<td>4g</td>
</tr>
</tbody>
</table>
Cholesterol 0 mg
Riboflavin 0.053 mg
Niacin 0.293 mg
Thiamin 0.067 mg
Vitamin A 0 IU
Vitamin C 10.2 mg
Vitamin K 16.4 µg
Sodium 3 mg
Potassium 236 mg
Calcium 10 mg
Copper 18 %
Magnesium 12 mg
Phosphorous 36 mg
Zinc 0.35 mg
Iron 0.30 mg

<table>
<thead>
<tr>
<th>Plant Component</th>
<th>Constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pomegranate juice</td>
<td>Anthocyanins, glucose, ascorbic acid, ellagic acid, gallic acid, catechin, quercetin, iron and amino acids</td>
</tr>
<tr>
<td>Pomegranate seed oil</td>
<td>Punicic acid, other constituents including ellagic acid, fatty acids, sterols</td>
</tr>
<tr>
<td>Pomegranate pericarp</td>
<td>Phenolic punicalagins; gallic acid and fatty acids, quercetin, rutin, and other flavonols, anthocyanidins</td>
</tr>
<tr>
<td>(peel, rind)</td>
<td></td>
</tr>
<tr>
<td>Pomegranate leaves</td>
<td>Tannins (punicalin and punicafolin) and flavone glycosides</td>
</tr>
<tr>
<td>Pomegranate flower</td>
<td>Gallic acid, ursolic acid, triterpenoids</td>
</tr>
</tbody>
</table>

Uses and Utilization
- Heart Problems: Pomegranate juice can maintain good flow of the blood in the body. Along with this, it decreases the risk of heart attack and heart strokes.
- Pomegranate juice is also used as a Mexican traditional medicine for the treatment of tuberculosis.
- Bark and leaves are used to calm the stomach disorder also helps in curing digestive problems.
- Pomegranate consists of advanced level of antioxidants called flavonoids that are effective in counteracting various cancer radials. The fruit juice helps in reducing the risk of developing prostate and breast cancer.
- Dried peel, plant bark and flower infusion powder of pomegranate are used for treating intestinal worms, bleeding noses and ulcers.
- It can also be used in controlling bacterial diseases of plants as it was reported that alcoholic extracts of fresh as well as dry skin of pomegranate are effective in inhibiting the growth of *Ralstonia solanacearum*, the causal agent of bacterial wilt of tomatoes.

References

4. HORTICULTURE

Mahua – The Valuable flower for tribes
Pavithra S¹, Kavana, G. B² and Vidya S.P.³

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India is known for plant biodiversity and we are blessed with the wide range of diversified.
plants which can be used for various purposes like decoration, flowering, fruiting and medicinal, etc. Exploitation and utilization of medicinal uses of many plants for commercial purposes have become emerging trend now and because of that, underutilized plants which are being utilized traditionally have gathered potential focus by researchers and industry people.

India is home for the medicinal plants, which are utilized traditionally and have significance of being commercialized. Mahua is one of the plant which is occupying novel space in the ethnic as well as economical life of the traditional people.

Mahua (Madhuca longifolia) belongs to same family that is which belong to sapota fruit (sapotaceae) and native to different India, Sri Lanka, Myanmar and Nepal. It is commonly used as rootstock for sapota. Even though mahua is used as rootstock but it is well known for its sweet flowers which possess a lot of ethnic values among the tribal people for the development of various fermented and non-fermented food products.

Flowering time of mahua is March-April and it bear once in a year. Fresh mahua Flowers are sweet in taste and contain different phytochemicals. Traditionally, the fresh flowers are collected and dried under direct sunlight for 2-3 days and stored in gunny bags in normal environment for future use.

**Composition and uses of Flower**

Flowers of plant are edible and have high nutritive value. Due to its valuable composition, the flower is used in preparation of medicines and is still utilized in value-addition of different products.

- Mahua flowers are rich source of sugars (sucrose, glucose, fructose, arabinose, few amounts of maltose and rhamnose) which is responsible for its sweet taste so it is used as a sweetener in preparation of numerous traditional dishes like halwa, kheer, meethi puri and barfi in mahua production belt of India.
- It can be utilized to make indigenous or modern alcoholic beverages.
- Mahua flowers contains good amount of Vitamin-C which is responsible for its antioxidant activity.
- Mahua flower contains carotene which is precursor of Vitamin-A.
- Flowers also contain good amount of minerals like Calcium and Phosphorus. Few amounts of proteins and fats are also present in mahua flowers.
- Tribal people are also utilizing the mahua flowers along with some grains (rice, ragi, jowar) or root crops (sweet potato) for preparing cake.
- Sundried flowers are boiled with seeds of Tamarin and Sal, taken as substitute of grain staples by poor tribal people.
- Fresh flower juice is concentrated and used as liquid sweetener in bakery and confectionary products.
- It is also utilized as cattle feed which helps in improvement of health of cattle and increases milk production.
- Pulp of ripe flowers can also be used in preparation of jam, jelly and marmalade.

**Fermented products**

- In term of fermented products flowers are also used as crude material for production of alcohol and alcoholic beverages. Local people of North-West India used to collect and dry the mahua flowers for preparation of “mahua daaru” which contains 20-40 (%) alcohol.
- Freshly prepared mahua wine has been fortified with traditional Indian herbs (Black pepper, cinnamon, clove, cumin, fenugreek, nutmeg, fennel and Indian cassia) for development of new value-added product, called mahua vermouth
- Dry flowers are also utilized to make fermented products like brandy, acetone, and lactic acid.
- Mahua flowers can be successfully used as a substrate for surface fermentation using Aspergillus Niger for production of citric acid.

**Medicinal value of the flower**

In Ayurveda, mahua flowers are considered as to be cooling agent, carminative, galactagogue and astringent. It is also reported to be beneficial
for heart, skin, and eye diseases. Mahua flowers are used traditionally as a remedy of many diseases by tribal people.

- Medicinal properties of mahua flowers like antihelmenthic, antibacterial, analgesic, hepatoprotective, antioxidant and anticancer.
- Fresh juice of flower is utilized as tonic and also cures skin diseases, eye diseases, raktapitta and headache due to “pitta”.
- Tribal people offer raw flowers to lactating mothers for increasing their lactation.
- Roasted flowers are consumed to cure cough and bronchitis.
- Mahua flowers can cure impotency and general debility when consumed with milk.
- Flowers fried in ghee act as a cooling agent and help to cure piles.

Mahua spirit as a sanitiser
The corona virus outbreak in 2020 throughout the world results in maintaining social distance, usage of mask and sanitiser become compulsion. In this situation, people from mahua growing regions like Chattisgarh and Madhya Pradesh has prepared organic hand sanitizer with the liquor made from mahua flowers. They used more purified and distilled mahua spirit.

Mahua is one of the naturally occurring wonderful plants with tremendous uses. With the changing scenario, there is need to enhance and promote the conservation and cultivation of medicinal plants. In addition to that exploitation and popularisation of these kinds of plants is needed.

References

5. HORTICULTURE-FRUIT SCIENCE

Role of Growth Hormones in Fruit Crops

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Plant growth regulators or phytohormones are organic substances produced naturally in higher plants, controlling growth or other physiological functions at a site remote from its place of production and active in minute amounts. The term Phytohormone proposed Thimmannas these hormones are synthesized in plants. Plant growth regulators include auxins, gibberellins, cytokinins, ethylene, growth retardants and growth inhibitors. The hormones first discovered in plants wereAuxins and later gibberellins and cytokinins were also discovered. Hormones are readily absorbed and move rapidly through the tissues, when applied to different plant parts. In other words, plant growth regulators are organic substances (other than nutrients), which in small amount promote, inhibit or otherwise modify any physiological process in plants. The use of plant growth regulators has resulted in some outstanding achievements in several fruit crops with respect to growth, yield and quality. Physiological responses that are currently regulated /influenced by PBR’s are- Promotion of feathering and branching, Increase flower bud formation inhibit flower bud formation, Thinning by promotion of fruit/flower abscission, Retard pre-harvest drop, Improve fruit finish, Improve fruit shape, Vegetative growth control, Increase fruit set, Increase fruit red colour, Advance fruit ripening, Delay fruit ripening, Enhance rooting, Suppress growth of water sprouts, Improve stress tolerance. Fruit trees are considered high value crops and even small modifications in production efficiency, product quality or enhanced cosmetic appeal have the potential to significantly increase product value.

Plant growth regulators are grouped into five
classes:
- Auxins: IAA, NAA, IBA, 2,4-D, 4-CPA
- Gibberellins: GA3
- Cytokinins: Kinetin, Zeatin
- Ethylene: Ethereal
- Abscisic acid: Dormins, Phaseic Acid

**Auxin:** NAA is a synthetic auxin plant hormone that is routinely used for the vegetative propagation of plants from stem and cutting. The effect of NAA on plant growth is greatly dependent on the time of admission and concentration. NAA has been shown to greatly increase cellulose fiber formation in plants. In majority of fruit plants fruit drop is controlled by spraying of NAA in different fruit crops in different concentration. It is applied after blossom fertilization.

**Gibberellins:** Gibberellins control fruit development in various ways and at different developmental stages. Fruit development is a complex and tightly regulated process. Growing fruits are very active metabolically and act as strong sinks for nutrients with hormones possibly modulating the process (Brenner and Cheikh, 1995). The development of a fruit can be separated into phases that include prepollination, pollination, fertilization and fruit set, post fruit set, ripening and senescence. The successful fertilization of the ovule is followed by cell division and cell expansion resulting in the growth of the fruit. Gibberellins are known to influence both cell division and cell enlargement (Adams et al., 1975).

**Cytokinins:** Cytokinins act in cell division, cell enlargement, senescence, and transport of amino acids in plants. Cytokinins are involved in branching and stimulating bud initiation.

**2, 4-D:** Endogenous hormones and their balance play a modulating role in the mobilization of nutrients to the developing organs and can influence the longevity of a bud. The dependence of abscission relative to the endogenous content of auxins has been proven by exogeneous application of 2,4-D or NAA, as the transportation of auxins by the plant lasts for a long time without ethylene appearing to affect it.

**Pacloburazol:** Paclobutrazol is probably the most widely used PGR in the production of fruit crops because of its wide range of efficacy and moderate- to long-lasting response. Applications of paclobutrazol, particularly when delivered as a spray, delay flower development and reduce flower size. Paclobutrazol is absorbed by roots and stems, and to a lesser extent, by leaves. Therefore, it can be applied as a spray, sputch, drench, or bulb or young-plant dip. Sprays are more effective when they penetrate plant canopies so that there is contact with stems. The postharvest application of a small amount of paclobutrazol to the soil significantly promotes flowering and fruiting in the following year.

**Ethylene:** Ethylene is a naturally occurring plant growth substance that has numerous effects on the growth, development and storage life of many fruits crops. Harvested fruits may be intentionally or unintentionally exposed to biologically active levels of ethylene and both endogenous and exogenous sources of ethylene contribute to its biological activity. Ethylene synthesis and sensitivity are enhanced during certain stages of plant development, as well as by a number of biotic and abiotic stresses

**Seed Germination:** Plant growth regulators are used to promote early seed germination and improve the germination percentage. Many seeds have natural dormancy which can be overcome by dipping the seeds in auxins.
- GA3 @ 500 ppm solution enhances seed germination in aonla
- Ber- 500 ppm GA

**Vegetative Propagation**
1. Cutting: Auxins play an important role in the initiation of roots in cuttings.
   a. Guava cuttings: 5000 ppm IBA by quick dip method
   b. Grape cuttings: 4000 ppm IBA by quick dip method
   c. Pomegranates: 2000 ppm IBA by quick dip method
   d. Litchi cuttings: 3000 ppm IBA by quick dip method
   e. Jamun cuttings: 5000 ppm IBA by quick dip method
   f. Fig cuttings: 1000 ppm IBA by quick dip
method
2. **Layering**: Paste of auxin pasted on the operated portion of the plant part helps in initiation of roots in grafting and layering e.g. Air layering in Guava.
   a. Air layering-guava: 3000 ppm IBA by pasting lanoline paste
   b. Air layering-pomegranate: 3000 ppm IBA by pasting lanoline paste
   c. Air layering-litchi: 5000 ppm IBA by pasting lanoline paste
   d. Air layering-jamun: 10000 ppm IBA by pasting lanoline paste
3. **Grafting**: IBA+6BA (500:500 ppm) in Bee wax paste is useful in joining the scion on stock in many fruit crops like Grapes, Mangoes, Sapota.
4. **Budding**: The treatment of IBA+6BA (500:300 ppm) in Bee wax paste is useful in bud joints in Citrus, Roses, Ber, Jamun, etc.
5. **Breaking Dormancy**: Gibberellins play an important role in breaking the dormancy of seeds of fruit crops by loosening the seed coat to permit water inside the embryo for germination (e.g., 500-700 ppm of GA3).
6. **Hastening Rootstock Growth**: Rangpur lime seedlings: 200 ppm of GA3 at one month interval.
   Jamberi rootstock seedlings: 200 ppm of GA3 at one month interval.
   Aonla seedlings: 20 ppm 6-BA at one month interval.
   Khirni and Custard apple seeds: 1000 ppm GA3 and 20-24 hours seed soaking

**Conclusions**
The exogenous application of bio-regulators might, thus act as a dynamic tool not only for enhancing the growth, productivity, quality of fruits but also in combating the harmful effects generated by various biotic and abiotic stresses in plants in the near future. Future research needs, thus, require a better understanding of the mechanism responsible for developmental processes in plants at the cellular and molecular levels, and a more comprehensive description of the specificity of bio regulators in resolving key biochemical steps.

**References**
Brahmchari, V.S., Mandal, A.K.,

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**6. SOIL SCIENCE**

**Strategies to Improve Phosphorus Availability in Sustainable Agricultural System**

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Phosphorus (P) limitation is a key challenge for crop productivity in major parts of the world, as P is least mobile and highly fixated in soil. To circumvent phosphorus deficiency, chemical fertilizers are used; however these are rapidly absorbed in the soil and not accessible for crops creating a need for more P fertilizer. Moreover, substantial amount of P is lost through runoffs and contributing to eutrophication is water bodies. Globally P is mined from geological sediments, and these non-renewable resources are being used up at an alarming rate and projected to become relatively a scarce resource in the near future. Such a scenario is a threat to sustainable crop production around the world. Therefore, there is a necessity for efficient and well managed use of P in agricultural system.

**Phosphorus as a major plant nutrient:**
- Phosphorus (P), next to nitrogen, is the second most important macronutrient
that significantly affects plant development and metabolism.

- Phosphorus plays a vital part in a multitude of life processes, including photosynthesis, respiration, energy generation, nitrogen (N) fixation, nucleic acid synthesis, membrane synthesis and stability, glycolysis, carbohydrate metabolism, membrane synthesis and stability, cell-signaling, enzyme activation/inactivation and redox reactions.

- Balanced phosphorus nutrition improves many aspects of plant development including flowering, fruiting, shoot growth and root growth.

**Phosphorus bioavailability in the soil:**

The soil P can broadly group into organic and inorganic form. The soil solution which is the major source of P for the plant roots contain P generally not higher than 10 µM in a favorable pH of 6.5, even in fertile soils. The level of inorganic phosphate (orthophosphate; Pi), the only form of P that is bio-available to the plants, is largely not available for uptake by the plant roots due to unique properties of P – slow diffusion rate at plant-soil interface and high chemical fixation in soils. P is an active element and thus has strong tendency to forms insoluble complexes with cation such as Al and Fe in low pH soil and with Ca and Mg in high pH soil conditions condition.

The organic form of P mainly, present as phytate, may account for more than 50% of total P in many soils. These forms cannot be directly used by the plants. Phytate must first be converted to mineral P form which then can contribute to overall Pi pool. Further, the availability of Pi to the plants is determined by the phosphate sorption isotherm for that soil. Due to multiple biogeochemical factors, plant roots are exposed to quite low Pi concentration in soil solution.

The fraction of bioavailable P in the soil solution is usually unable to fulfill the normal crop requirements in an intensive agricultural system. The quantity of P present in the soil solution represents only a small fraction of plant needs, and the remainder must be obtained from the solid phase by a combination of abiotic and biotic processes. It is estimated that around 70% of the global land, including acidic and alkaline, appropriated for agriculture suffers from P deficiency. This has severely limited crop output by more than 30 – 40%.

However, even when P fertilizers are added to the soil to improve soil fertility, about 70–90% of the P fertilizers is quickly adsorbed in the soil matrix and becomes chemically ‘fixed’ as various soil P compounds of low solubility thus significantly contributing little to crop production. This suggests that soil P fertilization alone is not a viable strategy to improve crop productivity in many P deficient soils. Also, the continuous and careless use of inorganic chemical P fertilizers, eventually leads to the degradation of soil fertility by disrupting microbial diversity, and therefore reducing crop productivity.

**Strategies to improve phosphorus availability to plants:**

A number of strategies have been documented to improve the phosphorus availability in soils including,

- Agronomic practices,
- Organic amendments
- Composting
- Arbuscular mycorrhizal fungi
- Phosphate solubilizing microbes

1. **Agronomic practices:** Nutrient use efficiency and nutrition uptake could be improved by means of good agronomic practices which can decrease the accumulation of nutrients in the soil and thus improving its bio-availability. Agronomic practices can decrease phosphorus fixation in soils and enhance the phosphorus availability. A number of agronomic practices have shown to greatly improve on efficient
use of P fertilizers on agricultural farms.

Conservation Tillage Practices and Use of Cover Crops: Conservation tillage practices and the use of cover crops are promoted as best agricultural practices to conserve P. Conservation tillage maintains a minimum of 30% crop residue on the field and includes no till or minimal tillage methods. Conventional tillage practices of mixing of surface and subsurface soil increase P adsorption. Conservation tillage encompasses methods of incorporating into the soil all crop residues that remain following harvest. These practices have been found to lower overall P losses, compared to conventional tillage practices. Conservation tillage practices offer many benefits to a farm field including; reduced soil erosion and particulate bound P export by decreasing the volume of surface runoff. Cover crops can increase nutrient use efficiency and reduce nutrient loss from leaching and erosion. Cover crops enhances the total root volume in agricultural system, thus increasing the surface area by which nutrients are absorbed and the total volume of plant root exudates.

2. **Organic Amendments**: Organic amendments are known to improve soil fertility. Many soil characteristics such as pH, electrical conductivity, organic content and humus fraction greatly improve upon addition of organic amendments. The issue of P limitation can possibly be resolved by the gradual addition of organic amendments to soil; however, the quantity, quality and management of this practice are fundamental factors that affect P availability. The addition of organic residues can improve soil conditions thus improving the overall plant available P.

3. **Composting**: Composted organic waste materials are known for increasing crop productivity compared to raw ones as they greatly improve soil physical, chemical and biological properties. During compost preparation, the raw organic matter undergoes physical, chemical and biological transformations, which result in greater proportions of stabilized organic matter. These stabilized organic matters decompose slowly releasing N and P to the soil.

Composting is a better technique to increase bioavailable P and thus improve P nutrition from raw organic materials of diverse nature and sources. The process of composting is accompanied by substantial decrease in the natural rate of P conversion into insoluble inorganic compounds - Al-P, Fe-P and Ca-P. Soil organic component increases during composting process which facilitates increases in soil microbial activity and diversity.

