Contents

1. Natural Enemies of Fall Armyworm in India
   Repalle Naganna ........................................ 4

2. Importance of Insect Ecology in Integrated Pest Management
   Krishnappa Biradarpaitil and Basavaraj Patil ................ 6

3. Fertilizer Related Problems
   P. Ramamoorthy and S. Thirumeninathan ..................... 8

4. Behoofful Action of Adventitious Roots
   S. Saphagiri, P. Kunjamalalan and G. Srinivasan ........ 10

5. Bionomics, Biology and Management of Storage Pests of Bruchidae
   Yogapriya A ............................................. 12

   Sawant Sanket R, Anjali Sudhakar and Abhinav Dubey .... 15

7. Present Scenario of Bee Keeping in India
   Gaurang Chhangani, Anil Vyas and M.K.Mahla ............ 17

8. Yield Estimation
   Priyanka Swamy ......................................... 19

9. Pre-Breeding in Rice
   S. Anandhi Lavanya and N.Vairam .......................... 22

10. Ultrasound and its Applications to Food Processing
    Kautkar, Rehana, Patil and Satankar ...................... 24

11. Speed Breeding: To Feed the Boosting Populations of the World
    Akash Gaurav Singh ..................................... 26

12. Fascinating Facts about Fireflies
    Niranjana devi J ........................................ 28

13. Do Insects Sleep?
    Niranjana devi J ........................................ 31

    Kishor Prabhakar Panzade ................................ 33

15. Why Bt Brinjals Needed for the Indian Farmers?
    Kishor Prabhakar Panzade ................................ 35
1. ENTOMOLOGY

Natural Enemies of Fall Armyworm In India

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Introduction

The Fall Armyworm (Spodoptera frugiperda), is native to tropical and subtropical regions of the Americas. The Fall Armyworm can feed on more than 80 plant species, including maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton. FAW can cause significant yield losses if not well managed. It can have several generations per year and the moth can fly up to 100 km per night.

Lifecycle of Fall Armyworm

The Fall Armyworm lifecycle includes egg, 6 growth stages of caterpillar development (instars), pupa and adult moth. Under warm conditions, a female moth can lay 6 to 10 egg masses of 100 to 300 eggs each, giving a maximum of 1 500 to 2 000 eggs in her lifetime of 2-3 weeks. As for other pests, most eggs will not develop into adults due to mortality in different parts of the lifecycle [1].

- Egg: Eggs are spherical (0.75 mm diameter); they are green at the time of oviposition and become light brown prior to eclosion. Egg maturity takes 2-3 days (20-30°C). Eggs are usually laid in masses of approximately 150-200 eggs which are laid in two to four layers deep on the surface of the leaf. The egg mass is usually covered with a protective, felt-like layer of grey-pink scales (setae) from the female abdomen. Up to 1000 eggs may be laid by each female.

- Larva: Larvae are a light green to dark brown with longitudinal stripes. In the sixth instar, larvae are 3-4 cm long. Larvae have eight prolegs and a pair of prolegs on the last abdominal segment. On hatching they are green with black lines and spots, and as they grow they either remain green or become buff-brown and have black dorsal and spiracular lines. If crowded (by a high population density and food shortage) the final instar can be almost black in its
armyworm phase. Large larvae are characterized by an inverted Y-shape in yellow on the head, black dorsal pinnacle with long primary setae (two each side of each segment within the pale dorsal zone) and four black spots arranged in a square on the last abdominal segment. There are usually six larval instars, occasionally five.

- **Pupa**: Pupae are shorter than mature larvae (1.3-1.5 cm in males and 1.6-1.7 cm in females), and are shiny brown.

- **Adult Male**: Male body length is 1.6 cm and wingspan 3.7 cm. The forewing is mottled (Light brown, grey and straw) with a discal cell containing straw colour on three quarters of the area and dark brown on one quarter of the area.