4. **Arbuscular Mycorrhizal Fungi**: Arbuscular mycorrhizal fungi (AMF) are abundant soil dwellers existing in close symbiotic associations with the root system of most plant species. AMF have a long evolutionary relationship with plants- more than 400 million years, and such long relationship has forged many beneficial effects. Many studies have confirmed the favorable role of the AMF symbiosis on plant P uptake. Increased AMF colonization with the host plant roots has repeatedly shown to increase nutritional uptake. AMF play an important role in P modifications and increases its bio-availability in soils. AMF seems more relevant pathway for P uptake in cereal plants such as wheat. AMF extending their fine hyphae, thus increasing the surface area exposed to the soil, aid in plant P uptake than is possible by the plants root system alone. The benefits of the symbiosis can be observed as either increase in total P uptake by the plant roots or increase in P concentrations in the plant tissues. The chief mechanism involved appears to be a spatial one, the AM hyphae tapping soluble P (and other nutrients) beyond the P-depletion zone that develops around root as they absorb P from the soil solution.

5. **Phosphate Solubilizing Bacteria**: Soil microorganisms have the potential to utilize these resources as they have the unique trait to convert insoluble P sources to bioavailable form. Many rhizospheric microorganisms that inhabit at plant-soil interface have shown this ability and thus increase crop
production. Many strains of bacteria and fungi have been isolated from the soil and rhizospheric region, and their unique trait examined as studied under laboratory and field conditions. Many of these microbes are isolated by traditional cultural techniques with species of Bacillus and Pseudomonas bacteria, and Penicillium and as per gill us fungi being dominant. These phosphate solubilizing microorganisms can be used as bio-fertilizer to circumvent phosphorus deficiency. In addition, many microbes involved in P solubilization also improve plant growth by improving the efficiency of biological nitrogen fixation, increasing the bio-availability of other trace elements such as Fe, Zn, etc. and by release of plant growth promoting substances. As such these phosphate-solubilizing microorganisms (PSM) has great potential in supplying the need P to plants in a more sustainable and eco-friendly way.

Reference

7. AGRONOMY

Herbicide Resistance
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*Research Associate, **Senior Research Fellow ZBNF Zone-3, AC, Vijayapur, UAS Dharwad,

Definition: Herbicide resistance refers to plants within a weed species that, after repeated use of a herbicide, are no longer controlled by normal rates of that herbicide.

Or

Inherited ability of a weed or crop biotype to survive a herbicide application to which the original population was susceptible.

History
• The first reported case of herbicide resistance in the United States was reported in the 1950’s.
• Field bindweed resistant to 2,4-D was reported in Kansas in 1964, and common groundsel resistant to triazine herbicides was discovered in Washington in 1970. Beginning in the 1980’s.
• In the world there were 304 Resistant Biotypes and 182 Species (109 dicots and 73 monocots) were recorded.
• Resistance to one or more of 25 herbicide families has been observed in more than 65 weed species in the U.S.

Types of Herbicide resistance
• Cross resistance: When resistance to two or more herbicides (with same or different mode of action) resulting from the presence of single resistance mechanism (one genetic mutation).

Ex: Imazethapyr resistant setaria faberi shows cross resistant to nicosulfon.

Table1: Cross Resistance to different herbicides

<table>
<thead>
<tr>
<th>Crop</th>
<th>Weed</th>
<th>With use of herbicide</th>
<th>Cross resistance to</th>
<th>Country/Region</th>
<th>Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Alopecurus myosuroides</td>
<td>Isoproturon</td>
<td>Clodinofop</td>
<td>UK</td>
<td>Read et al., 1997</td>
</tr>
</tbody>
</table>
Maize, Soybean | Setaria faberi | Nicosulfuron | Imazethapyr | U.S.A | Conley et al., 2000
---|---|---|---|---|---

- **Multiple resistance**: Resistant to several herbicides resulting from two or more distinct resistance mechanisms in the same plant (more than one mutation).

  *Ex*: *Lolium rigidium* against PS II inhibitors.

### Table2: Multiple Resistances in different weeds

<table>
<thead>
<tr>
<th>Weed</th>
<th>Multiple resistance to</th>
<th>Country/Region</th>
<th>Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poa annua</td>
<td>Atrazine, Diuron, Terbacil, Ethofumesate</td>
<td>Oregon</td>
<td>Heap, 1995</td>
</tr>
</tbody>
</table>

| Avena fatua | Fenixaprop, Imazamethabenz,floamprop–methyl Diclofop-methyl & pronamide | Canada | Heap, 2000 |

| Echinochloa crusgalli | Butachlor, Thiobencarb | China | Heap, 2000 |

| Kochia scoparia | Triazines, ALS inhibitors | U.S.A | Heap, 1995 |

| Amaranthus blitoides | Triazines, ALS inhibitors | Israel | Heap, 1995 |

| Echinochloa erecta | Quinclorac, propanil | Italy | Tabcchi et al., 2004 |

| Echinochloa crusgalli | Atrazine, Quinclorac | Spain | Noeria Lopez-Martinez et al., 1997 |

- **Negative cross resistance/collateral sensitivity**: Phenomenon where by individual resistant to one chemical or chemical family of herbicides have a higher sensitivity to other herbicides.

  *EX*: *Echinochloa crusgalli* which was 53 times more resistant than susceptible one, shows 33 and 2 times more sensitivity to fluazifop- butyl and sethoxydim, respectively (Gadamaski et al. 2000).

### Resistance mechanisms

Dekker and Duke (1995) broadly grouped mechanisms of herbicide in to the following two categories:

- Exclusionary resistance
- Site of action of resistance

**Exclusionary resistance**: Those that exclude the herbicide molecule from the site in plants where they induce toxic response. In exclusionary resistance mechanism the herbicide is excluded from the site of action in many ways. Resistance is caused in plants due to inaccessibility of the molecule at its site of toxic action.

   Exclusion of herbicide from the site of action can be due to several reasons.

   In resistant biotypes the herbicides are not taken up readily due to morphological uniqueness like over production of waxes, reduced leaf area etc.

   It can be differential herbicide uptake due to the morphological barrier on leaves such as extraordinarily increased waxy coating on the cuticle, hairy epidermis and low foliage number and size etc.

### Differential translocation:

- In resistant biotypes the apoplastic (cell wall, xylem) and symplastic (plasma lemma, phloem) transport of herbicide is reduced due to different modifications.

- It can also be due to differential translocation whereby apoplastic (xylem tubes) or symplastic path (phloem cells) restrict or delay movement of right concentration of herbicide at the site of action. (Ozair et al. 1987).

### Sequestration and compartmentation:

Herbicides are sequestered in many locations before it reaches the site of action. e.g. some lipophilic herbicide may become immobilized by partitioning into lipid rich glands or oil bodies (Stegink and Vaughn 1988).

- Compartmentation may be either by storage of the herbicide or its
metabolites in the cell vacuole or their sequestration in cells or tissue, far from the site of action.

- One of the major mechanisms of resistance to paraquat is compartmentation, though alternative explanations such as rapid enzyme detoxification have also been suggested.

**Metabolic detoxification:**
Herbicide is detoxified before it reaches the site of action at a rate sufficiently rapid that the plant is not killed.

The biochemical process that detoxifies herbicides can be grouped into four major categories: oxidation, reduction, hydrolysis, and conjugation.

Three enzyme systems are known to be involved in resistance due to increased herbicide detoxification.

- Resistance to atrazine in some population of *Abutilion theophrasti* is due to increased activity of glutathione-s-transferase that detoxifies atrazine.
- Resistance to propanil in *Echinochloa colona* is due to the increased activity of enzyme aryl-acyl amidase that detoxifies propanil.
- Increased herbicide metabolism due to cytochrome P450 monoxygenase is responsible for resistance to inhibitors of ACCase, ALS and PSII in a number of grass weed species.

**Site of action of resistance**
- Altered site of action: An herbicide has a specific site (target site of action) where it acts to disrupt a particular plant process or function (mode of action).

If this target site is somewhat altered, the herbicide no longer binds to the site of action and is unable to exert its phytotoxic effect.

- Over-expression of the target protein: If the target protein, on which the herbicide acts, can be produced in large quantities by the plant, then the effect of the herbicide becomes insignificant.

**Factors responsible for evolution of herbicide resistance**

**Weeds**
- Initial frequency of the resistant individuals.
- Weed seed residue in the soil seed bank.
- Hypersensitivity of weeds to a particular herbicide.

**Herbicides**
- Lack of rotation of the herbicides.
- Herbicides with long residue period.
- Herbicides with highly specific mode of action and with a single site of action.
- Herbicides used multiple times during the growing season.
- Herbicides used without other control strategies.

**References:**

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**PLANT PATHOLOGY**

**DNA Microarray**

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**Introduction**

The large-scale genomesequencing effortand theability to immobilize thousands of DNA fragments on coated glass slide or membrane, have led to the development of
microarray technology. An array is an orderly arrangement of samples where matching of known and unknown DNA samples is done based on base pairing rules. An array experiment makes use of common assay systems such as microplates or standard blotting membranes. A microarray is a pattern of ssDNA probes which are immobilized on a surface called a chip or a slide. Microarrays use hybridization to detect a specific DNA or RNA in a sample. DNA microarray uses a million different probes, fixed on a solid surface.

**Principle**

The principle of DNA microarray technology is based on the fact that complementary sequences of DNA can be used to hybridise, immobilised DNA molecules. There are four major steps in performing a typical microarray experiment they are as follows:

- Sample preparation and labelling
- Hybridisation
- Washing
- Image acquisition and Data analysis

**Sample preparation and labelling**

Isolate total RNA containing mRNA that ideally represents a quantitative copy of genes expressed at the time of sample collection. Prepare cDNA from mRNA using a reverse transcriptase enzyme. Short primer is required to initiate cDNA synthesis. Each cDNA (Sample and Control) is labelled with fluorescent cyanine dyes i.e. Cy3 and Cy5.

**Hybridisation**

Here, the labelled cDNA (Sample and Control) are mixed together. After purification, the mixed labelled cDNA is competitively hybridized against denatured PCR product or cDNA molecules spotted on a glass slide.

**Image acquisition and Data analysis:**

Slide is dried and scanned to determine how much labelled cDNA (probe) is bound to each target spot. Hybridized target produces emissions. Microarray software often uses green spots on the microarray to represent upregulated genes. Red to represent those genes that are downregulated yellow to represent those genes which are equal in abundance.

**Types of Microarrays:** There are 2 types of DNA Chips/Microarrays

1. **cDNA based microarray:** It involves the micro spotting of pre-fabricated cDNA fragments on a glass slide. Glass cDNA microarrays was the first type of DNA microarray technology developed. It was pioneered by Patrick Brown and his colleagues at Stanford University. Produced by using a robotic device which deposits (spots) a nanoliter of DNA onto a coated microscopic glass slide (50-150 µm in diameter). It includes following steps
   a. Selection of the material to spot onto the microscope glass surface.
   b. Preparation and purification of DNA sequences representing the gene of interest
   c. Spotting DNA solution onto chemically modified glass slides via a contact printing or inkjet printing

2. **Oligonucleotide based microarray:** Often referred to as a "chip" which involves
in situ oligonucleotide synthesis. Oligonucleotides are synthesized on the chip. Presently, the commercial versions of Affymetrix Gene Chips hold up to 500,000 probes/sites in a 1.28-cm² chip area. Due to such very high information content (genes) they are finding widespread use in the hybridisation based detection and analysis of mutations and polymorphisms, such as single nucleotide polymorphisms.

- In situ light directed oligonucleotide Probe array synthesis

  Light is directed through a photolithographic mask to specific areas of array surface. Activation of areas for chemical coupling. Attachment of A nucleotide containing photolabile protecting group X (MeNPOC). Next light is Directed to a different region of the array surface through a new mask. Addition of 2nd building block T containing a photolabile protecting group X. This process is repeated until the desired product is obtained

Companies manufacturing them:
Array it corporation, Illumina, Affymetrix, Insight, Genisphere, GSI group etc.

Applications of microarray technology:
- As gene expression profiling tool
- As comparative genomics tool
- As Disease diagnosis tool
- As Drug discovery tool
- In toxicology research

Disadvantages of microarrays include: The findings may lead to unethical medical procedures, high cost and scientists have no standardized way to share results.

Conclusion
DNA Microarrays are one of the most effective invention ever developed. It is a test that allows for the comparison of thousands of genes at once. Microarray technology uses chips with attached DNA sequences as probes for gene expression. Any DNA in the sample that is complementary to a probe sequence will become bound to the chip. Microarray technology is most powerful when it used on species with a sequenced genome. The microarray chip can hold sequences from every gene in the entire genome and the expression of every gene can be studied simultaneously. Gene expression data can provide information on the function of previously uncharacterized genes.

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www.gene-chips.com

9. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Garden Liquid Fertilizers for Sustainable Farming
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Introduction
In permaculture and sustainable agriculture we strive to produce an abundance of healthy plant products while actively working to enhance the health of the ecosystem that supports us. To do this effectively, we need to enhance the cycling of nutrients and fertility on our farms and in our gardens to ensure that we do not deplete soil reserves and provide the proper nutrients to plants at the optimal time in their growth cycle. While fertilizers of all types are readily available at garden centers, to create truly sustainable agricultural systems it becomes essential to explore ways to cycle and enhance fertility from resources we produce on site. Creating your own plant fertilizers is a fun and empowering process too. There are a number of simple, effective liquid solutions and brews we can make with more-or-less readily available materials to transform the health and character of our plants and soil. This document is a primer on several of these including comfrey, nettle, horsetail and seaweed teas; urine and aerobic
Use of Liquid Fertilizers

Liquid fertilizers provide plants with high concentrations of easily-absorbed, soluble nutrients, thereby enhancing their health and productivity. Easy to make with readily-available biological materials, these fertilizers are completely organic and cost nothing to make. Improved yields; pest and disease suppression; enhanced soil texture, structure and fertility; reduced watering; and the elimination of the need to use additional fertilizers and pesticides are all benefits to be gleaned from these homemade brews.

Types of fertilizers

Plant teas are made by steeping leaves in water for several weeks, thereby dissolving the nutrients into the solution. These teas are used to supply specific macro and micronutrients to plants at the appropriate time of year.

Aerobic Compost Tea: It is literally a liquid inoculum of beneficial microorganisms that work to actively build healthy soil and plants. This is explored in detail below. While not covered here, you can also make ‘leachate’ brews using compost, worm compost and manure by steeping the dry material in water (or pouring water through the screened material). Some care should be taken here though to ensure that the solution is not applied when anaerobic as this may adversely affect the health of the plants and soil biology we’re working to enhance.

Eg: Comfrey, Nettle and Horsetail Teas

These liquid fertilizers are rich in important plant nutrients and can be easily stored and transported and applied to plants by watering or spraying. The nutrients they contain are readily available and only need be applied in small quantities. Nitrogen (N) stimulates leaf growth, potassium (K) promotes developing flowers and fruit and phosphorus (P) enhances root growth.

Comfrey: Comfrey supplies extra potassium unavailable to most other plants. The plant’s deep roots accumulate potassium from subsoil and it’s leaves are high in nitrogen (even more than livestock manure). It has an N : P : K ratio of about 8 : 2.6 : 20.5%. Because comfrey is high in potassium, it promotes the development of flowers and fruit and so should be applied after the first flowers have set on plants like tomatoes and peppers. Regular feeding may then support better flower and fruit development. Be advised thought that in excess, potassium somewhat stunts growth and coarsens leaves. Due to its high K concentration, comfrey tea may be considered too strong for regular use. It can however be adapted by mixing with other garden-made fertilizers like a dilution of 1:9 with worm tea, providing an estimated NPK ratio of 2.5:2.2:2.5% which can then be diluted with water. The nitrogen supplied by comfrey is more likely to occur as ammonium, but the worm tea nitrogen is probably nitrate.

Nettles: Nitrogen-rich nettles are high in silica and encourage plant growth in early spring. Ideally, harvest plants before they flower.

Horsetail: Horsetail is high in silica and the infused stem is an effective fungicide against mildew, mint rust and blackspot. This is believed to be due to the horsetail tea enhancing plants’ light absorbing capabilities.

Preparation

For comfrey, if you are starting with a newly established plant, cut the leaves once in June to prevent flowering and allow the plant to grow and die back so as to build up reserves. Once the plant is well established, cut it before flowering in May when about 2ft high. Don’t cut later than September to allow the plant to recover food reserves before winter dormancy. As comfrey plants become strong they will be ready for cutting every 4 or 5 weeks giving 3 to 5 cuts per season. Nettles and horsetail can be harvested from the wild. It’s best to harvest nettles before plants go to flower - I am unaware of harvest timing recommendations for horsetail. Place the plant’s leaves into a large container, preferably one with a tap or hole at the bottom, and a tight lid at the top to exclude water and flies and keep any smell inside. Some recommend simply covering the bottom of the bucket/container with leaves while others advise to fill the bucket full. A black liquid smelling of ammonia will soon collect in the bottom. The solution needs to be diluted 15 - 20 times with water before application in the garden (For comfrey, this results in an N.P.K. = 0.5 : 0.4 : 3.8 - high in K).

Seaweed: Seaweed is an incredible source of trace minerals as well as a rich source of potassium up to 12%. Plants sprayed with...
seaweed are frequently more resistant to pest insect outbreaks and often show renewed growth and vigor. Seaweed is relatively poor in nitrogen and phosphate, but the addition of fish emulsion or another nitrogen rich fertilizer can make a very well-balanced solution. To make liquid seaweed brew, collect several plastic trash bags of kelp, empty them into a 55-gallon drum, fill it with water, and cover. As the seaweed begins to decompose, the water turns brown. Within about two months, the seaweed should be fully decomposed. This liquid can be used as a concentrate and diluted with water before spraying it on or pouring it around plants. The only drawback is the fishy, oceany odor detectable for a day or two after application.

Urine
It’s been found that the annual nitrogen output of humans is roughly equivalent to the nitrogen needs of the plants that feed us throughout the year. We are living in a world of broken cycles - the cycle of human waste and fertility being a primary one. In much of the western world, this high nitrogen resource is treated like a pollutant, diluted into drinking water and then extracted/purified through energy and chemical intensive means. That said, in parts of Scandinavia, urine separating/diverting toilets are the norm, directing the ‘liquid gold’ into tanks from which farmers collect the resource and apply it to their fields. Fresh human urine is sterile (unless there is a urinary tract infection – this urine should not be used) and free from bacteria. Dilute urine 10-15 parts water to 1 part urine for application on plants in the growth stage. Dilute to 30-50 parts water to 1 part urine for use on potted plants as they are much more sensitive to fertilizers of any kind. Trees, shrubs and lawn should cope well without dilution, but it’s important not to overload individual plants with a consistent nitrogen input. Apply the diluted solution to the soil beneath fruiting plants and avoid getting it on the fruit and foliage as the high nitrogen levels can ‘burn’ leaves. Stop using urine liquid fertilizer on all food plants at least two weeks before harvesting. Adding undiluted human urine to your compost heap will help heat it up quickly and will add to the overall nutrient value.

10. AGRONOMY (ORGANIC FARMING)

Egg Amino Acid and Fish Amino Acid - A Novel Organic Liquid Manure for Increasing Crop Productivity

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Organic liquid manure
Liquid organic manures are products obtained from the fermentation and/or decomposition of organic matter such as crop residues, animal dung, urine, plant materials and other natural resources.

- Natural resources like plants and animals
- Light nutrient boost
- Absorb roots and through leaf pores
- Overcome temporary nutrient shortages
- Catalysts, increasing nutrient uptake by plants
- Long shelf life, rapidly up taken by plants.

Egg amino acid
Egg amino acid is a nutrient for plant and helps in plant growth without affecting soil health.