- **Adult Female**: Female body length is 1.7 cm and wingspan 3.8 cm. The forewing is mottled (dark brown, grey). Hind wings are straw colour with a dark brown margin.

**Natural Enemies of Fall Armyworm**

The common management strategy for the control of FAW in infested regions of the world has been use of insecticide sprays. However, currently in agricultural pest control, the adverse effects of the use of insecticides are leading scientists to search for alternatives to chemical control of insect pests. Biological control has been used for pest management for many years and it has gained renewed interest because they are safe to environment, ecosystem and human health. In this regard, there is an urgent need to understand, promote and maximize the effectiveness of indigenous populations of natural enemies against the fall armyworm. The occurrence and parasitism rate of FAW larval parasitoids varies considerably between localities, regions, crop practices, plant stage, and environmental characters [2]. This information is needed to assess the potential value of the existing larval parasitoid fauna in controlling FAW on different host plants in India. The natural occurrence of *S. frugiperda* natural enemies in different maize growing areas of Karnataka and Tamil Nadu, recorded 5 larval parasitoids, 3 predators, and 1 entomopathogenic fungus of which larval parasitoid, namely *Coccygidium melleum* (Roman), *Eriborus* sp. (Hymenoptera: Ichneumonidae) and *Odontepyris* sp. (Hymenoptera: Bethylidae) were reported for the first time on *S. frugiperda* in the world. The extent of parasitism by *C. chlorideae* was 2 to 3% on maize. They also suggested that the native parasitoids of other *Spodoptera* spp. in India, such as *C. chlorideae* and *E. argenteopilosus*, may also adapt to *S. frugiperda* in due time [3]. The natural occurrence of Nucleopolyhedrovirus (NPV) infection on *S. frugiperda* larvae were found on maize fields of Gujarat [4]. The natural enemies list of *Spodoptera frugiperda* in India ecosystem presented in Table 1.

### Table 1: Natural enemies of *Spodoptera frugiperda* in India

<table>
<thead>
<tr>
<th>S.No</th>
<th>Scientific name</th>
<th>Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Telenomus</em> sp.</td>
<td>Hymenoptera: Platygastridae</td>
</tr>
<tr>
<td>2</td>
<td><em>Trichogramma</em> sp.</td>
<td>Hymenoptera: Trichogrammatidae</td>
</tr>
<tr>
<td>3</td>
<td><em>Glyptapanteles creatonoti</em> (Viereck)</td>
<td>Hymenoptera: Braconidae</td>
</tr>
<tr>
<td>4</td>
<td><em>Forficula</em> sp.</td>
<td>Dermaptera: Forficulidae</td>
</tr>
<tr>
<td>5</td>
<td><em>Coccygidium melleum</em> (Roman)</td>
<td>Hymenoptera: Braconidae</td>
</tr>
<tr>
<td>6</td>
<td><em>Campoletis chlorideae</em> Uchida</td>
<td>Hymenoptera: Ichneumonidae</td>
</tr>
<tr>
<td>7</td>
<td><em>Eriborus</em> sp.</td>
<td>Hymenoptera: Ichneumonidae</td>
</tr>
<tr>
<td>8</td>
<td><em>Odontepyris</em> sp.</td>
<td>Hymenoptera: Bethylidae</td>
</tr>
<tr>
<td>9</td>
<td><em>Exorista sorbillans</em> (Wiedemann)</td>
<td>Diptera: Tachinidae</td>
</tr>
<tr>
<td>10</td>
<td><em>Forficula</em> sp.</td>
<td>Dermaptera: Forficulidae</td>
</tr>
<tr>
<td>11</td>
<td><em>Harmonia octomaculata</em> (Fabricius)</td>
<td>Coleoptera: Coccinellidae</td>
</tr>
<tr>
<td>12</td>
<td><em>Coccinella transversalis</em> Fabricius</td>
<td>Coleoptera: Coccinellidae</td>
</tr>
<tr>
<td>13</td>
<td><em>Nomuraea rileyi</em> (Farlow) Samson</td>
<td>Ascomycota: Clavicipitaceae</td>
</tr>
<tr>
<td>14</td>
<td><em>Nucleopolyhedrovirus</em> (NPV)</td>
<td>Baculoviridae</td>
</tr>
</tbody>
</table>

**Conclusion**

From mid 2018 onwards, Fall Armyworms...
infesting large swathes of corn crops across India. With the persistent and reticence attack of FAW on maize production, notable research institutes cum researchers have proffered possible prospect to curtail this menace. There is a need to effectively utilize and quantify the benefits of host plant resistance in multi-tactic Integrated Pest Management (IPM) programs and keys to overcoming the barriers. For eco-friendly management of pest population, further information on the occurrence and rates of parasitism of indigenous natural enemies is of paramount importance in designing a biological control program for fall armyworm, either through conservation of native natural enemies or the introduction of new species for augmentative release. It would be worthwhile to evaluate indigenous parasitoids that known to be effective in India against S. frugiperda.

References

2. AGRICULTURE- AGRICULTURAL ENTOMOLOGY

Importance of Insect Ecology in Integrated Pest Management

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2 Training Associate, Centre for Natural Resource Management, NIRDPR, Hyderabad

Insect Ecology may be defined as the understanding of physiology and behaviour of insects as affected by their environment. The term ecology was coined by a German biologist Ernst Haekel (1869).

Agroecosystem is largely created and maintained to satisfy human wants or needs. It is not a natural ecosystem but is man made. Agroecosystem is the basic unit of pest management - a branch of applied ecology.

Unique Features of Agroecosystem

- Dominated by plants selected by man
- No species diversity and no intraspecific diversity. Genetically uniform
- Phenological events like germination, flowering occur simultaneously

Lack of temporal continuity - due to various agricultural operations carried out by man like ploughing, weeding, pesticide application etc.
- Plants contain imported genetic material
- Nutrients are added
- Outbreak of pests, weeds and diseases occur frequently

Biotic and abiotic Factors Affect Insect Populations by:

- Extending the growing season
- Altering timing of emergence
- Rapid growth and development rates
- Shortening generation times
- Prolonged overwintering
- Shorten predation window
• Altering geographic distribution.

**Different Factors Influences on Insects Growth and their Development**

- Abiotic factors
  - Temperature
  - Co2
  - Photoperiod
  - Humidity
  - Irrigation
  - Mulching
  - Drought
  - Shade
- Biotic factors
  - Intraspecific competition
  - Interspecific competition
  - Intercrop
  - Trap crop

**Effect of fluctuating temperature on insects:**
Insects are poikilothermic - do not have mechanism to regulate body temperature - Body temperature depends on environmental conditions

- Preferred or Optimum temperature is the temperature at which normal physiological activities take place - insects survive at this temperature.
- Upper lethal limit - 40-50°C (even upto 60°C survival in some stored product insects)
- Lower lethal limit - Below freezing point e.g. snow fleas
- The total heat required for completion of physiological processes in life – history is a constant - thermal constant.
- At low temperature (winter) insect takes more days to complete a stage (larval or pupal stage)
- At high temperature (summer) it takes less than to complete a stage.
- Some insects when exposed to extremes of temperature
- Undergo - Aestivation (during summer) or Hibernation (during winter)

**Influence of Temperature on Fecundity:** Insects fecundity will be maximum at moderately high temperatures and declines at upper and lower limits of favourable temperature.

- DBM lays more eggs at a larval temperature of 18°C than 22°C
- Grasshopper lays 20 -30 times more eggs at 32°C than 22°C
- Oviposition of bedbug is inhibited at 8°C to 10°C
- *Pediculus spp* doesn’t oviposit below 25°C

**Effect of Elevated CO₂ on Insects**
The present change in climate is closely linked with the rise in atmospheric carbon dioxide (CO₂) levels from 280 to 387 ppm since the start of the Industrial Revolution. And current levels of CO₂ are expected to double by 2100 (IPCC 2007). Such rise in CO₂ levels affects the biological system of living organisms, including insects.