Materials
- 5 eggs
- 10 to 15 Lemons Juice
- 250 grams Jaggery
Preparation of egg amino acid

- Twenty numbers of ripened lemon was squeezed and the juice was taken in a plastic container.
- Then 10 numbers of eggs kept inside the lemon juice till the eggs were soaked completely and kept for 10 days.
- After 10 days, eggs were smashed well and 250 g jaggery was added and kept for 10 days.
- The content was filtered after 10 days and the liquid portion was collected and stored in separate container for foliar spray (Anonymous, 2015).

Application method: Add one to two ml of this with one liter of water for spraying.

Fish Amino Acid

Fish amino acids are a good source of nitrogen for crop plants and may be used to supplement compost and manures in coastal regions which have a good supply of inexpensive fish byproducts. It is absorbed directly by the crops and it also stimulates the activity of microorganisms.

Materials

- Uncooked fish trash such as gills and intestines.
- Raw sugar or molasses

Procedure

- Mix equal parts fish trash and brown sugar or molasses. Lactic acid bacteria serum (LABS) may be added to minimize the foul smell.
- Place in earthen jar or any convenient container, cover with paper and allow the fish juice to extract and fermentation to occur for 14 days.
- Filter out the solids and retain the liquid fish amino acids.
- Store in glass or plastic bottles. Do not completely close the cap on the bottle.
- Shake the solution weekly and add sugar to it every month (20% of the volume).

Application method

Use 1-2 tbsp/L water and apply as soil drench or foliar spray weekly or depending on the vigour of the plants. High dosage can have adverse effects on plants.

Benefits

- Fish amino acid and egg amino acid is a good organic liquid manure applying both the soil and foliage since it enhances the growth of crops during their vegetative growth period. It also increases the yield and fragrance of green leafy vegetables.
- It reduces the nutrient leaching loss by application as foliar spray
- It improves the soil physical, chemical and biological activity
- It reduces the overall cost of cultivation by utilizing natural resources

Conclusion

Organic farming is the most effective and efficient replacement for chemical fertilizer.

Choosing organic manures in liquid form is a much more effective practice than conventional solid farm. But the availability of efficient manure in liquid form is the major barrier. Egg and fish amino acid is an excellent solution for such shortcomings. It is an well recognised and renowned liquid manure that helps to improve crop productivity. On the other hand although there are so many advantages for these practices, the lack of availability of sufficient research, standardized practice and awareness hinders their utilisation among the farmers. Thereby more emphasis needs to be given on such areas as well.

Reference

http://agricultureforeverybody.blogspot.in.
Introduction

Coconut (Cocos nucifera L.) is most useful palm belonging to family Palmae. In India, coconut tree is called as kalmpriksha the tree of life, coconut is grown in a wide range of agro-climatic conditions. Productivity of coconut in India in terms of nuts/hectare is highest among major coconut growing area. Coconut is mainly consumed as raw nuts, copra and oil, whereas other products are coir and nuts. Coconut oil is the main commercial product. Copra obtained after drying kernel of coconut contains 65-70 % oil. Copra is used to extract coconut oil and coconut meal in the ratio of 3:2. The products like hair oil, soaps, shampoos and medicine use coconut oil as a main ingredient. In India, only 10% of the production is used for tender nut water. Traditionally, coconut industry in India is centered on copra making, coconut oil extraction and coir manufacture. The industrial products are desiccated coconut, cream milk powder, vinegar, Nata-de-coco etc.

Important Coconut Products: following products are made from coconut on a commercial scale.

- Copra
- Coconut oil
- Coconut milk or cream
- Tender coconut water
- Coconut meat
- Instant coconut milk powder etc.

1. **Copra**: The dried coconut endosperm is called copra with oil content of 65% to 70% copra is the richest source of fat. The focus of copra are made in our country namely milling copra and edible copra, milky copra is made in the form of cups used for oil extraction. It is also used as a dry fruit for consumption. Whole, edible copra is shredded and used as garnish in various dishes. Drying of copra can be carried out in open sun or in hot air driers. Even electrical and solar driers can also be used. Sun drying takes 6-8 days while hot air driers involve 20-24 hours for drying. During drying the moisture content from 50-55 % is reduced to 5-6 %. Dried copra should be packed in polyethylene lined gunny bags and stored ion cool and dry place.

   Copra: It is made in the form of cups and balls.

   a. **Ball copra**: Fully ripe nuts of 12-14 months are stored in upper floor of specially made store (two storied brick and mortar building). The floor and four sides of upper story and smoked by a slow fire set under the platform using coconut palm waste. During this period, the water inside the nut dries up and kernel gets detached from shell and raflles on shaking. The process completes in 8-12 months. Small sized nuts are preferred over large sized one.

   b. **Cup copra**: Nuts stored as above for shorter period are used for making edible cup copra. The copra balls are cut into halves and then they are sun dried for a few days.

2. **Coconut oil**: Coconut oil is extracted from milling copra. The pulped copra is fed continuously to the expeller from which oil and cake are expressed. Hydraulic pressing of cake also results in extraction of copra oil. Coconut oil is very low in unsaturated and
poly unsaturated fatty acids, particularly linoleic acid as compared to other vegetable oils (Kumar et al. 2000). It is more resistant to oxidation than many other types of oils. It is obtained from mature meat which when dried contain 65% oil and the oil obtained from coconut milk is called as virgin coconut oil. Coconut oil is used for culinary, edible purposes and for industrial use like toiletries and soap making etc. Coconut oil processing methods are classified into two major types: dry and wet processes. When the oil is extracted from copra as raw material is termed as dry process, while use of fresh coconut as starting material is called wet process.

3. **Coconut milk or cream**: Coconut milk or cream is the oil-protein-water emulsion obtained by freezing grated fresh coconut kernel. It is the processed milk extracted from fresh matured coconuts. It is the processed milk extracted from fresh matured coconuts. It is used either directly or diluted with water to make various preparations like curries, sweets, puddings and many bakery preparations. Processed and packed coconut cream has a shelf life up to three months.

4. **Tender coconut water**: Water from tender coconut (7-8 month old) is a refreshing drink, effective in cases of gastroenteritis, diarrhea, vomiting and in preventing dehydration. The nut water is less nutritious from mature coconut as compared to tender coconut water. Nata-de-coco, soft drink, vinegar, food yeast etc are the products in which coconut water is main source. Coconut water can also be used to produce carbonated and non-carbonated beverages as refreshing and more nutritious drinks than other similar products.

5. **Coconut meat**: The kernel of seven to eight month old nut is very soft with maximum contents of protein and sugar. Kernel is as such consumed or with sweet nut water. Fresh kernel is consumed in the grated form and in the form of milk or cream obtained by squeezing the grating with or without addition of water. As the nuts turn more mature the quality decreases gradually. Fresh coconut meat contains 50-55% moisture which is to be brought down to 5-6% during drying.

6. **Instant coconut milk powder**: It is a spray dried product similar to dairy milk powder. The spray dried coconut milk powder if dissolved in water, results in coconut milk which can be used in place of fresh coconut milk for food preparation.

7. **Coconut husk products**: The coconut husk usually forms 35-45% of the whole nut weight at ripening. About 30% of husk is fibre and 70% is the coir dust. Coir pith is used as manure, as mulch or in making briquettes with good export potential. Coconut husk is the basic raw material for coir industry. The fibers extracted from coir is used for spinning into yarn for making mats, ropes, rugs, carpets, bleaching, dyeing, printing, poly coir, coir matting decorated boards, husk particle boards etc.

Other products: Coconut sap, coconut syrup and sugar, fermented coconut sap, coconut vinegar, coconut shell powder, coir fibre and pith are some of the important coconut products.

### 12. HORTICULTURE

**Nano Agents in Food Industry**

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Food packaging is simply used as the means of containers in which foodstuffs were transported from production place to retail or consumption place. The packaging materials act as a barricade between the food and the environment by controlling the transmission of light, heat, moisture, and gases, and the movement of microorganisms or insects. Packaging protects tampering resistance and special physical, chemical, or biological. In the food industry, the application of packaging materials and methods to minimizes food losses and provide safe and nutritious food products. Bio-nanocomposites are a new generation of nano packaging materials that are highly useful to minimize the growth of contaminant microorganisms and further extend the shelf life of food and maintaining product quality and safety during storage. Antimicrobial packaging is one of the most used active packaging, which can diminish or hinder the growth of pathogenic and spoilage bacteria in the food matrix. The antimicrobial compounds incorporated into packaging materials act as an additional hurdle to advance microbial safety and shelf life of perishable foods. Different types of antimicrobial nanocomposites used in food packaging classified based on their type of antimicrobial properties.

Metal nanoparticles, metal oxide nanomaterials, and carbon nanotubes are the most used nanoparticles in the development of a new generation of antimicrobial active packaging (Silvestre et al., 2011). Metallic basic nano antimicrobial agents, such as silver nanoparticles (AgNPs), copper nanoparticles (CuNPs), zinc oxide nanoparticles (ZnONPs), and titan oxide nanoparticles (TiO$_2$NPs), with organic or inorganic polymers, have been extensively investigated for antimicrobial packaging preparation (Llorens et al., 2012).

Silver is well known for its intrinsic antimicrobial property since ancient times. Silver ion is highly active, as it binds to tissue proteins and brings a structural change in the cell wall and nuclear membrane leading to cell distortion and death. Silver nanomaterial helps in the reduction in size and leads to increases in their activity. Silver NPs are the most effective acceptable antimicrobial activity against the microorganisms (Cioffi and Rai, 2012) and has low toxicity to eukaryotic cell biocompatibility, high hydrophilicity, good complexity, favourable solubility in water, and many organic solvents and acceptable process ability.

Titanium dioxide (TiO$_2$) is a metal oxide NPs photocatalytic substance has multifunctional properties such as self-cleaning, antimicrobial, and ultraviolet (UV) protecting properties (Han and Yu, 2006). TiO$_2$ has other characteristics such as stability, non-toxicity, the capability of repeated use without substantial loss of catalytic ability, cheapness, and use in human food, drugs, cosmetics, food contact materials and approved by the US Food and Drug Administration (Yemmireddy and Hung, 2015). TiO$_2$ photocatalysts produce a potent oxidizing power when illuminated in the ultraviolet (UV) range by wavelength less than 385 nm. Food packaging films are incorporated with TiO$_2$ nanoparticles to have the protection of the food content from the oxidizing effects of UV irradiation to maintaining good optical clarity and have efficient short-wavelength light absorbers with high photostability. (Llorens et al., 2012).

Copper-based nanomaterials are low-cost materials, insignificant sensitivity to human tissues, and high sensitivity to microorganisms. Copper complexes used in many applications such as a liquid sterilizer, antibacterial, antifungal, antiviral, and anti fouling agent (Borkow and Gabbay, 2006). Copper nanomaterials synthesized through chemical techniques such as solegel method, thermal decomposition of precursor, electrochemical (such as sacrificial anode method), and physical/mechanical approaches (such as ion beam cosputtering technique). The main disadvantage of chemical methods is due to the presence of some toxic chemical absorbed on the surface that may have an adverse effect. (Sivaraj et al., 2014). To minimize the toxicity of inorganic NPs, green synthesis of metal NPs is an alternative approach for producing copper NPs and other metal NPs.

Zinc oxide (ZnO) is one of the five zinc compounds that are currently listed as generally recognized as safe (GRAS) by the US Food and Drug Administration (21CFR182.8991) (Espitia et al., 2012). It has a white appearance, easily
production process, inexpensive, high thermal conductivity and refractive index, photo oxidizing against biological species and chemicals, self-sterilization, antimicrobial activity, semiconducting properties, good catalytic and photochemical activity, UV blocking safe substances for human and animals. ZnO NPs have an inhibitory effect against both Gram-positive bacteria such as *Bacillus subtilis*, *Staphylococcus aureus*, and Gram-negative bacteria such as *E. coli*, *Klebsiella planticola*, *Pseudomonas aeruginosa*, and *Proteus mirabilis*.

Carbon nanotubes (CNTs) are arrangements of carbon hexagons into tube having diameters of a few nanometers with lengths up to centimeters. They have received considerable attention due to their mechanical, electrical, and thermal properties, and reported to have antimicrobial properties (Kang et al., 2007). The application of CNTsuspended because several studies suggest that CNTs are cytotoxic to human cells at least in contact with skin.

The fusion of antimicrobial nanomaterials into a food-packaging system can impede the growth of spoilage and pathogenic microorganism, improve food safety, and significantly extend the shelf-life time of food. Many inorganic nanomaterials and organic nanomaterials have been explored in packaging materials, such as AgNPs, CuNPs, ZnONPs, chitosan, and antimicrobial peptides. Three general procedures proposed to incorporate nanomaterials to packaging systems: incorporating directly within packaging material, immobilizing/grafting to polymers surface and depositing onto polymer surface as nanocomposite coatings to increase the shelf life and retard the microbial attack.

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13. AGRICULTURAL ENTOMOLOGY

Medicinal Properties Associated with Honey Bee

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Introduction

Insects belong to the class hexapoda/insecta are important creatures in maintaining the diversity of the environment and performs role in ecology and has its influence in agriculture, human health and natural resources. Among the insect orders, hymenoptera, the third largest order contains social insects like bees and wasps that performs many functions for the benefit environment like pollination, parasitization, honey production, etc. of many insects of the order hymenoptera, honey bees are the largest commercially reared insects mainly for their honey production and also they possess many therapeutic values.

Honey bees and bee keeping

Five species of honey bees viz., Apis dorsata (Rock bee), Apis cera indica (Indian bee), Apis florea (dwarf bee), Apis mellifera (European or Italian bee) and Tetragonula iridepennis (dammer or stingless bee) have gained commercial importance in India. Bee keeping was mentioned in Vedas scriptures and rock painting found Madhya Pradesh but however, the scientific method of bee keeping was started since 19th century in India. Several products of honey bees like pollen, honey, bee wax, propolis were used in traditional medicines (Schimid, 1996).

Propolis

It is a waxy natural resinous substance collected from various parts of the plants, buds, exudates by honey bees and is usually used to repair their hives and to seal the cracks on the inner walls to protect from entering pathogens. This propolis consists of resins 50%, waxes 30%, essential oils 10%, pollen 5%, various other organic compounds 5% including flavonoids, phenolics and aromatic compounds (Park et al., 2002). They found to possess antibacterial activity against Streptococcus mutans, Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli, Candida albicans, and Asparagus niger and they are highly suitable for gram positive bacteria than gram negative. Propolis found to contain antifungal property because of the presence of flavanoids particularly against yeast like Candida famata, C. glabrata, C. kefyr, C. pelliculosa, C. parapsilosis, and Pichia ohmeri. This antifungal property illustrated that the propolis microparticles can be used in the therapy of vulvovaginal candidiasis and the possible prevention of the occurrence of new symptomatic episodes (Dota et al., 2011). Because of its antimicrobial property it was also fund to protect dental caries in human. It also possess antioxidant property because of the presence of flavonoids by protecting lipids and several other compounds like vitamin C from being oxidized by scavenging free radicals and found to play a greater role in immunomodulatory properties. This propolis in animal model found to inhibit the synthesis of DNA in the tumour cells and ultimately causes apoptosis of tumour cells. The ethanolic extract of propolis was found to delay the occurrence of diabetic nephropathy in diabetes mellitus (Wagh, 2013).

Bee venom

Female worker honey bee has a sting in their abdomen which is a modified ovipositor secretes venom to protect it from its enemies. This venom is synthesized by the venom gland and stored in the venom reservoir associated with the sting apparatus. About 100-150 µg of venom is stored in a mature defender. This venom is a transparent liquid with an ornamental pungent odour and with the blend of proteins, peptides, enzymes and several other compounds. The main pain inducing compound found in its venom is melittin which might be responsible for their use in arthritis. This venom is collected by removing the venom gland from the insect and later it was done by electroshock method. This venom was tested in a rat and it reduced the formaldehyde induced arthritis in its foot pad. In humans it is used to treat inflammatory disorders like arthritis, bursitis, tendinitis, joint disease, dissolving scar tissue osteoarthritis, rheumatoid arthritis, gout, multiple sclerosis and lyme disease and other immune disorders like sclerodema and asthma (Ali, 2012). A protozoan parasite of the genus Leishmania (Protozoa) which is transmitted by sandflies, known to cause a worldwide serious disease in human and this
Bee venom found to show high inhibitory effect on *Leishmania tropica* at low concentration in vitro (Al-Asafar *et al.*, 2019).

**Bee pollen**

Honey bees as they collect the pollen form the plants in addition to the nectar. These collected pollens are then mixed with their salivary secretions and they store it their pollen basket which is situated in the tibia of their hind legs. After reaching their hive, the collected pollen is then then fragmented by worker bees and store it their comb and covered with the thin layer of honey and wax. The major compounds in the bee pollen includes carbohydrates (13 – 55%) including, proteins (10-40%), essential amino acids including methionine, lysine, threonine and tryptophan, crude fibers (0.3 to 20%) and lipids (1 – 10%). It has several properties and are widely used as antifungal, antimicrobial, anti-inflammatory, immunostimulating, anti-oxidant, anti-radiation, hepatoprotective, chemoprotective and chemopreventive agents. Because of the antimicrobial property and regeneration of damaged tissues it is widely used in burn wound treatment and ulcerations of different etiology.

**Royal jelly**

Royal jelly is a milky secretion of worker honey which helps in the development of queen bee. It constitutes of water (67%), Protein called royalactin (12. 5%), simple sugars (11%), fatty acids (6%) - 10-hydroxy-2-decenoic acid (HDA) and vitamins (0.8 to 3%). This fatty acid has found to contain numerous. They were found to increase the growth of the young children. Several reports were stated that they found to possess antibacterial, immune- modulating, anticancer, anti- diabetes, antiaging properties. In addition to this they promotes endothelial health and acts as anti-hypertensive and anti-hyperlipidemia.

**Bee wax**

Young worker bee secrets liquefied wax from the wax secreting glands located in their abdomen and gets solidified when exposed to air. This waxes are used for coating drugs or pills and they do not interact with the digestive system of human as they are inert. In addition to this they also has anti-microbial property and are used in cosmetics as they improves the elasticity of skin and this bee wax is used as a main product of thermotherapy (Basa *et al.*, 2016). Bee wax is the least allergic product of honey bee.

**Honey**

Honey is a sweet, viscous substance produced by worker honey bees. Worker bee, they collect nectars from plants and other honeydew secreting insects and they regurgitate and store it in their honey cells for ripening. Honey is well known for its antimicrobial and wound healing property which can heal almost all types of wounds like abrasions, abscess, amputation, fistulas, diabetic malignant, septic wounds and surgical wounds. Though the modern ointments can heal the burns and wounds they may cause tissue death and leave scars while honey treats the wounds without tissue death. Honey based remedies are used to treat gastritis, gastric and duodenal ulcers which are caused by *Helicobacter pylori*. Several studies have reported that honey helps in reduction of gastric acid secretion. On oral administration of honey, about 80% of gastric ulcer patients were recovered (Ball, 2007). The phenolic compounds present in honey increases their efficiency in the treatment of cardiovascular diseases. The flavonoids in honey is responsible to decrease the risk of coronary heart disease (CHD) by improving coronary vasodilatation, decreasing the ability of platelets to cause blood clots (Khalil and Sulaiman, 2010).

**Conclusion**

Beekeeping (or apiculture) is the maintenance of bee colonies, commonly in man-made hives, by humans. Besides these medicinal properties, about 80 percent of all pollinations of cultivated crops are done by honey bees. Many negative impacts of environment in recent years threaten the life of several living species especially the honey bees.