Since fitness of any herbivorous insects depends on nutritional status of their host, any change in the quality of host plants can affect their growth, development, population dynamics and survival. The extent of growth, yield and biochemical responses of plants to elevated CO₂ depends on the photosynthetic pathway. Crops with C3 photosynthesis respond markedly to increasing CO₂ concentrations by inhibiting photorespiration, making photosynthesis more efficient, however, leaf nitrogen and protein concentrations ultimately decrease by more than 12%. Such a loss of nitrogen and protein significantly diminishes the nutritional value of plant affecting growth and development of insect herbivores either directly or indirectly. In contrast, plants with C4 photosynthesis will respond little to rising atmospheric CO₂ due to saturation of photosynthesis).

Effect of photoperiod on insects:

- Each day cycle inclusive of a period of illumination followed by a period of darkness
- Photo period influences induction of diapause (a resting stage) in most of the insects

Ex: Long day during embryonic development causes adult to lay diapausing eggs in *Bombyx mori*.

- Seasonal dimorphism occurs in aphids due to change in photo period
• Short day - Sexual forms
• Long day - Asexual - Parthenogenetic forms

Impact of precipitation and Humidity on pests:
• In Sub-Saharan Africa, changes in rainfall patterns are driving migratory patterns of the desert locust (Schistocerca gregaria)
• Thrips and white flies are sensitive to precipitation and are killed or removed from crops by heavy rains
• Out breaks of Amsacta moorei are directly related to heavy and frequent rains
• BPH populations increase with the increased precipitation up to 400 mm and decrease with >500 mm.

Influence of RH on Fecundity
• Migratory locust (Locusta migratoria) failed to produce eggs at 40% RH but at 70% RH only it sexually matures
• Rice weevil (Sitophilous oryzae) fecundity is less at 34% and max.at 70%.

3. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Fertilizer Related Problems

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Introduction
Fertilizer is any organic or inorganic material of natural or synthetic origin that is added to soil to supply one or more plant nutrients essential to growth of plants. Fertilizer use in India started in 1906 but not much growth took place up to 1965. Evolution of fertilizer responsive HYVs of rice and wheat - a turning point. Fertilizer consumption and food grain production increased rapidly after mid 60s. Fertilizer played a key role in ensuring self sufficiency in food grain production. Fertilizers alone account for 55% increase in food production. Total nutrient consumption(NPK) - 25.58MT (2013)

Fertilizer usage status in India

<table>
<thead>
<tr>
<th>Nutrient consumption</th>
<th>Zone wise</th>
</tr>
</thead>
<tbody>
<tr>
<td>India ranks second – Nutrient ratio of NPK-4:2:1</td>
<td>East zone-14%</td>
</tr>
<tr>
<td>But, India has nutrient ratio- 5.9:2.8:1 Tamil nadu nutrient ratio- 3.9:2:2:1</td>
<td>North zone-28%</td>
</tr>
<tr>
<td>Remaining - South zone-26%</td>
<td>West zone-31</td>
</tr>
</tbody>
</table>

Constraints
• Quality of food available is declining.
• It affected soil, water, food quality, human health and atmosphere.
• Chemical fertilizers being used are increasing at an alarming rate.

Nitrogen and phosphorus- important ones as used in larger amount by farmers.

Fertilizer Pollution

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Leaching to field drains</td>
<td>1. P - poorly taken up by crops.</td>
<td></td>
</tr>
<tr>
<td>2. Gaseous loss as nitrogen oxides after De nitrification.</td>
<td>2. Remaining - effectively converted to water insoluble form.</td>
<td></td>
</tr>
<tr>
<td>1. P adsorbed on soil particles may be carried into surface waters.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effects of Fertilizers
1. In Fertile Soil - High levels of nutrients that some chemical fertilizers contain can over saturate soil and cancel out the effectiveness of other vital nutrients.
2. Acid Soil- Fertilizers can make soil infertile by increasing its acidity. Many chemical fertilizers contain sulfuric and hydrochloric acid, which if used in excess can cause serious harm to microorganisms. This can have a serious impact on the soil's pH and
adversely affect plant growth

3. **Increased Microorganisms** - Nitrogen-rich chemical fertilizers can have complete opposite effect on soil in comparison to more acidic fertilizers. Too much nitrogen can lead to microorganism population boom. In large enough numbers, these microorganisms, instead of helping plants, will hurt them, as they will consume all of organic material and nutrients in surrounding soil. On other side useful microbes like nitrogen fixing bacteria are destroyed.

4. **Groundwater Pollution** - Plants can only absorb a certain amount of nutrients. Unused fertilizer seeps into ground, where it can be carried by rain and irrigation ditches into streams, rivers, lakes, reservoirs and oceans. Chemical compounds in fertilizer can contaminate drinking water supplies and disrupt ecosystems.

5. **Salt Burns** - Chemical fertilizers are often very salty. Over-application of chemical fertilizers can thus contribute to plants developing unsightly “salt burns”. These occur when over saturation of salt leads to certain areas of plant becoming dehydrated, and plant tissues dry out.

6. **Excess Growth** - Due to high potency of chemical fertilizers, they can sometimes lead to plants becoming too big for their own health. Larger limbs and thicker foliage translates to considerable increase weight, which can put stress on plant's roots.

7. **GROUND WATER POLLUTION**

<table>
<thead>
<tr>
<th>Risk zone</th>
<th>Average fertilizer consumption (N kg/ha)</th>
<th>Average NO3 in ground water (mg/l)</th>
<th>Ground water development</th>
<th>Region (States)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little or No</td>
<td>2</td>
<td>6.8</td>
<td>&lt;2</td>
<td>J&amp;K, North states</td>
</tr>
<tr>
<td>Low</td>
<td>4 - 11</td>
<td>8 - 45</td>
<td>5 - 22</td>
<td>HP, MP, Orissa, maharashtra</td>
</tr>
<tr>
<td>Moderate</td>
<td>14 - 53</td>
<td>13 - 50</td>
<td>16 - 40</td>
<td>UP, Uttranchal, Bihar, WB,AP, Gujarat</td>
</tr>
<tr>
<td>High</td>
<td>118 - 163</td>
<td>55 - 100</td>
<td>70 - 100</td>
<td>Punjab, Haryana</td>
</tr>
</tbody>
</table>

Water flow that occurs when soil is infiltrated to full capacity and excess water from rain, melt water, or other sources flows over land. May carry fertilizers along with water.

8. **Eutrophication** - Enrichment of surface waters with plant nutrients. Associated with anthropogenic sources of nutrients. Process of change from one tropic state to higher tropic state by addition of nutrients.

**Symptoms and Impacts of Eutrophication**

- Increase in production and biomass of phytoplankton, attached algae, and macrophytes.
- Shift in habitat characteristics due to change in assemblage of aquatic plants.
- Replacement of desirable fish (e.g. salmonids in western countries) by less desirable species.
- Production of toxins by certain algae.
- Increasing operating expenses of public water supplies, including taste and odour problems, especially during periods of algal blooms.
- Deoxygenation of water, especially after collapse of algal blooms, usually resulting in fish kills.
- Economic loss due to change in fish species, fish kills, etc.

10. **Effects On Atmosphere** - Greenhouse effect: increase in nitrogen oxides due to nitrogenous fertilizers use like urea. Ammonia emission from fertilized lands, may be oxidized and turn into nitric acid, sulfuric acid from industrial sources, create acid rain after the chemical transformations. Nitrous oxide content in the atmosphere has increased by about 25% over the previous century. About 1/3rd of this increase is thought to be due to agricultural practices. Adding urea fertilizer to soil enhances methane emission further leading to greenhouse effect.