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14. AGRICULTURAL ENTOMOLOGY

**Recent Advances in Biological Control**

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**Introduction**

Excessive use of pesticides poses many serious problems like environmental pollution, human health hazards, pest resistance, killing of beneficial insects and non-target organisms and resurgence or secondary pest outbreak, etc. Therefore, biological control is the widely accepted eco-friendly pest control method at global scenario which is an effective alternative for pesticide use. It can be defined as the use of living organisms (called natural enemies) to suppress the population density or impact of a specific pest organism, making it less abundant or less damaging than it would otherwise be. Biological control includes the control of invertebrate pests using predators, parasitoids and pathogens, the control of weeds using herbivores and pathogens, and the control of plant pathogens using antagonistic micro-organisms and induced plant resistance (Eilenberg et al., 2001).

Ensuring the efficacy of these natural enemies is not always simple, as their performance as biocontrol agents can be affected by many abiotic and biotic factors, such as unfavorable climatic conditions, the presence of chemical pesticides, potential attack by predators, the existence of plant defense mechanisms, and potential deleterious effects of unwanted breeding selection and inbreeding in mass-rearing programs. In addition to looking for new indigenous natural enemies, the possibility to ‘improve’ the efficacy of a potential biocontrol agent has also attracted the attention of researchers and biocontrol companies over the last century (Le Hesran et al., 2019).

**Recent techniques to improve the efficacy of biocontrol agents**

Many challenges are still ahead, including: (1) a better understanding of the genetic processes related to adaptation and selection of natural enemies; (2) choosing the right traits to select for in terms of biocontrol efficacy and understanding the genetic basis of these traits; (3) evaluating the existing genetic variation for these traits within and among populations; (4) choosing an adequate method of selection; and (5) maintaining the selected traits in mass-reared populations before an improved biocontrol agent can be released. Applying genetic and genomic knowledge to improve biocontrol agents, a development that is being referred to as ‘next generation biocontrol’ (Le Hesran et al., 2019). If it applied correctly and combined with new genomic methods, experimental evolution and artificial selection can be powerful and promising tools to improve the biocontrol efficacy of natural
enemies (Lirakis and Magalhaes, 2019).

**Recent past success in improving the efficacy of biocontrol agents**

Molecular tools like microsatellite markers can help in determining the genetic diversity in biocontrol agent populations, but also in distinguishing between species and strains of biocontrol agents. *Amblyseius swirskii* Athias-Henriot (Acari: Phytoseiidae) is a predatory mite used to control whiteflies and thrips in protected crops. Commercially reared *A. swirskii* have reduced genetic variation compared to their wild counterparts, which may reduce their performance when released to control pests in an integrated pest management (IPM) context. Performing additional genetic analysis of more commercial populations to further assess the impact of genetic diversity on the performance of *A. swirskii* as a biocontrol agent. To achieve this, it is recommended to use a pooled microsatellite analysis (Paspati et al., 2019).

The weed biocontrol agent, *Eccritotarsus catarinensis* (Carvalho) (Hemiptera: Miridae) underwent post-release adaptation to environments with temperatures beyond those in its native range. Such change in temperature tolerance is likely to be caused by a combination of phenotypic plasticity and rapid evolution. The plastic nature of the insect’s thermal physiology has allowed it to survive in the very different climatic conditions of the introduced range, and there has been some adaptive change to the insect’s thermal tolerance since establishment. The biological control practitioners could take advantage of the thermal plasticity of biocontrol agents and the micro-evolutionary changes that might occur post-release in order to maximize the impact of biocontrol agents across a broad range of thermal environments (Griffith et al., 2019).

The resistance can be enhanced in biocontrol agents by artificial selection under laboratory conditions, starting with populations showing no or very low tolerance. The variation in tolerance to neonicotinoid insecticides among populations of the biocontrol agent *Orius* sp. (Fieber) (Hemiptera: Anthocoridae) can be exploited to optimize its performance in the field (Balanza et al., 2019).

Cryptic variation can also be a source for the selective breeding of natural enemies. The artificial selection on wing truncation in the biocontrol agent *Adalia bipunctata* (L.) (Coleoptera: Coccinellidae) to ensure that it remains close to its place of release. The two-spot ladybird beetle, *A. bipunctata* (L.) (Coleoptera: Coccinellidae), is used for the biological control of aphids in greenhouses and on urban trees. Flightlessness due to truncated wings occurs at very low frequency in some natural populations of *A. bipunctata*. Selective breeding of wing truncation may be exploited to improve mass rearing of flightless strains of *A. bipunctata* for commercial biological control (Lommen et al., 2019).

The molecular tools can be efficiently used both in field and laboratory studies to better interpret the various interactions like host-parasitoid and parasitoid-parasitoid. And it can be useful for risk assessment to test whether the biocontrol agent can unwantedly target other species (Le Hesran et al., 2019).

**Future prospects**

The use of natural genetic diversity, artificial selection, and molecular tools can potentially help to improve the biocontrol efficacy. These approaches, in combination with other traditional methods helps in the exploration of new indigenous natural enemies.

**References**


15. AGRICULTURAL ENTOMOLOGY

Exploitation of Behaviour Modifying Chemicals in Pest Management

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Introduction
The changing climatic scenario and extensive mono-cropping have influenced the ecology and biology of insect pests leading to a considerable shift in the pest status across several crops posing challenges to farmers and researchers alike. Considering the recent global emphasis on sustainable pest management solutions with minimal ‘carbon foot printing’, intensive efforts are being made to identify green chemicals that can support integrated pest management strategies with the least disturbance to agro-ecosystems. In this context, the dependency of insects on chemical cues to locate their hosts and mates offers tremendous opportunity to identify the potential ‘behaviour-modifying chemicals’ that can be exploited for their management. Therefore, a thorough understanding of the chemical mediated communication among the insect pests with their hosts, con-specific and natural enemies help to identify weak behavioural links that can be manipulated across the trophic interactions. However, in order to understand the various behaviour-modifying chemicals that are being deployed by insects and to maximize their usefulness to make insect pests vulnerable, collaborations between biology, chemical ecology, physiology and analytical chemistry are of paramount importance.

Behaviour modifying chemicals for pest management
The behavioural modifying chemicals involve a long-distance attractant and the mechanism consists of a device whereby the attracted pests are killed or trapped.

Methodology
Plant volatiles from healthy, infested (herbivore induced) and mechanically damaged plants were collected through air entrainment as per the procedure described by Jayanthi et al. (2020). Behavioural assays will be carried out in Y-Tube/four arm/wind tunnel olfactometer.

Diaphania indica (Saunders), is a serious pest of cucurbitaceous plants which feed on vegetative tissue of the plants and thereby cause severe economic loss of crops. The four compounds [(Z)-6-nonenal, octanal, (E)-2-octen-1-ol, and 1-hexanol, benzyl alcohol and benzaldehyde cucumber volatiles attract gravid females of cucumber moth, which could be used further to develop lures for management. Host plant, attraction to host odour could conceptually be mediated by specific compounds released from host plant Vitis vinifera to the attraction of female grapevine moth, Lobesia botrana (Denis
and Schiffermüller) host odour recognition and the evolution of insect-plant associations. Alarm pheromone secreted by aphids, (E)-F-farnesene, is a repellent that has been used to protect a plant resource from aphid infestations. (E, E)-α-farnesene, produced by infested coffee berries has been identified as a potential repellent against the coffee berry borer. Adult female of Helicoverpa armigera (Hubner) elicited response to host plant-produced compounds Oicimene, β-phellandrene, phenylacetaldehyde and benzaldehyde.

Gravid female Bactocera dorsalis (Hendel), strong elicited response to synthetic compound γ-octalactone from mango infested volatile had a powerful effect. Behavioural manipulation of herbivore and associated natural enemies with varied combination of plant-insect derived odour sources. Parasitoids can able to perceive the volatile compounds through micro cilia present on the antenna of parasitoid wasp. Parasitoids olfactory system to discriminate among several odours to exploit certain volatile organic compounds for host location. Specialist parasitoids which attack fewer host species are predicted to utilize as host location cues host specific volatile signals (e.g. certain HIPV’s). Generalist parasitoids may have evolved to use general host-related volatiles (such as GLVs and common HIPV’s) as host location cues. Egg parasitoid, Chysonotomyia rufulorum (Karusee) were showed strong response of oviposition and induced pine twigs revealed the synthetic chemical compounds viz., β-Caryophyline (E)-β-farnesene. Egg parasitoid, Trichogramma bournieri elicited response to volatiles from egg deposition by Chilopartellus Swinhoe to egg volatiles like (E)-4,8-dimethyl-1,3,7-nonatriene. Specialist larval endoparasitoid, Campoletis chlorideae (Uchida) elicited response to four terpenoids namely β-pinene, β-myrcene, D-limonene, and (E)-nerolidol, from H. armigera infested volatile. The generalist parasitoid, Trichogramma pretiosum (Riley) and specialist, Telenomus remus (Nixon) significant response to Spodoptera frugiperda (J.E Smith) infested maize volatile. Bactrocera tryoni (Froggatt) odours from mature guava. Herbivore induced organic volatiles compounds (VOCs) emitted maize plant feeding by S. frugiperda virgin mated response females to herbivore induced plant volatiles of maize Lymantria dispar (Linn.) towards constitutive and herbivore-induced black poplar (Populus nigra L). Chemicals elicits viz., salicylic acid (SA), jasmonic acid (JA), are well studied and known to induce both direct and indirect defense against insect pest as well as natural enemy complex. Such induced responses in plants are important components of pest management and can be triggered by external application of elicitors. Exogenous application of SA-induced plant volatiles attractant nonviruliferous Bemisia tabaci B and Q or B- and Q-carrying tomato yellow leaf curl virus (TYLCV). Three species of parasitoid wasps, Cotesia glomerata, C. rubecula, and Diadegma semiclausum were tested for their behavioural responses to volatiles from herbivore-induced, JA-induced, and non-induced plants. Results revealed that three species were attracted to volatiles from JA-induced plants compared with control plants. Recent studies have uncovered a rich panorama of odour mediated plant pollinators interactions. Olfactory learning in insects are form holometabolous insects like Diptera, Lepidoptera and Hymenoptera which are reported commonly as pollinators on Allium sepa. Thus pollinators rely on floral scents as olfactory indicators of floral indicator of presence of nectar. Red palm weevil (Oliver) behavioural response to food baits banana, pineapple, coconut petiole compared with pheromone ethyl acteate Highest response to pheromone followed by banana bait trap. Futher banana bait analyze for compound identification. Callibruchus maculatus (F.) might be attracted to dried green pea seeds as a blend (1-pentanol, 1-octen-3-ol, (E)-2-octenol, nonanal, and 3-carene). Future prospects

Besides increasing understanding of insect behaviours, such studies should also provide knowledge of more stimuli for behavioural manipulation. Given the present emphasis on chemical stimuli and their advantages, as well as the increasing sophistication of chemical techniques, a wider variety of chemicals that mediate behaviour presumably should be identified and used. Understanding of pest behaviour and the identification of the volatiles
responsible for such behaviour in insects could help develop attractive lures or traps for the control and/or monitoring of the target species. The lure can be a synthetic pheromone, a food or host attractant, or a combination of the two, which is sufficiently effective when deployed in an optimally efficient trap design at a suitable density to suppress the pest and reduce economic damage to the target crop.

Reference


16. AGRICULTURAL MICROBIOLOGY

Mechanism of K-Solubilizing Bacteria for Potassium Use Efficiency in Agriculture Soil

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Introduction
The potassium solubilizing microorganisms (KSMs) are a rhizospheric microorganism which solubilizes the insoluble potassium (K) to soluble forms of K for plant growth and yield. K-solubilization is carried out by a large number of saprophytic bacteria and fungal strains. Major amounts of K containing minerals (muscovite, orthoclase, biotite, feldspar, illite, mica) are present in the soil as a fixed form that is not directly taken up by the plant. Nowadays most of the farmers use injudicious application of chemical fertilizers for achieving maximum productivity. However, the KSMs are the most important microorganisms for solubilizing the fixed form of K in the soil system. The KSMs are an indigenous rhizospheric microorganism which shows effective interaction between soil and plant systems. The main mechanism of KSMs is acidolysis, chelation, exchange reactions, complexolysis, and production of organic acid. According to literature, the currently negligible use of potassium fertilizer as a chemical form has been recorded in agriculture for enhancing crop yield.

K-solubilizing microorganism (KSMs)
K solubilization is done by a wide range of saprophytic bacteria, fungal strains, and actinomycetes (Ahmad et al., 2016; Bakhshandeh et al. 2017; Gundala et al., 2013; Meena et al., 2014). There is strong evidence that soil bacteria are capable of transforming soil K to the forms available to plant effectively (Meena et al., 2015a; Meena et al., 2014; Meena et al., 2016). There is a considerable population of KSB in soil and plant rhizosphere. These include both aerobic and anaerobic isolates that the most frequently KSB in the soil are aerobic. A considerably higher concentration of KSB is commonly found in the rhizosphere in comparison with non-rhizosphere soil (Padma and Sukumar, 2015). Solubilization of K by KSB from insoluble and fixed forms is an import aspect regarding K availability in soils. Among the soil bacterial communities, B. mucilaginosus, B. edaphicus, and B. circulans can have been described as effective K solubilizers (Meena et al., 2015a; Meena et al., 2014; Meena et al., 2016). KSB is usually present in all soils and has been isolated from rhizosphere soil, non-rhizosphere soil, paddy soil (Bakhshandeh et al., 2017), and saline soil (Bhattacharya et al., 2016.).

In general, the microbial solubilization of K is strongly influenced by pH, oxygen, the bacterial strains used, and kind of K bearing minerals; in fact, moderate alkalinity favors the solubilization of silicate (Sheng and Huang, 2001). These studies show that optimal conditions for K solubilization by KSB need to be
Mechanisms of K-solubilization

The mechanism of potassium solubilization means by which insoluble potassium and structural unavailable forms of potassium compounds are mobilized and solubilized due to the production of various types of organic acids. These acids are accompanied by acidolysis, complexolysis exchange reactions and these are key processes attributed to their conversion in a soluble form (Uroz et al. 2009). The organic and inorganic acids convert insoluble K (mica, muscovite, biotite feldspar) to the soluble form of K (soil solution form) with the net result increasing the availability of the nutrients to the plants. The various types of organic acid produced by KSMs differed with different organisms. Organic acids were detected in the microbial suspension. KSMscan weather phlogopite via aluminum chelation and acidic dissolution of the crystal network (Leyval and Berthelin, 1989, Abouel-Seoud and Abdel-Megeed, 2012).

The release of various types of organic acids was reflected by microorganisms to solubilize the insoluble K to an available form of K which is easily taken up by the plant. Researchers suggested that the plant growth promotion was related to K solubilization as well as the release of organic acids by the K-solubilizing strains. Sheng and He (2006) reported that solubilization of illite and feldspar by microorganisms is due to the production of organic acids like oxalic acid and tartaric acids, gluconic acid, and 2-ketogluconic acid, oxalic acid, citric acid, malic acid, and succinic acid. Tartaric acid seems to be the most frequent agent of mineral K-solubilization (Zarjani et al., 2013, Prajapati et al., 2012, Prajapati and Modi, 2012). Other organic acids, such as acetic, citric, lactic, propionic, glycolic, oxalic, malonic, succinic acid, fumaric, tartaric, etc. have also been identified among K-solubilizers (Wu et al. 2005).

The solubilization of structural K compounds by naturally-abundant KSMs are common under in vitro conditions (Raj, 2004, Sugumaran and Janarthanam, 2007, Zarjani et al., 2013, Sheng and He, 2006, Prajapati et al., 2012), field and greenhouse condition (Basak and Biswas, 2009, Basak and Biswas, 2012, Singh et al., 2010, Prajapati et al., 2013, Parmar and Sindhu, 2013). The indigenous rhizospheric microorganisms are effective in releasing K from structural K through solubilization and from exchangeable pools of total soil K by acidolysis, chelation, and solubilization by KSMs (Uroz et al. 2009). Biomass of the rhizospheric microorganism in the soil also contains a significant quantity of fixed K that is potentially available to plants (Girgis, 2006, Jones et al., 2003).

The mechanisms for KSMs to solubilization of K are by: (i) lowering the pH, or (ii) by enhancing chelation of the cations bound to K, and (iii) acidolysis of the surrounding area of microorganism. The lowering in pH of the medium suggests the release of organic acids and protons by the K-solubilizing microorganisms (Zarjaniet al., 2013, Parmar and Sindhu, 2013, Uroz et al., 2009). Such acidolysis by organic acids produced by the rhizospheric microorganisms can either directly dissolve the mineral K as a result of slow releases of exchangeable K, readily available exchangeable K, or can chelate both Si and Al ions associated with K minerals (Romheld and Kirkby 2010). Thus, the synthesis and discharge of organic acids by the microorganisms into the surrounding environment acidify the microbe’s cells and their surrounding environment that ultimately leads to the release of K ions from the mineral K by protonation and acidification (Goldstein 1994). Of the different organic acids involved in the solubilization of insoluble K, succinic, citric, gluconic, α-ketogluconic and oxalic acids are the most prominent acids released by microbial strains.

Organic acids produced by the KSMs can be detected by high-performance liquid chromatography and enzymatic methods (Archanæ et al., 2012, Archanæ et al., 2013; Zhang et al. 2013). However, the acidification does not seem to be the only mechanism of solubilization, as the ability to reduce the pH in some cases did not correlate with the ability to solubilize mineral K (Zarjani et al., 2013, Rosa-Magriet al., 2012). Furthermore, the chelating ability of the organic acids is also important, as it has been shown that the addition of 0.05 M EDTA to the medium has the same solubilizing effect as inoculation with Penicillium bilaii (Kucey, 1988, Sheng and He,
Table 1: Potassium solubilizing microorganisms (KSMs) produce various organic acids in different strains, which help insolubilization of insoluble potassium to soluble potassium. (Vijay Singh Meena et al., 2013).

<table>
<thead>
<tr>
<th>Organism</th>
<th>Predominant acid produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillium frequents, Cladosporium</td>
<td>Oxalic, Citric, Gluconic Acids</td>
</tr>
<tr>
<td>Paenibacillus mucilaginosus</td>
<td>Tartaric, Citric, Oxalic</td>
</tr>
<tr>
<td>Aspergillus niger, Penicillium sp.</td>
<td>Citric, Glycolic, Succinic</td>
</tr>
<tr>
<td>B. megaterium, Pseudomonas sp., B. subtilis</td>
<td>Lactic, Malic, Oxalic, Lactic</td>
</tr>
<tr>
<td>B. megaterium, E. freundii</td>
<td>Citric, Gluconic</td>
</tr>
<tr>
<td>Arthrobacter sp., Bacillus sp., B. firmus</td>
<td>Lactic, Citric</td>
</tr>
<tr>
<td>Aspergillus fumigatus, Aspergillus candidus</td>
<td>Oxalic, Tartaric, Citric, Oxalic</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Acetate, Citrate, Oxalate</td>
</tr>
<tr>
<td>Pseudomonas spp</td>
<td>Tartaric, Citric</td>
</tr>
</tbody>
</table>

17. AGRICULTURE

**Rivina humilis**, An Invasive Weed Identified in Tree Shades of Coimbatore - May Be an Addition to The List of Worst Weed Like *Parthenium hysterophorus*

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I have found a new plant (*Rivina humilis*), another invasive weed from American residential quarters of Tamil Nadu Agricultural University, Coimbatore during the end of 2016 in the shades and drainage of the quarters and under trees nearby. From my first observation, I found the weediness of the plant with more number of fruits/berries in a raceme and seeds. I have gone for a short survey around the tree plantation in the quarters’ area and found that a minimum 10 m was encroached by this invasive weed and found another new colony under an age old banyan tree. Since the Agricultural University is with a large area under cultivation, I searched for the presence of this weed in cropped area also. Fortunately, this was not entered in the cropped areas. Before which I have confirmed this invasive weed as *Rivina humilis* belongs to Petivearceaefamily with Botanical Survey of India, Coimbatore and to possible extend I have removed this weed manually and fired. I have found colonies under the banyan tree also it showed that it is spreading under the tree shades. I observed the difference in the fruit size and depth of red colour of the fruit over seasons and spreading very fastly after the fruit set in the next season may be turned to a worst weed like *Parthenium hysterophorus* and have officially informed to the University to have a check on this new weed in cropped area.

**Origin and Biology**

Common names: Blood berry, pigeon berry, Ink berry, coral berry, baby pepper, rouge plant, small poke weed, Rakthanelli (Malayalam) and Netturupalli (Telugu).

*Rivina humilis* L. belongs to the family Phytolaccaceae is a native of tropical America and is now widespread throughout in tropics and subtropics. In many countries this species is often cultivated in gardens as the juicy pericarp is used in cosmetics. The genus was recognized by Linnaeus in 1753 and since then several species have been recognized by various workers, giving emphasis to morphological plasticity in vegetative as well as reproductive characters.
Present day Rivina is treated with a single species, R. humilis (Mabberley, 2008) and a new species reported in west Bengal as of R. bengalensis (Manasi Mandalet et al., 2018)

*Rivinahumilis* is a perennial, erect, much-branched herb, of 100 cm tall; branches woody, sulcate. Leaves simple, remote, extipulate, petiolate, spiral, glabrous, margin wavy, apex acute to long, slightly acuminate, base obtuse to round. Inflorescence a terminal raceme, up to 10 cm. Flowers pedicellate, bracteate, bracts subulate, bracteoles 2, opposite, located below the perianth, hermaphroditic, tetramerous; tepals white with margins tinged pink; stamens 4, alternate with tepals, anthers dithecal, intorse; ovary superior, sub-globose, style short, bent in the fruit, persistent, stigma peltate. Fruit a berry, globose to pyriform, with persistent calyx and filaments, bright red when ripe. Seed lenticular, pubescent. Flowering & Fruiting is during June to January and reported that due to its high fruit-set and being un-grazed by animals, the species is fast spreading in the region (Vankaiah et al., 2018).

**Have a control and surveillance on this invasive weed**

This weed is shade loving forest weed of American origin and was reported with high sulphur removal and fast spreading in nature. Hence this is not our native weed, we should have a strong check on this weed otherwise it will be a great threat to the national forest biodiversity. We should learn the lessons from the invasion of Parthenium, Prosopis, Lantana, water hyacinth etc.,

**References**


**18. HORTICULTURE**

**Shankapushpi - Indian Traditional Ayurvedic Medicine**

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Since long time immemorial nature has been a mere source of medicinal plants. These medicinal plants are gift of God, to cure infinite number of diseases in human beings and other living organism. They have been the major source of drugs in all system of medicine and other ancient systems in the world. In the various systems of medicine, many plants and herbs are used to treat various infirmities.

In all ancient scriptures of Ayurveda, Shankapushpi is mentioned as one of the important herb commonly known as ‘Butterfly pea’, conch flower, Asian pigeon wings, bluebell vine, blue pea, butterfly pea, cordofan pea and Darwin pea,. Its botanical name is *Clitoria ternatea* and belongs to *Fabaceae (Pipilionaceae)* family. Clitoria genus is indigenous climber and a common garden flower found through out the tropical and subtropical regions of the world. Now the genus becomes rare in humid and sub-humid lands of Asia, America, and Africa and also in semi-arid tropical Australia.
Plant description

It is an ornamental perennial climber, up to 2–3 m in height, growing wild and also in gardens, bearing conspicuous blue or white flowers resembling a conch-shell. It is a vigorous, trailing, scrambling or climbing tropical legume. Its sparsely pubescent stems are sub-erect and woody at the base and may be up to 5 m long. They root only at the tips. The leaves are pinnate, bearing 5–7 elliptical, 3-5 cm long leaflets. The flowers are solitary or paired, deep blue or pure white, about 4 cm broad. The fruits are flat, linear, sparsely pubescent pods that dehisce violently at maturity and throw 8-10 dark and shiny seeds.

Agronomic characteristics

Clitoria is well adapted to grow in wide range of soil types (in between pH range 5.5-8.9) from deep alluvial to sandy including calcareous soils. It extremely well adapted to heavy clay alkaline soils, and especially on clay soils but also grows well in moderate fertile soils. Clitoria ternatea likes a rich, moist soil (peat moss: loam: part sand or perlite 2:1:1) therefore the soil should be evenly moist at all times for well growth. It is moderately shade-tolerant but can normally grow in full sunlight. Establishment of C. ternatea is most favourable when the temperature is between 24–32°C. It grows from sea level to 1800 and also grown as an ornamental in the warmer parts of the world.

Propagation

It contains around 20% of hard seed according to the seasonal conditions where it is produced and grows rapidly in warm-moist weather. It is harvested manually by hands and is propagated from seed by cuttings. The seeds of Clitoria ternatea are covered by hard seed coats therefore do not germinate or imbibe water, but when stored for 6 months 15-20% germination can be obtained.

Traditional and ornamental uses:

- Originally selected as a cover crop, but now used for short and medium-term pastures and as green manure, cover crop and protein bank. Increases soil fertility to improve yields of subsequent crops (maize, sorghum, wheat) when grown as green manure or ley pasture.
- Widely planted as an ornamental on fence rows
- Clitoria ternatea has long been cultivated as a forage crop generally preferred by livestock over other legumes.
- Clitoria ternatea roots produce large round nodules known to house nitrogen-fixing bacteria, making the plant ideal for use in a crop rotation system.
- In Malaysia, the leaves are employed to impart a green color to food, ternatins are blue anthocyanins found in the petals the blue flower pigment is traditionally utilized as food colorant because of the high stability and impart a bright blue color to rice cakes.
- Proteins and peptides isolated from C. ternatea are reported to exhibit insecticidal properties.

Medicinal uses.

- A wide range of secondary metabolites including triterpenoids, flavonol glycosides, anthocyanins and steroids has been isolated from Clitoria ternatea. Its extracts possess a wide range of pharmacological activities including antimicrobial, antipyretic, anti-inflammatory, analgesic, diuretic, local anaesthetic, ant diabetic, insecticidal, blood platelet aggregation-inhibiting and for use as a vascular smooth muscle relaxing properties.
- Flowers and tender pods are eaten as vegetable in Kerala (India).
- The herb is also used as one of the most important ingredients in the treatment of disorders such as hypertension, hypotension, anxiety neurosis, stresses etc.
- It is also beneficial in rejuvenation therapy and works as a psycho-stimulant and tranquilizer.
- The extract from shankapushpi helps in reducing the level of cholesterol in blood, including triglycerides, phospholipids and fatty acids.
• The herb is helpful fighting ulcers that are formed in the body due to glycoproteins, improving nerve tissues and bone marrow quality.
• The studies on shankpushpi have also put forward that it is beneficial in remediying hypo-thyroidism.
• The flowers are mixed with water in a preparation used to treat eye problems
• Rich in bioflavonoids, Butterfly Pea can promote hair growth and reduce greying of hair.
• Clitoria Ternatea’s cyclotides can cause cancer cell death by disrupting cell membrane integrity.
• Treatments of various ailments like infections, as anthelmintics, antidote to animal stings
• Especially the roots of C. Ternatea are useful in severe asthma, remittent fever and bronchitis.
• It has been used for the treatment of various neurological disorders as an active ingredient in ‘Medhya Rasayana’.
• It is also one of the best herb that are use for enhancing beauty and helps in nursing all layers of skin.
• The herb serves to induce a feeling calm and peace, promotes soothing and relieves from anxiety.
• It also help in removing certain types of fatty acids that are harmful for the body
• Still there is a need of improve or enhance the western medical drug preparation using these flower i.e., shankapushi.

Pests and diseases
Fungal leaf diseases (e.g. Cercospora, Colletotrichum, Odium and Rhizoctonia) have been recorded in cool wet weather but rarely as a serious problem. Minor susceptibility to various leaf-eating caterpillars and grasshoppers. Most lines (variably) susceptible to root nematode Meloidgyne incognita.

Nature has been a source of medicinal agents since time immemorial. The plant kingdom harbours an in exhaustible source of active ingredients invaluable in the management of many diseases. They are well known in traditional herbal medicine for their diseases curing property. It is one of the herbs mentioned in all ancient scriptures of Ayurveda. Thus Clitoria ternatea merits further phytochemical, pharmacological and clinical investigations for development of an effective natural remedy from Ayurveda to provide therapeutically effective lead compounds or extracts.

References
indehiscent fruit is also known as chia seeds, where in ancient times Mayan and Aztec population include chia seed as their basic diet food. Chia seeds contents of 69 calories in 1 tablespoon. The Chia seed contains average value of 23 g of protein, 46 g of carbohydrates; 24 g and dietary fiber 5 g per 100 g. Chia seeds are high quality resource of vitamins, minerals and also good quality supplement of antioxidant compounds which protect the body from free radicals, aging and cancer. Chia seeds are like hale and hearty diet food which is incorporated with flaxseeds. Purpose of chia seeds are use in baked products or as topping of salads, cereals, and soups. Since chia seed has a mild flavor can be supplementary in several dishes. Not only in pharmaceutical and food companies but also used in cosmetic, as protective agent against moisture, foam stabilizer and emulsifier agent.

There are different usages of chia seeds in food industries chia seeds oil, gum and fiber as high nutritive value and it enhances the palatability of the product.

1. Chia oil: The oil yield of chia seeds is 30 %. Pre-cleaned seeds are milled, heat treated in oven for 1 hour. The oil is extracted by using screw press method and stored in tin cans at 27°C for 60–days.

2. Chia gum: Chia is a starting material in the food industry for its dietary fiber content, gum is extracted from dietary fiber fraction of Chia by treatment of seeds with water, and the gum is also stable at high temperature 244°C, thus useful in many food formulations. Chia gum consists of 26.2% of fat act as additive to control viscosity, stability, texture, and consistency in food systems.

3. Fiber fraction: Due to the particular structure of the mucilage chia fiber fraction has less oil-holding capacity and act as a suitable substitute in foods as foam stabilizer and emulsifier.

4. Other uses of Chia seeds:
   a. Chia seeds are used as a component of biodegradable film thickening agent for bread and pasta, particularly in gluten-free products.
   b. Chia seeds have great potential on the development of healthy and good-quality meat and fish products.
   c. In fact, seeds are a rich source of nutrients first of all the polyunsaturated omega-3 fatty acids that protect from inflammation, enhance cognitive performance and reduce the level of cholesterol.
   d. Seeds are also rich in polyphenols derived from caffeic acid that are antioxidant compounds protecting the body from free radicals, aging and cancer.
   e. In addition, carbohydrate based fibers, present at high concentration levels are associated with reducing inflammation, lowering cholesterol and regulating bowel function.
   f. Chia seeds have been used in the traditional medicine against eye infections and for the treatment of stomach disorders.
   g. Seeds also contain several phenolic compounds such as tocopherols, phytosterols and carotenoids with their related antioxidant activities that play a very important role in the deterioration of the oil due to lipid oxidation.
   h. Consumption of 7.3 g of chia seed per day provides 100% of the recommended intake of omega-3 fatty acids, which help to prevent chronic diseases related to diet.
   i. A good balance of essential amino acids was found in the seed flour and globulins, especially for methionine and cytosine.
   j. Chia seed is a good source of total dietary fiber, which has prebiotic effect and it is active on coronary heart disease, stroke, hypertension, diabetes etc.

**Conclusion**

*(Salvia hispanica)* Chia seeds are a good source of nutraceuticals as well as they are rich in dietary fiber and polyunsaturated fatty acids, mainly a-linolenic acid, chlorogenic acids which provide high antioxidant activity. Due to its mucilaginous gel, Chia seeds used in cosmetic, pharmaceutical and food companies as protective agent against moisture, foam stabilizer and emulsifier agents.
References

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20. FOOD TECHNOLOGY

Alternative Technology for Frying

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Introduction
Frying is an oldest and popular method of cooking to prepare snack foods. Commonly snacks are deep fat fried in hot oil, where the temperature is above the boiling point of water serves as the heat transfer medium. Oil also migrates in to the product resulting in high heat transfer rate, rapid cooking,
browning, crisp texture and flavour development and also which is leads to absorb more oil content in fried product. However, sudden change in colour and many adverse reactions take place during deep fat/atmospheric frying due to because of high temperature. Therefore, deep fat fried products increase the risk of coronary heart diseases, obesity diabetes, hypertension and cancer (Saguy and Dana, 2003). There is a growing demand for healthier or low fat food products, and this the demand of new formulations and process for developing low fat food products. There are several research studies were carried out to reduce the oil content in fried products. One of the interesting techniques that reduce the problems in deep fat fried products is vacuum frying technique which is an alternative technology to reduce the oil content.

**Vacuum frying technology**

Vacuum frying is an alternative and promising technique that may be an option for producing novel snacks such as fruits and vegetable crisp, meat nuggets, that present the desired quality attributes and respond to good and new health trends (Dueik et al., 2010). This vacuum frying is carried out at lower temperature and lower pressure that is below atmospheric pressure, which lowers the boiling point of water hence, higher temperatures are not required to remove moisture content from food. At vacuum level it reduces the boiling point of water and allowing frying to be carried out at low temperatures even lower than 100 °C. It is important that temperature should not be too low otherwise the required structural change may not take place. The simulation of heat and mass transfer take place during vacuum frying. Heat transfer included convection of heat from the oil surface to the food product, conduction of heat into the product and the loss of heat when using heat source term to represent evaporation. The mass transfer included water loss and oil absorption. Oil absorption is a surface phenomenon that occurs when the product is removed from the fryer due to temperature difference between the product and ambient temperatures. The change in temperature causes an increase in capillary pressure in the product pores, which causes the oil to flow into the opened pore spaces (Bauny et al., 2012). The de-oiling process becomes more important during vacuum frying to reduce the oil content in the fried food.

**Figure 1. Schematic of the vacuum frying system (Garayo and Moreira 2002)**

### Advantages

- Vacuum fried product has low moisture content and low water activity thus it increases the shelf life of the product.
- The absence of air during frying may inhibit oxidation including lipid oxidation, enzymatic browning therefore, the colour and nutritional value of fried products are preserved.
- The product crispiness, original taste, colour aroma are retained as the natural food.
- Vacuum frying reduces the oil content of the product and less adverse effect on fried oil quality.

### Disadvantages

- Initial investment of vacuum frying process is much higher.

### Applications of vacuum frying and their benefits in processing of food products

- Vacuum frying reduces oil uptake and improves the quality parameters of carrot crisps and plantain chips.
- The effect of a de-oiling mechanism on the production of high quality vacuum fried potato chips.
- Vacuum frying preserves carotenoid content of carrot chips.
- Vacuum frying is most effective on the oxidative stability of oils.
• Low temperature in vacuum frying reduces the acrylamide formation in potato chips

References

21. AGRICULTURAL ENGINEERING

Watershed Management through Modeling

M. Angaleeswari and E.Sujitha

Watershed models simulate natural processes of the flow of water, sediment, chemicals, nutrients, and microbial organisms & quantify the impact of human activities on these processes. Simulation of these processes plays a fundamental role in addressing a range of watershed based water resources, environmental, social & economical problems.

Main tool in addressing a wide spectrum of environmental and water resources problems

water resources planning, development, design, operation, and management; flooding; droughts; upland erosion; stream bank erosion; coastal erosion; sedimentation; nonpoint source pollution; water pollution from industrial, domestic, agricultural, and energy industry sources; migration of microbes; deterioration of lakes; desertification of land; degradation of land; decay of rivers; irrigation of agricultural lands; conjunctive use of surface and groundwater; reliable design of hydraulic structures and river training works.

System Approach

Problems involve 3 steps:

• Describe the system - involves modeling the watershed system

• Describe the objective function – normally stated in terms of economic terms

• Optimize the system

Classification of Models

Black Box Models

Models describe mathematically the relation between variables (eg rainfall and surface runoff) without describing the physical process by which they are related. e.g. Unit Hydrograph approach; ANN; Rational formula etc formula etc.

Lumped models

These models occupy an intermediate position between the distributed models and Black Box Models. e.g. Soil Conservation Curve number method, Stanford Watershed Model.

Distributed Models

These models are based on complex physical theory, i.e. based on the solution of real governing equation. Eg: Model based on unsteady flow St. Venant equations for watershed modeling.

Structure of Watershed Model - Simulation of process that takes place in watershed

Watershed modeling steps:

• Formulation

• Calibration/verification

• Application
Watershed model constitutes
1. Input function
2. Output function

Hydrologic Models – Types
1. **Event model**: represents a single runoff event occurring over a period of time ranging from about an hour to several days. Accuracy of the model output is depending on the reliability of initial conditions. An event model may omit one or both of the subsurface components and also evapotranspiration.
2. **Continuous watershed model**: will determine flow rates and conditions during both, runoff periods and periods of no surface runoff. Initial conditions must be known or assumed.
3. **Complete or comprehensive watershed models**: Solves the water balance equation. Represents more or less all hydrologic processes. Increases the accuracy of the model.
4. **Partial Models**: Represents only a part of the overall runoff process. **Ex**: Water yield model gives runoff volumes but no peak discharges.

Watershed simulation Analysis

**Model selection criteria**
- Assumptions & conceptualization
- Ability of model to predict variables required by the project.
- Hydrologic processes that need to be modeled to estimate the desired outputs adequately (single-event or continuous processes).

- Availability of input data.
- Expertise available & computational facility Price.

**Steps**
- Selection of model
- Input data collection: rainfall, infiltration, land use, channel characteristics etc.
- Evaluate the study objectives under various watershed simulation conditions.
- Selection of methods for obtaining basin hydrographs and channel routing
- Calibration and verification of model
- Model simulations for various conditions
- Sensitivity analysis
- Evaluate usefulness of model and comment on needed changes.

**Conclusion**

The ability to deliver reliable water resources to a growing population and effectively forecast flooding, drought, and surface/groundwater water contamination represent increasingly difficult and interrelated challenges to water resource managers, engineers, and researchers. Such challenges necessitate the employment of a more holistic approach that is capable of examining individual processes and systems and the interface between them.

**References**

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**22. HORTICULTURE**

**Ornamental Plants as a Source of Antioxidants**

**Anamika Gurung**

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**Introduction**

Ornamental plants are grown in garden for decorative purpose, in landscaping, as cut flower, potted plant and for religious purpose. Besides, ornamental plants play an important role in human health and psychology. The use of edible flowers as a source of human nutrition for centuries has already been described in detail in ancient literature. Some of the very important bioactive compounds are found in many ornamental flowers and their possible role as dietary components has been reported. In flowers, important compounds with antioxidant activities
and anti-inflammatory properties are represented by polyphenols, carotenoids and vitamin C (Mlcek and Rop, 2011) and often present in higher concentration compared with the most common fruits and vegetables (Cavaiuolo et al., 2013).