11. **Effects On Quality Of Crop** - Leads to dwarfism of crops. Affect growth of elongating hormones of crops resulting into dwarf crops. With excessive use of urea, plants become succulent and dark green colour thus becoming more vulnerable to pests and diseases. Increases growth of plant but weakens stem. Reduces quality of seeds

**Conclusion**

Today, use of fertilizers is seen as a necessary agricultural technology. Firstly soil analysis should be performed carefully, after then, fertilizers should be applied to soil. The structure and chemical content of the soil should be identified and most appropriate type of fertilizers should be selected. Application of fertilizers at right place, right dose and right time without causing any harm to environment can lead to greater productivity and greater results.

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**4. AGRONOMY**

**Behooveful Action of Adventitious Roots**

S.Sapthagiri, P.Kunjammaland G. Srinivasan  
*Ph.D., Scholars, Department of Agronomy, Agricultural College and Research Institute, Coimbatore*

**Adventitious Root**

‘A root in an unusual position, such as on a stem or leaf’

Adventitious root are roots in an unusual place, that originates from stem or leaf tissue rather than from another root, often where a branch or other part contacts soil or damp material. Adventitious roots are produced both during normal development (crown roots on cereals and nodal roots on strawberry [Fragaria spp.]) and in response to stress conditions, such as flooding, nutrient deprivation, and wounding.

**Origin and Development**

A plant’s normal growth comes from meristematic tissue, but adventitious growth comes from non-meristematic tissue. Adventitious roots are indeed very common in vascular plants. A plant cannot be reproduced - from cuttings or layering unless adventitious roots develop.

**Growth**

Adventitious roots usually develop near the existing vascular tissues so they can connect to the xylem and phloem. However, the exact location varies greatly. In young stems, adventitious roots often form from parenchyma between the vascular bundles. In stems with secondary growth, adventitious roots often originate in phloem parenchyma near the vascular cambium. In stem cuttings, adventitious roots sometimes also originate in the callus cells that form at the cut surface. Leaf cuttings of the...
Crassula form adventitious roots in the epidermis.

**Modified Forms**

- **Tuberous roots** lack a definite shape; example: sweet potato.
- **Fasciculated root** (tuberous root) occur in clusters at the base of the stem; examples: asparagus, dahlia.
- **Nodulose roots** become swollen near the tips; example: turmeric.
- **Stilt roots** arise from the first few nodes of the stem. These penetrate obliquely down into the soil and give support to the plant; examples: maize, sugarcane.
- **Prop roots** give mechanical support to aerial branches. The lateral branches grow vertically downward into the soil and act as pillars; example: banyan.
- **Climbing roots** arising from nodes attach themselves to some support and climb over it; example: money plant.
- **Moniliform or beaded roots** the fleshy roots give a beaded appearance, eg: bitter gourd, some grasses.

**Key Concepts ARs Development**

- ARs are the main root system for monocots.
- ARs are an adaptative response to environmental changes.
- ARs are required for vegetative propagation of plants.
- ARs arise from any organ of the plant but the root.
- ARs originate from different cell types depending on the organ or the species.
- ARs can be induced by ECMs or *Agrobacterium rhizogenes*.
- AR development is controlled by environmental factors.
- Adventitious rooting is an age-dependant process.
- Auxin cross talks with other hormones to control adventitious rooting.

- Adventitious rooting is a complex quantitative genetic trait.

**Importance**

- Economically (for cuttings and food production)
- Ecologically (environmental stress response)
- Human Existence (food production)

**Need**

To improve sustainable food production under environmentally extreme conditions, it is important to understand the adventitious root development of crops both in normal and stressed conditions (Fig 1, 2 and 3).