Antioxidants are substances that can prevent or slow the damage to cells caused by free radicals, which is an unstable molecule that the body produces as a reaction to environmental and other pressures. It plays a critical role in maintaining the cell functioning and integrity, and act as a protective shield for our body against certain diseases such as cancer, cardiac diseases, premature ageing etc. It reduces the effect of dangerous oxidants by binding together with these harmful molecules and decreases their destructive power. They are sometimes called ‘free-radical scavengers.’

**Free radical**

A free radical contains an unpaired electron in an atomic orbital; they are highly unstable and reactive. They behave like oxidants or reductants by either donating an electron to or accepting an electron from other molecules. A presence of free radicals leads to cell damage and homeostatic disruption by attacking important macromolecules. Targets of free radicals include all kinds of molecules in the body. Among them, lipids, nucleic acids, and proteins are the major targets.

Free radicals may form spontaneously or due to the result of exposure to heat, light, pollution, ionizing radiation, smoking, etc. Sometimes the body’s immune system creates them on purpose to neutralize viruses and bacteria. Both enzymatic and non-enzymatic reactions are responsible for the continuous formation of free radical. Enzymatic reactions, which serve as a source of free radicals, include those involved in the respiratory chain, in phagocytosis, in prostaglandin synthesis, and in the cytochrome P-450 system. Free radicals can also be formed in non-enzymatic reactions of oxygen with organic compounds as well as those initiated by ionizing reactions.

**Reactive Oxygen Species**

The most important oxygen-containing free radicals in many disease states are Hydroxyl radicals (·OH), Superoxide anions (O₂⁻), Singlet oxygen(¹O₂), Hydrogen peroxides (H₂O₂), Organic peroxides (R-OOH), Nitric oxide radical and Peroxynitrite radical.

**Antioxidants based on defense mechanism:**

1. **Preventive antioxidants**: Enzymes such as peroxidase, catalase, lactoferrin etc. suppress the free radical formation
2. **Radical scavenging antioxidants**: This includes vitamin C and carotenoids that suppress the chain initiation reaction.
3. **Repair and de novo antioxidant**: It comprises of proteolytic enzymes and repair enzymes of DNA and genetic materials.
4. **Enzyme inhibitor antioxidants**: This induces production and reaction of free radicals and the transport of appropriate antioxidants to appropriate active site.

Free radicals are normally neutralized by efficient systems in the body that include the antioxidant enzymes such as superoxide dismutase, catalase, and glutathione peroxidase and the nutrient-derived antioxidant small molecules like vitamin C, vitamin E, carotenones, flavonoids, glutathione, uric acid, and taurine, phenols, and zinc and selenium among minerals.

**Vitamin C**

- It prevents free radical damage due to its property of donating free radicals.
- Gives up electrons very easily when they are needed
- Helps to reactivation Vitamin E
- It is beneficial in boosting immune system

**Vitamin E**

- It has been found beneficial against certain types of cancer and cardiac problems
- Protects cell membranes
- Stored in liver and fat cells
- It protects (low-density lipoproteins) against oxidation, which in return protects us against heart disease

**Phytochemicals**

Plants contain certain chemicals such as carotenoids, flavonoids, bioflavonoids, phenols,
phytosterols etc. that possess antioxidative properties.

**Carotenoids**
- These are a group of antioxidant composed of α-carotene, β-carotene, cryptoxanthin, lycopene, lutein and zeaxanthin.
- Carotenoids also play an important role in human nutrition and health; it provides provitamin A and has an anti-cancer activities.

**Flavonoids**
- Sometimes referred to as 'Super Antioxidants'
- Over 4000 flavanoids have been found, fall in four different groups: flavones, flavanones, catechins and anthocyanins
- Plants contain flavonoids like quercetin, kaempferol which scavenge free radicals.

**Phenols**
- It prevents oxidative damage of tissues from ROS of DNA, RNA, enzymes, proteins and has anti-inflammatory properties

**Anthocyanins**
- They are a group of water-soluble pigments flavonoids (glycosides) that are in solution in the vacuoles in plant cells of fruits, flowers, stems and leaves
- Delphinidin, cyanidin, pelargonidin

**Minerals**
- Selenium is an essential component of several enzymes that prevent free radical formation & their removal from the blood stream.
- Found in Glutathion peroxidase which is a free radical scavenging enzyme
- It destroys peroxides and thus protects lipid membranes

**Ornamental plants as a source of antioxidants**
Ornamental plants are a substantial source of chemical compounds which shows antioxidant activities that has the marked inhibitive effect on free radicals (ROS). It has been observed that antioxidant compounds increase during early senescence of flowers and decline during advanced senescence. These antioxidant compounds protect the cell from damaging due to the effect of free radicals (ROS) on biomembrane.

One of the most important parameters used to estimate the antioxidant content is the determination of the total phenolics. Flowers with higher total phenolic content are *Antigonon leptopus*, *Bougainvillea glabra*, *Tagetes erecta*, *Cosmos sulphureus*, *Prunus mume* and *Sophora vicifolia* with values >100 mg/g DW. Two important methods for the evaluation of antioxidant capacity of flower tissues are 2,2-diphenyl-1-picrylhydrazyl (DPPH) and Ferric-reducing antioxidant power (FRAP). Ornamental flowers like *Antigonon leptopus*, *Bougainvillea hybrid*, *Cosmos sulphureus*, *Nelumbo nucifera* and *Tagetes erecta* contains high values of FRAP.

In ornamental flowers like *Nelumbo nucifera* and *Plumeria obtuse* contains flavonoids like quercetin (194–238 mg/100 g DW) whereas *Bougainvillea hybrid*, *Ixora chinensis* contains rutin (50 mg/100 g DW). The flowers with higher content of kaempferol are *Antigonon leptopus*, *Bougainvillea glabra* and *Tagetes erecta*, ranging from 76 - 87 mg/100 g DW (Cavaiuolo et al., 2013). In begonias, chrysanthemum, roses (*Rosa rugosa* and *Rosa davurica*) and garden nasturtiums, an important antioxidant activity has been observed. A strong scavenging activity of ROS and lipid peroxidation has been found in extracts of daylily. In addition, daylily flowers also contain essential phenolic compounds like catechin, chlorogenic acid, rutin and quercetin (Fu et al., 2009). Other important antioxidants may be flavonols such as kaempferol and quercetin are found in rose petals mainly in a glycoside bound form (Mlcek and Rop, 2011) and rose hip is a rich source of vitamin C.

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23. PLANT PATHOLOGY

PCR: A Strong Tool for Plant Disease Diagnosis

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Introduction

Polymerase chain reaction (PCR): PCR has emerged as a powerful pathogen detection method in crop sciences, including certification programs, plant quarantine, pathogen identification and diagnosis, disease management, and crop production. It is a method widely used in molecular biology to rapidly make millions to billions of copies of a specific DNA sample allowing scientists to take a very small sample of DNA and amplify it to a large enough amount to study in detail. PCR was invented in 1983 by Kary Mullis. Using PCR, copies of very small amounts of DNA sequences are exponentially amplified in a series or cycles of temperature changes. PCR is now a common and often indispensable technique using for broad variety of applications in research.

Steps

Initial denaturation: 95°C-4 min.
Denaturation: 94°C-1 min.
Annealing: 55-58°C-1 min.
Extension: 72°C-1 min.
Final extension: 72°C-10 min. and Hold: 4°C-up to removed

Denaturation: This breaks the weak hydrogen bonds that hold DNA strands together in a helix, allowing the strands to separate creating single stranded DNA.

Annealing: This allows the primers to bind (anneal) to their complementary sequence in the template DNA.

Extension: The reaction is then heated to 72°C, the optimal temperature for DNA polymerase to act. DNA polymerase extends the primers, adding nucleotides onto the primer in a sequential manner, using the target DNA as a template.

Types of PCR

1. Quantitative real time PCR (Q-RT PCR): Used to measure the quantity of a target sequence (commonly in real-time). It quantitatively measures starting amounts of DNA, cDNA, or RNA. Quantitative PCR is commonly used to determine whether a DNA sequence is present in a sample and the number of its copies in the sample. Quantitative PCR has a very high degree of precision. Quantitative PCR methods use fluorescent dyes, such as Sybr Green, EvaGreen or fluorophore-containing DNA probes, such as TaqMan, to measure the amount of amplified product in real time. It is also sometimes abbreviated to RT-PCR (real-time PCR) but this abbreviation should be used only for reverse transcription PCR. qPCR is the appropriate contractions for quantitative PCR (real-time PCR).

2. Reverse Transcriptase PCR (RT-PCR): For amplifying DNA from RNA. Reverse transcriptase reverse transcribes RNA into cDNA, which is then amplified by PCR. RT-PCR is widely used in expression profiling, to determine the expression of a gene or to identify the sequence of an RNA transcript, including transcription start and termination sites. If the genomic DNA sequence of a gene is known, RT-PCR can be used to map the location of exons and introns in the gene.

3. Multiplex PCR: It consists of multiple
primer sets within a single PCR mixture to produce amplicons of varying sizes that are specific to different DNA sequences. By targeting multiple genes at once, additional information may be gained from a single test-run that otherwise would require several times the reagents and more time to perform. Annealing temperatures for each of the primer sets must be optimized to work correctly within a single reaction, and amplicon sizes. That is, their base pair length should be different enough to form distinct bands when visualized by gel electrophoresis.

4. Nested PCR: It is used to increase the specificity of DNA amplification. Two sets of primers are used in two successive reactions. In the first PCR, one pair of primers is used to generate DNA products, which may contain products amplified from non-target areas. The products from the first PCR are then used as template in a second PCR, using one ('hemi-nesting') or two different primers whose binding sites are located (nested) within the first set, thus increasing specificity.

**Application of PCR in Plant Pathology**

PCR technology has become an essential research and diagnostic tool for improving knowledge regarding identification, characterization, detection and diagnosis of plant pathogens. PCR technology allows scientists to take a specimen of genetic material, even from just one cell, copy its genetic sequence over and over, and generate a test sample sufficient to detect the presence or absence of a specific fungi, virus, bacterium or any particular sequence of genetic material.

**References**


**24. EGRONOMY**

**Biofuel crops: Need an Hour**

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**Introduction**

The increase in consumption of fossil fuels as economies grow and the nearing depletion of such fuels has prompted a search for their alternatives worldwide. Hence, biofuels have emerged as a substitute for fuel oil, especially for oil-importing countries and serve a multitude of purposes. The most important advantage of these fuels is that they are renewable and are being seen as sustainable sources of energy. Some studies have also pointed out that biofuels help reduce environmental emissions (Arai, 2009) apart from addressing the problems of the rising import cost of crude oil. Among liquid fuels, there are mainly two types of biofuel, they are alcohols (ethanol and butanol) and diesel substitutes (such as biodiesel and hydro-treated vegetable oils). These can be used either individually as fuels or for blending in petrol or diesel. While biodiesel is mainly manufactured by trans-esterification of vegetable oil, ethanol is produced from starch contained in crops such as corn and sorghum or through fermentation of sugarcane molasses and sugarbeet. In India, ethanol production is mainly done using sugarcane as feedstock.

**Importance of ethanol**

Ethanol is also known as ethyl alcohol, drinking alcohol or grain alcohol which is flammable, colourless chemical compound having a pleasant odour. Ethanol can be used in vehicles in its pure form, but is usually used as a gasoline additive to increase the octane number and improve vehicle emissions. In India, the total available ethanol is mainly used for three purposes, the maximum about 45 per cent is used to produce potable liquor, about 40 per cent is
used in the alcohol-based chemical industry (as a solvent in synthesis of other organic chemicals) and the rest is used for blending with petrol and other purposes. The demand for ethanol has been continuously increasing on account of the growth of user industries and use of ethanol as a fuel in the country. However, the production and availability of ethanol has largely lagged behind. India is the fourth largest producer of ethanol in the world after Brazil, the United States of America (USA) and China, producing approximately 3,120 million litre of ethanol per year (Anon., 2016).

In recent years, a new round of enthusiasm in biomass and bioenergy has been initiated with the recognition that the global crude oil reserve is finite, and its depletion is occurring much faster than previously predicted. In addition, the environmental deterioration resulting from the over-consumption of petroleum-derived products, especially the transportation fuels, is threatening the sustainability of human society and one of the greatest challenges for society in the 21st century is to meet the growing demand for energy for transportation, heating and industrial processes and to provide raw material for the industry in a sustainable way. The increased concern for the security of the oil supply and the negative impact of fossil fuels on the environment, particularly greenhouse gas emissions, has put pressure on society to find renewable fuel alternatives. Ethanol, both renewable and environmentally friendly, is believed to be one of the best alternatives, leading to a dramatic increase in its production capacity. The most common renewable fuel today is ethanol produced from sugar or grain (starch).

The Supreme Court of India informed the Government of India (GOI) to use Compressed Natural Gas (CNG) as an alternative to petrol and diesel for fuelling automobiles to reduce environmental pollution. The GOI has made it mandatory to blend petrol and diesel with alcohol (to reduce carbon monoxide emission in automobiles) initially up to 5% and gradually hiking it to 10% in the second phase. There are two objectives in this strategy, reducing both the environmental pollution and the fuel-import bill for the country. According to the Federation of Indian Chambers of Commerce and Industry (FICCI), India could save nearly 80 million L of petrol annually if petrol is blended with alcohol by 10%. Burning quality of alcohol-blended petrol is more eco-friendly than that of CNG. These environment and cost considerations have triggered a debate on the availability of adequate raw material to meet the possible increased demand for ethanol production. About 95 per cent of ethanol is produced by fermentation of carbohydrates derived from agricultural crops, the remainder is synthetic ethanol. Molasses (a by-product of sugarcane after the extraction of sugar), the traditional source of raw material for ethanol production, is unlikely to meet the actual demand in the long run. The crops like sugarcane, sugarbeet, sweet sorghum and sweet potato are helps in meeting out of the requirement of ethanol production. In this context, ethanol producing crops like sugarbeet, sweet sorghum and sweet potato can be grown profitably and intensify the production of ethanol.

Biofuel crops:

Sugarcane (*Saccharum officinarum* L.) is a most important cash crop of India. It involves less risk and farmers are assured up to some extent about return even in adverse condition. The juice Sugarcane per serving (28.35 grams) contain Energy-111.13 kJ (26.56 kcal), Carbohydrates-27.51 g, Protein-0.27 g, Calcium11.23 mg (1%), Iron 0.37 mg (3%), Potassium 41.96 mg (1%), Sodium 17.01 mg (1%)It is an important commercial crop gaining greater attention in the tropics for ethanol production as a bio fuel supplement apart from sugar and other uses. Sugar cane juice and sugar cane molasses are the substrates of choice for fuel ethanol because of its high sugar content and availability. It can produce about 6,500 liters of ethanol per ha.

Sugarbeet (*Beta vulgaris* L) is considered as the second most important sugar crop all over the world after sugar cane (*Saccharum officinarum* L.). Composition wise, a freshly harvested sugarbeet root contains 75-76 per cent water, 15-20 per cent sugars, 2.6 per cent non-sugars and 4-6 per cent the pulp. Processing one ton of fresh sugarbeet roots yields 121 kg sugar, 38 kg molasses (containing 18.2 kg sugar, 12.1 kg
impurities and 7.8 kg water) and 50 kg of pulp. The molasses available from beet sugar industry can be used in pharmaceutical industry for vitamin B-12, citric acid, yeast, antibiotics manufacturing and other products of fermentation industry and subsequently make value added products like sulphurless white crystal sugar and ethanol as a fuel. Ethanol is produced from impure sugary pulp (molasses) and it also fermented to beers. It can yield about 5000 - 6000 liters of ethanol per ha.

Sweet sorghum \( [Sorghum\ bicolor\ (L.)\ Moench] \) is a special purpose sorghum with a sugar-rich stalk, almost like sugarcane. Besides having rapid growth, high sugar accumulation, and biomass production potential, sweet sorghum has wider adaptability. It has a great potential for jaggery, syrup and most importantly fuel alcohol production (Ratnavathi et al. 2004). It can produce about 3000 liters of ethanol per ha.

Sweet potato \( (Ipomoea\ batatas\ L.) \) is an important biomass resource for fuel alcohol production, because of its chemical composition and high density of starch, compared to other forms of biomass, and thus it as an alternative bioresource for the production of ethanol through fermentation. The starch can be hydrolysed to monomer units of carbohydrates and can be used by the microorganisms in fermentation process. It has been considered a promising substrate for alcohol fermentation since it has a higher starch yield per unit land cultivated than grains.

Table 1: Ethanol Demand, Supply for Blending in Gasoline

<table>
<thead>
<tr>
<th>Year</th>
<th>Gasoline Demand (l)</th>
<th>Ethanol Demand (l)</th>
<th>Molasses Production (T)</th>
<th>Ethanol Production (T)</th>
<th>Utilization of Ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-02</td>
<td>10.07</td>
<td>416.14</td>
<td>8.77</td>
<td>1779</td>
<td>648</td>
</tr>
<tr>
<td>2002-03</td>
<td>15.07</td>
<td>591.72</td>
<td>11.24</td>
<td>2300</td>
<td>795</td>
</tr>
<tr>
<td>2011-12</td>
<td>12.05</td>
<td>756.35</td>
<td>11.24</td>
<td>2300</td>
<td>887</td>
</tr>
<tr>
<td>2016-17</td>
<td>16.4</td>
<td>965.30</td>
<td>11.24</td>
<td>2300</td>
<td>1023</td>
</tr>
</tbody>
</table>

References


25. AGRICULTURE (BIODIVERSITY CONSERVATION)

Trees are Our Treasure
Darthiya M and Mude Ashok Naik

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Introduction

Vegetation is very important for the existence of all living organisms. The above saying is evident from the ecological pyramid, where producers (plants/trees) form the base of the food chain. Since the beginning, trees have furnished us with two of life’s essentials, food and oxygen. As we evolved, they provided additional necessities such as shelter, medicine, and tools. Today, their value continues to increase and more benefits of trees are being discovered as their role expands to satisfy the needs created by our modern lifestyles. Hence we should treasure our trees. By saving plants, we are not doing any favor to plants but to ourselves only. Because trees and plants life does not depend on us but our lives depend on them.

Trees are our life saviours

Trees contribute to their environment by providing oxygen, improving air quality, climate amelioration, conserving water, preserving soil and supporting wildlife. According to the U.S. Department of Agriculture, “One acre of forest...
absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people.” Trees, shrubs and turf also filter air by removing dust and absorbing other pollutants like carbon monoxide, sulfur dioxide and nitrogen dioxide. After trees intercept unhealthy particles, rain washes them to the ground. Trees control climate by moderating the effects of the sun, rain and wind. Leaves absorb and filter the sun’s radiant energy, keeping things cool in summer. Trees also lower the air temperature and reduce the heat intensity of the greenhouse effect by maintaining low levels of carbon dioxide. Both above and below ground, trees are essential to the eco-systems in which they reside. Far reaching roots hold soil in place and fight erosion. Trees absorb and store rainwater which reduce runoff and sediment deposit after storms. This helps the ground water supply recharge, prevents the transport of chemicals into streams and prevents flooding. Fallen leaves make excellent compost that enriches soil. Thus, trees and forest makes the existence of biodiversity in the earth.

Existence of Biodiversity

Forest serves as habitat for many wild animals. Many animals, including elephants, koalas and giraffes monkeys, birds bats and many insects etc., entirely depends on the forest for their survival. According to the national cancer institute in US of 3000 plants identified as active against cancer cells, 70% grow in rainforests. Tropical rainforests are among the most biodiverse habitats in the world. Mangrove forests protest shorelines from damaging storm and hurricane winds, waves and floods. Mangroves also help in prevent erosion by stabilizing sediments with their tangled root systems. They maintain water quality and clarity, filtering pollutants and trapping sediments originating from land. In addition, mangroves act as a barrier against tsunamis and cyclones. Hence, forests are mandatory for the existence of biodiversity and life in the earth.

Deforestation and Locust swarm

Due to climate change, these migratory insects are causing unprecedented damage in several parts of India. As their name suggests, desert locusts normally live and breed in semi-arid/desert regions. For laying eggs, they require bare ground, which is rarely found in areas with dense vegetation. So, they are more likely to breed in Rajasthan than in the Indo-Gangetic plains or Godavari and Cauvery delta. Grasshoppers or hoppers are solitary creatures that don’t live in groups. But if driven by hunger, caused by drought or food scarcity, they start to gather together while foraging for food. As their population increases in an area, they start becoming “gregarious”.

Deforestation could modify the preferred migration pathways of the locust by opening new pathways related to the structure of the vegetation cover. Deforestation is one of the major causes of climate change. This climate change turns the humid regions as semi arid and semi arid as arid regions. It may also bring unseasonal heavy downpour. This unseasonal rainfall received in Rajasthan arid regions attracted the dessert locust. Therefore, to overcome climate change, global warming and these locust attacks deforestation should be stopped and Afforestation should be promoted.

Forest and Agriculture

There is a practice called shifting cultivation is being followed in the north east India. It is a practice of cultivation of crops in the forest vegetation after slash down and burn of forest trees of certain area. After the certain period, the area left fallow to regenerate itself. Thus the forest serves the subsistence of the tribal people from many centuries ago. But, this should not be encouraged as the population and demand of the food is growing. This can be altered with agroforestry or forest farming.

Agro forestry and Carbon sequestration

Agricultural systems, such as agroforestry, that combine trees with livestock and crops on the same area of land, are particularly popular in developing countries. We can plant grain and vegetable crops around trees that produce fruit, nuts and wood and the trees in turn produce shade for livestock that provide meat and milk. In addition to these economic benefits, agroforestry could also have a role in mitigating climate change. This is because it sequesters more atmospheric carbon in plants and soil than
conventional farming.

Conclusion

Trees are our treasure; as they are our life savours. We have to conserve our forest area to maintain the biodiversity of the ecosystem and to mitigate climate change and the alarming global warming. Actions should take to accomplish afforestation and restoration of forest area. Right to clean water and clean air is a birth right of any living being in the earth; which put forth deforestation as offensive crime to the society and that should be brought controlled without any excuses. Hence treasure our trees to save the lives on the earth.

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26. ENTOMOLOGY

Role of Forensic Entomology for Solving Crime Investigations

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Introduction

The field of forensic entomology is broadly defined as the study of the application of insects and their arthropods relatives in crime investigations. Insects or arthropods are found in a decomposing vertebrate corpse or carrion. These insect colonizers can be used to estimate the time of death i.e., time interval between death and corpse discovery, also called post mortem index (PMI), movement of the corpse, manner and cause of death and association of suspects at the death scene. The primary purpose of forensic entomology is to determine elapsed time since death.

Sub fields of forensic entomology:

Entomology is broken down into three different areas: 1. Medico legal forensic entomology 2. Stored-product forensic entomology 3. Urban forensic entomology.

- Medico legal forensic entomology - The medico legal area focuses on the criminal component in regards to the insects that feed on and are found on human remains. These insects are referred to as carrion. This area covers evidences of rape, suicide.

- Stored-product forensic entomology – Stored product forensic entomology is often used in litigation over insect infestation or contamination of commercially distributed food.

- Urban forensic entomology - The urban area of forensic entomology has components of both civil and legal crimes. The insects looked at in this area feed on both the living and the dead.

Methods to determine elapsed time -

There are two main ways of using insects to determine elapsed time: The first method issued when the corpse has been dead for a month up to a year or more, and the second method is used when death occurred less than a month prior to discovery.

- First method: It is based on the fact that a human body, or any kind of carrion, supports a very rapidly changing ecosystem going from the fresh state to dry bones in a matter of weeks or months depending on geographic region. During this decomposition, the remains
go through rapid physical, biological and chemical changes, and different stages of the decomposition are attractive to different species of insects. Certain species of insects are often the first witness to a crime. They usually arrive within 24 hours of death if the season is suitable and can arrive within minutes in the presence of blood or other body fluids. These first groups of insects are the calliphoridae or blowflies and the sarcophagidae (the flesh flies). Other species are not interested in the corpse when the body is fresh, but are only attracted to the crops later such as the piophilidae or cheese skipper which arrive later, during protein fermentation. Some insects are not attracted by the body directly, but arrive to feed on the other insects at the scene. Many species are involved at each decomposition stage and each group of insects overlaps the once adjacent to it somewhat. Knowledge of insect succession, together with regional, seasonal, habitat and meteorological variations, is required for this method to be successful.

- **Second method** - The second method, that of using maggot age and development can give a date of death accurate to a day or less, or a range of days, and is used in the first few weeks after death. Maggots are larvae or immature stages of diptera. The insects used in the method are those that arrive first on the corpse that is the calliphoridae or blowflies. Those flies are attracted to a corpse very soon after death. They lay their eggs on the corpse, usually in a wood, if present, or if not, then in any of the natural orifices. Their development follows a set, predictable, cycle. The insect egg is laid in batches on the corpse and hatches into a first instar. The larva feeds on the dead body and moult into a second and third instar. The third instar can be determined by size. When in the third instar, the larvae continues to feed for a while then it stops feeding and wanders away from the corpse, either into the clothes or the soil, to find a place to pupate. The larvae then looseness itself from its outer skin, but remains inside. After a number of days an adult fly will emerge from the pupa and the cycle will begin again.

An analysis of the oldest stage of insect on the corpse and the temperature of the region in which the body was discovered leads to a day or range of days in which the first insects oviposited, this in turn to occurrence of death. This method can be used until the first adults begin to emerge, after it is not possible to determine which generation is present. Therefore, after completion of single generation, the time of death is determined using the first method.

**Factors influencing decomposition rate**

- **Time of year** - High temperatures increase decomposition rate.
- **Condition of the body** - Open wound and/or minimal burning increase decomposition rate.
- **Buried/exposed** - Exposed corpses decompose faster than buried corpses (or corpses found indoor).
- **Clothed/unclothed** - Unclothed corpses decompose faster than clothed.
- **Chemical exposures (e.g., narcotics, lime, pesticides)** - Decomposition is generally slowed by chemicals; however, some chemicals may increase decomposition rate.

**Conclusion**

Forensic entomology is an emerging field in forensic sciences, where the insects feeding on corpses are studied. It has become an important tool in criminal investigations. In the present scenario, the role of forensic odontologists is not confined to hard tissues examination alone. Increased instances of forensic odontologists being involved in criminal investigations, as part of the forensic team, have necessitated the need for an increase in awareness of emerging sciences like forensic entomology and its applications in forensics.
References

27. SYNTHETIC BIOLOGY

The Future of Creation
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Synthetic biology is the advanced biological technologies used for creating new biological pathways, parts, or entities. Emerging field of synthetic biology offers new promises for addressing the challenges rose in the field of food security without affecting the quality of the food. The definition of synthetic biology is yet to reach a consensus within the community. This field is still in its infancy within the plant community but recent proof of concept studies has proven that the delivery of synthetic genetic circuits is possible in plants, offering the opportunity of greatly accelerating crop improvement (Arkin et al., 2017). Synthetic biology will enable the design of biological systems in a rational and systematic way. Taking into an extreme, we can say, that only projects that involve the use of standardized parts (genes, proteins, circuits) could be considered proper Synthetic Biology projects. In an ideal world, designing living systems for a practical purpose should be like redesigning a car to make it more efficient, or redesigning a computer with a faster processor. One would have the parts, the right software, the brains, and the knowledge about the target system. Synthetic biology incorporates the techniques of molecular biology, but it is extremely different from recombinant DNA technology in that synthetic biology introduces synthetically constructed parts and is not limited to the modification of natural organisms.

Synthetic biology in plants
Plant synthetic biology aims at applying engineering principles to the design and alteration of plant systems as well as to the de novo construction of artificial biological pathways whose behavior in plants can be predicted, controlled, and, ultimately, programmed (Glass and Alon, 2018). Since yield, nutritional values and other characteristics in plant system completely depends upon the metabolic pathways, in silico design, testing and validation of this metabolic pathway provide a roadmap for rational manipulation of the important plant traits. Also understanding of plant metabolic pathways is required for the construction of synthetic metabolic pathways.

A succinct view of models of plant metabolic pathways can provide the understanding of key components and phenotypes affecting the important traits such as nutritional value, yield, and biochemical reaction rates. Then by using a systematic review of computational approaches synthetic in silico metabolic pathways can be designed in both plants and organisms (Kuken and Nikoloski, 2019). Many of these approaches are based on advances that synthetic biology has achieved in microbial systems (Liu and Stewart, 2015). While the same concepts and design principles are readily applicable to plants, the transfer between species faces challenges due to the increase in complexity and diversity of plant cell types, tissues, and organs (Cook et al., 2014).

Applications of synthetic biology
Environment sector: The ‘sentinel’ plant containing the complete synthetic pathway isolated from a bacterium acts as a biosensor that de-colors when it detects a specific molecule such as trinitrotoluene (TNT) (Antunes et al., 2011).

Health sector: Production of antimalarial drug artemisinin (Paddon et al., 2014) through synthetically engineered strain of yeast. Demonstrated the complete biosynthetic
pathway including the discovery of a plant dehydrogenase and a second cytochrome that provide an efficient biosynthetic route to artemisinic acid and produced fermentation titres of 25 grams per litre of artemisinic acid.

Energy production: The introduction of monolignol ferulate transferase (MTF) into transgenic poplar plants increased the monolignol ferulate conjugates and biomass produced was more susceptible to hydrolysis (Wilkerson et al., 2014).

Biobased machineries and chemicals:A synthetic abscisic acid receptor was recently engineered in Arabidopsis thaliana to recognize a pesticide called mandipropamid (Parker et al., 2015).

Fabricate materials and structures:Re-engineered the Type III secretion system of Salmonella typhimurium to secrete spider silk protein (Notti et al., 2016).

Natural substitutes: Synthetic production of rubber through isoprene – a crucial building block for making artificial rubber. The gene encoding isoprene has been synthetically engineered into E. coli to produce isoprene. (Yeom et al., 2018).

References

28. PLANT BREEDING AND GENETICS

Accelerating Crop Research through Speed Breeding
Sonu get
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Introduction
Many traditional breeding methods (pure line, lineage, bulk, backcross etc.) have been developed and used in crops. These methods take farmers 10 to 15 years to access the seeds of new varieties for commercial cultivation, which affect the parameters of the developed varieties due to changes in specific environmental conditions over time. To address this bottleneck in the growing concern for varieties development and global food security, a new breeding tool known as Speed Breeding (SB)...
is expected to speed up research and breeding programs for grain crops. SB is a pioneering new technology set to accelerate the global search for crop improvement in a development that echoes the Green Revolution of the post-war period and offers potential new solutions to the global challenge for the 21st century. Speed breeding is inspired by NASA’s experiment, in which wheat plants were grown using continuous light in an enclosed chamber in space, accelerating the early reproduction of wheat (Wheeler et al. 1996). The original approach was first described and implemented for wheat (Hickey et al. 2009) and peanut (O Connormet et al. 2013). Speed breeding suppressed “shuttle breeding”, which allowed only two generations of planting annually (Krishnanandaeta et al. 2019). In 2018, Australian plant scientist Dr. Lee Hickey and a PhD student Amy Watson, University of Queensland first published their work on wheat at the Nature plants, based on this NASA-inspired technology, and concluded that the breeders have grown six generations of wheat, chiku and barley plants in one year and four generations of canola plants can grow in a modified glasshouse, as opposed to two or three generations in a regular glasshouse and a single generation in the field (Watson et al. 2018). Using Glasshouse and Growth Chamber, Drs. Lee Hickey and co-workers developed Australia’s first high-protein milling wheat variety through rapid crossing and inbreeding, named DS Faraday, tolerant to pre-harvest germination (John Innes Centre, 2018). Speed breeding shortens the breeding cycle and accelerates crop research through rapid generation advancement and allows researchers and plant breeders to make fast genetic improvements such as yield gain, disease resistance and climate resilience in a range of crops such as wheat, barley, oilseed and pea. Variation of SB has been demonstrated to be an efficient system for rapid screening of wheat germplasm for adult plant resistance to various diseases (Hickey et al. 2012; Dinglasanet et al. 2016; Riazet al. 2016; Alahmadet al. 2018) and also for pyramiding multiple disease resistance in barley (Hickey et al. 2017). Speed Breeding can be carried out in numerous ways, which involves photoperiod adjustment by extending the duration of plants’ daily exposure to light, combined with early harvesting of completely viable seeds, to cycle quickly from seed to seed, thereby reducing the generation times for some long-day or day-neutral crops (Wada & Takeno, 2010). SB involves the use of 22-hour complementary lighting using LEDs for photosynthesis in a glasshouse environment, which allows for rapid generation cycling through single seed lineages (SSDs) with higher plant densities for large crop improvement program (Watson et al. 2018). In India, alternative approaches have to be followed to speed up the breeding cycles in photoperiod sensitive crops. The ICAR-Indian Institute of Soybean Research, Indore is extensively taking up off-season (January–April) generation advancement of segregating material at the University of Agricultural Sciences, Bengaluru. This significantly helps in reducing the duration of the varietal development program. In addition, ICAR-IISR has greenhouse and polyhouse facility, which is being used for advancement of F2 and important individual plant selections during off-season i.e. November–February (Shivakumaret al. 2018).

Core ‘recipe’ to set up existing growth chamber for Speed Breeding

This article describes the Speed Breeding protocol proposed by Watson et al. 2018, how to implement SB in existing growth chambers and in temperature-controlled glasshouses using supplementary LED lighting, which provides significant cost savings.

**Lights:** Any light that produces a spectrum that reasonably covers the PAR region (400–700 nm), with particular focus on the blue, red and far-red ranges, is suitable to use for SB. An appropriate spectral range can be achieved through LEDs, or a combination of LEDs and other lighting sources (e.g., halogen lamps), or in the case of a glasshouse, by simply supplementing the ambient lighting with LEDs or SVLs.

**Photoperiod:** Researchers recommended a photoperiod of 22 h with 2 h of darkness in a 24-h diurnal cycle. A photoperiod of 18 h was found sufficient to achieve fast generation times for wheat, barley, oat and triticale.

**Temperature:** The optimal temperature...
regime (maximum and minimum temperature) for each crop must be predetermined. A higher temperature should be maintained during the photoperiod, whereas a fall in temperature during the dark period can aid in stress recovery. A 12-h 22 °C/17 °C temperature cycling regime with 2 h of darkness occurring within 12 h of 17 °C has proven successful. By contrast, a temperature cycling regime of 22 °C/17 °C for 22 h of light and 2 h of dark, respectively, is used (SB I). In both cases, the generation times of all crops were successfully accelerated and comparable.

**Humidity:** A reasonable range 60–70% of humidity is ideal. For crops that are more adapted to drier conditions, a lower humidity level may be advisable.

**Experimental design**
To set up an effective SB system, certain factors require careful consideration. These include the following:

**Germplasm**
Not all plant species (or indeed cultivated within a species) are responsible for extended photoperiod. Care must therefore be taken in the selection of germplasm occurring under SB, and appropriate modifications should be applied to ensure optimal conditions for each species.

**End-use requirements**
The intended end-use plant may affect all aspects of the initial setup of the SB approach, such as glasshouse space and sowing density. For example, within the SSD program, a large number of plants are grown within a defined location, so a suitable sowing density must be determined.

**Nutrients**
The nutritional requirement of plants depends on the size of the pot and the type of soil. In small pots (~100 mL), a single or fortnightly application of a liquid nutrient feed should be considered to prevent the plant leaves from turning yellow prematurely. Appropriate slow-release fertilizer within the soil media is recommended for growth to maturity, and maintenance of soil pH is important to avoid restriction of nutrient absorption.

**Preparation of seed for sowing**
To increase germination efficiency, some seeds may need a pretreatment either by cold stratification or scarification.

1. **Germination with pretreatment to break seed dormancy:** The requirements for germination pretreatments are specific to each species, and accessions of that species, and should be determined on an individual basis.
   a. Place dormant seed on moistened filter paper in a Petri dish to imbibe for 24 h and then chill at 4 °C for ~3 d (longer times may be required, depending on the level of dormancy) in the dark.
   b. Leave the seeds at room temperature (~20–25 °C) for 1–3 d to germinate in the dark before transferring to soil.
   c. Grow the plants under the desired SB conditions.

2. **Germination without pretreatment to break seed dormancy**
   a. If pretreatment is not required, germinate the seed in a Petri dish on moistened filter paper in the dark before transferring to soil. If seeds germinate in a Petri dish and become too well established (i.e., develop green leaves) before transplanting to soil, the shift to SB conditions, especially the presence of intense light, can shock the plants, resulting in a strong hypersensitive response and possibly death.
   b. Grow the plants under the desired SB conditions.

**Harvesting of the seed**
Timing of harvesting depends on crop, cultivar/genotype and SB setup used. Shortened generation times can also be achieved in some species by harvesting premature seed. To do this, one should first wait until the seeds have set in the plant (indicated by filled seed in spikes for wheat, or filled pods for legumes). After this has occurred, either increase the temperature or withhold water from the plant to hasten seed ripening and drying. After a week of this stress application, harvest the seeds.

**Speed breeding in single-seed descent programs**
In breeding programs, SSD is often an
important step in cultivar development that requires high-density plantings. The SB approach provided for glasshouses is ideal for SSD programs, particularly cereal crops. Increasing sowing density under SB can enable rapid cycling of many lines with healthy plants and viable seed. At higher densities, plant height and seed numbers can be reduced, owing to the greater competition and low soil volume. Researchers' results demonstrated that plants can be grown at high densities under SB conditions to produce plants suitable for effective and resource-efficient generation turnover in SSD programs.

**Future prospective**

Scientists envisage great potential for integrating speed breeding with other modern crop breeding technologies, including high-throughput genotyping, genome editing and genomic selection, accelerating the rate of crop improvement. "Speed breeding allows researchers to rapidly mobilize the genetic variation found in wild relatives of crops and introduces it into elite varieties that can be grown by farmers. Currently experiencing one of the worst droughts on record are using the technology to rapidly cycle genetic improvements to make crops more drought resilient.

**References**

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**29. AGRICULTURAL ENTOMOLOGY**

**Evolution of Sexual Dimorphism in the Lepidoptera**

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Introduction

Lepidoptera is an order of insects that includes butterflies and moths. It is one of the most widespread and widely recognizable insect orders in the world. Recent estimates suggest the order may have more species than earlier thought and is among the four most speciose orders, along with the Hymenoptera, Diptera and Coleoptera (Capinera and John, 2008). The Lepidoptera show many variations of the basic body structure that have evolved to gain advantages in lifestyle and distributions such as polymorphism, polyphenism, sexual dimorphism etc. Sexual dimorphism is the differences in behavioural, morphological, physiological and life-history traits between males and females. It is a form of intra specific variation. The evolution of extravagant sexual ornamentation has intrigued biologists since at least Darwin (1874) and continues to pose considerable empirical and theoretical challenges. Colour-based mate choice in butterflies has been most frequently investigated from the perspectives of reproductive isolation and the mechanisms underlying speciation. Sexually dimorphic traits can have a mix of sexual and nonsexual functions or function exclusively in non-reproductive contexts.

Evolution of sexual dimorphism:
The selective forces driving the evolution of sexual dimorphism have been subject to intense and ongoing debate. However, Darwin and Wallace discussed that sexual and natural selection were important in the evolution of sex differences. They eventually advocated different positions; Darwin arguing for sex-specific sexual selection (female choice of bright male coloration) and Wallace for sex specific natural selection (intense predation on females favouring cryptic or mimetic coloration). Despite the fact that the two hypotheses are not necessarily exclusive, research has generally focused on sexual selection as the primary cause of dimorphisms. Natural Selection is the process whereby organisms better adapted to their environment tend to survive and produce more offspring. Natural selection is the differential survival and reproduction of individuals due to differences in phenotype. It is a key mechanism of evolution. Sexual selection is a mode of natural selection in which members of one biological sex choose mates of the other sex to mate with (intersexual selection) and compete with members of the same sex for access to members of the opposite sex (intrasexual selection). The evolution of sexual dimorphism likely involves complex interactions between sexual and natural selection.

Causes for evolution: The major causes for the evolution of sexual dimorphism are followed.

Polyandry: Polyandry is a class of mating system where one female mates with several males in a breeding season. The majority of female butterflies and moths mate multiply, although populations may contain a mix of monandrous and polyandrous individuals (Wedell, 2005).

Monandry: A mating pattern in which a female mate with only one male in a single breeding season.

Male courtship: Males frequently engage in courtship displays prior to mating. In both butterflies and moths, for example, males court females prior to mating by releasing pheromones that function as aphrodisiacs to stimulate copulation.

Anti-aphrodisiacs: Male butterflies and moths also transfer chemical compounds or anti-aphrodisiacs to females at mating that reduce their attractiveness.

Mating plugs: Males of many species transfer substances at copulation that harden to form amating plug. Mating plugs are also formed in the Lepidoptera by substances from the males’ accessory glands and can be remarkably large and elaborate. They seem to function as a means to reduce likelihood of female remating.

Fecundity selection: Under polyandry, males are selected to compete effectively in sperm competition. Theory predicts that production of large number of sperm is advantageous in sperm competition. This is supported by comparative studies, with the males of more polyandrous species having relatively larger testes, producing larger ejaculates and more sperm. Male butterflies transfer a spermatophore at mating which contains both sperm for fertilization and accessory substances. In addition to the nucleated fertile ‘eupyrene’
sperm, males allocate resources to the production of vast numbers of non-fertile, anucleate, 'apyrene' sperm. In some species, the accessory substances contain nutrients which are incorporated into female's eggs before fertilization resulting in increased female fecundity and may therefore act as parental investment.

Effects of sexual dimorphism

1. **Sexual dimorphism in life history traits:** Typical life-history traits are age and size at hatching, size and number of offspring and reproductive life span. Although life history traits together are expected to evolve to an optimal life-history configuration in a given environment, individual life-history traits may not be maximized in the direction of increased fitness because of trade-offs between traits closely related to fitness. The evolution of reproductive division of labour (i.e., separate sexes) and subsequent natural selection toward sex-specific reproductive optima can readily lead to the evolution of sexually dimorphic life histories visible at the behavioural, morphological and physiological levels. Sexual selection can also shape the evolution of life history traits when the reproductive potential of males and females differs. The life history traits influenced by sexual dimorphism are sexual size dimorphism (SSD) which defined as the inequality in the body sizes of males and females. SSD has been typically ascribed to sexual differences in the selection pressure on body size. There are two types in sexual size dimorphism i.e. female biased and male biased sexual size dimorphism. Another one is protandry, which is the tendency for males to emerge before females and it is common in insects with discrete, non-overlapping generations in which females’ mate only once. Selective pressures for gaining access to sexually receptive females before other males has driven the evolution of a wide range of mate-searching and mating behaviours in animals. One remarkable effect of such pressures is the ability of males to locate and establish permanent associations with sexually immature females. Variations of such behaviour have evolved several times across vertebrate and invertebrate taxa and have been studied under names like 'pre-copulatory mate guarding' in aquatic crustaceans, salmon, frogs and ants, pupal attendance in mosquitoes, cohabitation of males and juvenile females in spiders and 'pupal mating' in butterflies.

2. **Sexual dimorphism in physiology:** Many organisms encounter periods of starvation in their life and most organisms have evolved some form of adaptive physiology to cope with them. In times of food abundance, the excess of energy is typically stored as lipids that can then be used as resources in less affluent periods. Starvation resistance that enables survival under prolonged conditions of no food is an extreme form of adaptive physiology that occurs in some species. It has often been suggested that the mechanisms that induce survival under starvation also underlie the regulation of longevity. In a range of well-studied animal species long-lived individuals appear to be more resistant to multiple stresses often including starvation.

3. **Sexual dimorphism in morphological traits:** Sexual dimorphism occurs in a wide variety of morphological traits including, wing size and shape, size and colour of pigment patches and UV-reflective regions on the wings, body size and body composition (e.g. relative thorax or abdomen size), colour and density of body hairs, size and shape of sensory structures such as eyes, auditory organs and antennae, structures associated with production and release of chemical attractants and size and shape of genitalia. A good example is Bag worm, *Metisa plana* (Rhainset al., 2009). In the male, wing discs proliferate rapidly in the penultimate larval instar and continue to proliferate. In the female in contrast the wing discs remain as in the previous (seventh) instar, without proliferation of cells inside.

4. **Sexual dimorphism in behaviour:** The behaviours which are influenced by sexual dimorphism are sex pheromone and sexually dimorphic mimicry system. Like visual and acoustic signals, lepidopteran sex
pheromones have several potential functions to prevent heterospecific mating by signalling species identity, to directly influence mate choice by acting as honest signals of mate quality, to mediate receptivity or acceptance of courtship and to influence intrasexual competition by signalling competitor presence or competitive ability. Complex interactions can occur between these differing modes of communication and as a result there can be complex interactions between sexual and natural selection acting on chemical signals and their related morphological structures.

5. **Sexually dimorphic mimicry system:** Although mimicry is widespread among insects, sex-limited mimicry is especially prevalent in the Lepidoptera. Two key features of sex-limited mimicry are relevant to discussion of the selective forces that generate sexual dimorphism. Sex-limited mimicry in the Lepidoptera is associated primarily with Batesian mimicry systems. Palatable mimics benefit when their population size is low relative to the distasteful model species (strong, negative frequency-dependent selection). Female-limited mimicry occurs in butterflies, in which both sexes are active in daylight whereas male-limited mimicry occurs only in moths and only in species in which the male is active in daylight and the female is active at night.

**Conclusions**

The lepidopterans have long been central to discussions about the ultimate causes of sexual dimorphism, it can be concluded that sexual selection generates the driving force for the evolution of dimorphism and natural selection limits or enhances the degree of difference between the sexes.

**References**


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**30. HORTICULTURE**

**Phalsa – A Nutritive Fruit of India**

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Phalsa, scientifically called as *Grewia asiatica* L., a small woody perennial tree native to India, belongs to the family Tiliaceae. It is an arid zone fruit. It is a having drooping branches. Leaves are alternate, deciduous, heart-shaped with cyme flowers in its axils. The round fruits, on peduncles are produced in great numbers in open, branched clusters. The hairy skin turns from green to nearly black after ripening. Pulp is soft, fibrous, purplish-red at ripening. The flavor is pleasantly acid, somewhat grape-like. Large fruits have 2 hemispherical, hard, buff-colored seeds. Small fruits are single-seeded. The cultivation of phalsa is limited to very small scale in Punjab, Haryana, Rajasthan, Gujarat and Uttar Pradesh.

**Nutritional and Medicinal Importance**

The fruits are potential sources of vitamins and mineral. The citric acid predominant acid present in the phalsa fruit along with traces amount of malic acid. It contains high amount of vitamin A and high antioxidant value. The phalsa fruits are rich sources of flavonoids, carotenoids and anthocyanins. The phalsa fruits are potential sources of potassium which plays crucial important role in energy metabolism and normalizing blood pressure. Fruits are a potential source of nutrients such as proteins, amino acids, vitamins, and minerals and contain various bioactive compounds like anthocyanins, tannins, phenolics and flavonoids. Phalsa fruits are good source of Vitamin A (410mmicro gram/100gram)
and Vitamin C (22mg/100g).

**Uses**

The fruits are eaten fresh as dessert, are made into syrup and extensively employed in the manufacture of soft drinks. The fruit is astringent and stomachic. When unripe, it alleviates inflammation and is administered in respiratory, cardiac and blood disorders, as well as in fever. The root bark is used in rheumatism. The ether extract of phalsa leaves has antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*.

**Varieties**

Thar Pragati is a variety released from ICAR-Central Institute of Arid Horticulture, Bikaner. This variety has spreading growth habit, thick stem, dense foliage and drooping branches. Fruit ripens in 60 days from fruit set. It is dwarf, early precocious bearer (bearing in 3rd year), drought tolerant and suitable for high density planting. It is suitable for table and processing purpose.

Sharbati is a variety being cultivated. At Haryana Agricultural University two distinct typesviz., Tall and dwarf have been recognized.

**Climate and soil requirements**

It can be grown in a tropical and sub-tropical climate. It can tolerate high temperature up to 40°C. It also tolerates drought and therefore well suited for arid climate and waste lands. Under sub tropical climate, it behaves as a deciduous plant. Though it can grow on a wide range soils, a well drained deep soil will be the best suited. It can tolerate moderate alkalinity (pH 8.5) and salinity up to 6 m. mhos/cm.

**Propagation**

It is propagated by seed vegetative methods like cutting, layering and budding. Planting is done in pits of size 60 x 60 x 60 cm spaced at 2.5 to 3.0 M either way accommodating 1100-1500 plants/ha. The pits are manured with 15 kg of FYM and filled with top soil. Then the seedlings of layers or budded plants are planted. Seeds are the usual means of propagation and they germinate in 15 days. Seedlings are transplanted when a year old. Fruiting will commence in 13 to 15 months after planting.

**Manures and manuring**

10-15 Kg of FYM, a quantity of 250 g of N, 100 g of P2O5; 50 g and 100 g of K applied to each plant. Application of 0.4% ZnSO4 and 0.4% FeSO4 at pre bloom stage and berry set will improve the juice content. Sprays of 10 ppm gibberellic acid have increased fruit-set. At 40 ppm, there is increased fruit size but decreased fruit-set.

**Irrigation**

Though it is a drought resistant crop, irrigation once in 15-20 days will help to increase the yield as well as juice content.

**Intercultural operation**

Annual pruning to a height of 75 to 120 cm from ground level encourages new shoots and better yields than more drastic trimming. The plants are pruned during December to January.

**Plant protection**

**Pest:** Bark eating caterpillar can be controlled by injecting kerosene oil 0.05% in the holes and plugging them during December – January after pruning. Leaf eating caterpillars can be controlled by spraying 0.2% carbaryl.

**Disease:** Cercospora leaf spot and alternaria leaf spot can be controlled by spraying 0.2% dithane Z 78. Rust (brown pustules) on leaves can be controlled by 0.2 % dithane M-45.

**Harvest and Yield:** Phalsa starts yielding from second year of planting. Economic yield can be obtained from 5th year. Fully ripe dark red fruits have to be harvested in several pickings from April to June. Yield 5-6 Kg/tree/year. The fruits keeping quality is poorly and must be marketed within 24 hours.

**Reference**


http://agritech.tnau.ac.in/horticulture/hortifruits.html
31. SOIL SCIENCE

Impact of Agrochemicals Used on Soil Quality
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Introduction
According to the (USDA) Natural Resource Conservation Service, “Soil quality is how well soil does what we want it to do”. Soil fertility is only one component of soil quality. Fertile soils are able to provide the nutrients required for plant growth. These are the chemical components of soil. Soil contamination or soil pollution is caused by the presence of man-made chemicals or other alterations in the natural soil environment. Agricultural chemicals, industrial activity or improper disposal of wastes typically causes it. Agrochemicals are used in agricultural setting in an effort to ensure an abundant food supply. Many important benefits are achieved by the use of agrochemicals. These are largely associated with increased yields of plant and animal crops, and less spoilage during storage. These benefits are substantial. In combination with genetically improved varieties of crop species, agrochemicals have made important contributions to the successes of the “green revolution.” This has helped to increase the food supply for the rapidly increasing population of humans on Earth. However, the use of certain agrochemicals has also been associated with some important environmental and ecological damages. Extensive application of external agricultural inputs to agricultural production systems leads to soil quality degradation. Organic (carbon-based) pollutants that impact soil quality include pesticides. Pesticides, which are very persistent in soil, slowly break down and result in source of contamination. (Stephenson and Solomon, 1993). Soil acts as filter, buffer and degradation potentials with respect to storage of pollutant with the help of soil organic carbon (Burauel and Bassmann, 2005), but it is recognized that the soil is a potential pathway of pesticide transport to contaminate water, air, plants, food and ultimately to human via, runoff and sub-surface drainage; interflow and leaching; and the transfer of mineral nutrients and pesticides from soil into the plants and animals that constitute the human food chain (Abrahams, 2002). The capacity of the soil to filter, buffer, degrade, immobilize, and detoxify pesticides is a function or quality of the soil. Soil quality also encompasses the impacts that soil use and management can have on water and air quality, and on human and animal health.

Inappropriate use of chemical fertilizers and pesticides, amongst common farming practices, can contribute significantly to the soil degradation process. There is evidence that prolonged use of heavy doses of fertilizers can result in soils becoming more acidic than has serious implications in terms of long term productivity of soils. Inappropriate, viz. imbalanced or excessive, use of fertilizers is a major cause of pollution of ground waters or surface water bodies resulting from inefficient use of applied nutrients.

Soil quality indicators
1. Physical indicator: Bulk density, water retention and transfer parameters and structural stability are Basic physical soil characteristics. Soil bulk density (and porosity) varies according to soil texture, structure, and organic matter content, but within a given soil type, it can be used to monitor degree of soil compaction and puddling. Changes in bulk density affect other properties and processes that influence water and oxygen supply (Schoenholtz et al., 2000). Water soil and transfer parameters are universally important for monitoring all soil functions. Available water holding capacity and saturated hydraulic conductivity are the two most frequently found in minimum data set (MDS) of physical soil quality indicators. Available water holding capacity measures the relative capacity of a soil to supply water and saturated hydraulic conductivity...
conductivity is both an indicator of drainage rate and water/air balance in soil.

2. Chemical indicators: Among chemical indicators for soil quality, soil reaction (pH) is obviously important in the case of liming. This basic factor is known to influence nutrient availability and microbiological activity. Soil organic matter (SOM) is one of the most important parameter of soil quality for both scientists and farmers. Soil organic matter is a nutrient sink and source, enhances soil physical and chemical properties, and promotes biological activity.

3. Microbiological indicators: Soil organic matter (SOM) levels may vary within years, whilst active SOM-fractions like Macro- and light fraction-organic matter, soil microbial biomass and microbial functions may change within shorter periods of time. Soil microorganisms have been shown to be potentially useful (early and sensitive) indicators of soil health, because they respond to soil management in time scales (month/years) that are relevant to land management. They have an important role in soil fertility (especially) decomposition of organic matter and recycling nutrients for plants) and decontamination of soils, especially degradation or bioaccumulation of toxic residues. They also form symbiotic associations with roots, facilitating nitrogen fixation or phosphate uptake.

References

32. SOIL SCIENCE

Pusa Hydrogel; Boon for Farmers
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Introduction
Of the total cultivation in India, 60 percent is cultivated in an area where there is a scarcity of water. 30 percent of these places do not receive adequate rainfall. Farming in India is mainly rain dependent. 60 percent of the agriculture in the country is dependent on rain water and the annual rainfall in these areas is less than 1500 millimeters. There are strong signs of water scarcity in India.

The drought in many states of the country completely destroyed farming. Drinking water crisis was also seen in many places. Drought also led to migration from rural areas.

Overall, the situation has become such, which indicates that in the coming times the watery and macabre will take shape. Apart from drinking water for the country's growing population, water will be needed for farming in large quantities. In such a situation, there is a dire need for better management of water so that future water crisis can be countered.

India is an agricultural country and its economy is based on agriculture, so a method has to be used in irrigation so that water can be used optimally. Better use of water in agriculture is being done here because 85 percent of the water consumed in India is used in agriculture. 15 percent water is being used in the industrial sector and 5 percent in domestic areas, but as the population of the country is increasing and factories are opening day by day, it will increase the domestic and industrial consumption of water in the coming time, which will result it will turn out that there will be scarcity of water for
farming. If agriculture is to be saved in this situation, then alternatives have to be considered in which there is no waste of water in irrigation and hydrogel can play an important role in the whole exercise.

Recently, agricultural scientists have conducted a research which has shown that rain water can be stored with the help of hydrogels and can be used when crops need water.

**What is Hydrogel?**

Hydrogel is a polymer that has great ability to absorb water and does not dissolve in water. Hydrogel is also biodegradable due to which there is no risk of pollution. Hydrogel is generic term referring to hydrophilic polymers used in oil recovery, medical grafting supplements, clarification of potable and waters, dewatering sludge, mining separations, food processing, personal care products, laboratory supplies, etc. “hydrogel is a semi-synthetic, cross linked, derivatized cellulose-graft-anionic polyacrylate superabsorbent” it was designed specifically to perform in tropical and subtropical conditions of the country.

**Characteristics of hydrogel**

- Employs cellulosic (a natural polymer) backbone
- Contains no detectable level of the toxic monomer (acrylamide)
- Exhibited absorbency at height temperatures (40°C -50°C), suitable for semi-arid and arid regions
- Absorbs a minimum of 350 times of its dry weight in pure water and gradually releases
- Low rate of application (1.5 kg/acre)
- Effective in soil for at least crop season
- Less affected by the presence of salts in its immediate environment
- Improves physical properties of soil and soil less media
- Improves seed germination and the rate of seedling emergence
- Improves root growth and density
- Helps plants withstand extended moisture stress
- Reduces nursery establishment period
- Reduces irrigation and fertigation requirements of crops
- Delays onset of permanent wilting point

**How hydrogel works in the field**

The hydrogel particles absorb the water that goes into the field when it rains or during irrigation, and when there is no rain, the water automatically leaks out from the particle, which gives water to the crops. Then if it rains, the hydrogel absorbs the water again and then it starts leaking from it as per the need. According to the paper, once the hydrogel is used in the fields, it works for 2 to 5 years and is destroyed only after that. But the destruction does not have any negative impact on the fertility of the fields; instead giving water from time to time only benefits the crops and fields.

**Application method**

The method of pouring is to broadcast hydrogel by mixing 1 kg of Hydrogel and 2 kg of soil and either placing it in the root of the plant or placing it in the root of the plant as the farmer feels comfortable. Key approaches include the distribution of an admixture of hydrogel and soil in the furrows at the time of sowing, root dipping, nursery application, etc.

**Where to get**

Farmers who want to get this hydrogel can directly contact the KVK or ICAR. The initial cost of the hydrogel the range of Rs 1000-1400/kg.

**Conclusion**

A very low rate of application, ranging from 1to 2 kg per acre is effective in most of the crops. Lesser effect of fertilizer and salt solution on the swelling ratio of hydrogel compared to commercial products. It’s improved significantly in yield and water use efficiency in most of the crops.
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