![Fig 1. Normal condition- maize](image)

![Fig 2. Flood condition- Maize](image)

![Fig 3. Flood condition- Sugarcane](image)

**Conclusion**

Adventitious roots, play a key role for our existence- cereal crops (wheat, rice and maize) provide 60 per cent of global caloric intake (FAO)-root systems composed almost exclusively of adventitious roots - to achieve global food security- improve food production in increasing extreme weather events- for which it is very essential.

**Reference**

Hayward, H. E. 1938. The structure of economic plants. Macmillan, New York, USA.

5. AGRICULTURAL ENTOMOLOGY

Bionomics, Biology and Management of Storage Pests of Bruchidae

Yogapriya A
Dept. of Agricultural Entomology, Agricultural College and Research Institute, TNAU, Madurai

Introduction
In India, pulses are the good source of protein, vitamin, mineral, fiber and also enrich the soil fertility. During 2017-18, pulses were cultivated over 29 million ha of area and the annual production of India is about 25.23 million tonnes at a productivity level of 841 kg/ha. India is the world’s largest producer as well as consumer of green gram and India contributes 70% of world’s greengram production. But, this production was lost upto 8.5% at the time of storage and postharvest handling (Kosar & Srivastava, 2016).

Bruchidae - cosmopolitan family of small beetles (Coleoptera) with about 1,500 described species. The pulse beetles or bean weevils or seed beetles are a subfamily (Bruchinae) of beetles, now placed in the family Chrysomelidae, though they have historically been treated as a separate family. They are granivores, and typically infest various kinds of seeds or beans, living most of their lives inside a single seed. The family includes about 4,350 species and is found worldwide.

Bean weevils are generally compact and oval in shape, with small heads somewhat bent under. Sizes range from 1 to 22 mm for some tropical species. Colors are usually black or brown, often with mottled patterns. Although their mandibles may be elongated, they do not have the long snouts characteristic of true weevils.

General Characteristics of Bruchids (Pulse / Seed Beetles)
- Small, short beetles.
- Head small and the blunt snout.
- Antenna serrated.
- Hind femur thick
- Elytra short and do not cover the abdomen fully (Pygidium).
- Eggs are usually placed on leguminous seed pods.
- The emerging larvae, possess thick, curved bodies, mine and feed therein.

Life Cycle
- Eggs whitish, scale like glued to pods or seeds by glutinous secretion.
- Grubs feed on seed pupation occurs within the seed.
- Adult emerges by cutting circular exit hole.
- Adult: Chocolate brown, Defluxed head
- Compound eyes: Emarginated (having margin around eyes)
- Antenna: Serrated (female) Pectinate (male) in Callosobruchus spp.

List of Major Pests
- Callosobruchus maculatus (Pulse beetle)
- Callosobruchus chinensis (Pulse beetle)
- Caryedon seratus (Groundnut beetle)
- Bruchus pisorum (Pea beetle)

Pulse Beetles - Callosobruchus maculates and Callosobruchus chinensis

Eggs
The eggs are cemented to the surface of pulses and are smooth, domed structures with oval, flat bases.

Larva and Pupa
The larvae and pupae are normally only found in cells bored within the seeds of pulses. For a description and key to larvae of Callosobruchus spp.,
**Adult**

- Adults are 2.0-3.5 mm long.
- The antennae are pectinate in the male, and serrate in the female.
- The elytra are pale brown, with small median dark marks and larger posterior dark patches, which may merge to make the entire posterior part of the elytra dark in colour.
- The side margins of the abdomen have distinct patches of coarse white setae, a feature that is shared with *C. rhodesianus* and *C. theobromae*. In common with other species of *Callosobruchus*, *C. chinensis* has a pair of distinct ridges (inner and outer) on the ventral side of each hind femur, and each ridge has a tooth near the apical end.
- The inner tooth is slender, rather parallel-sided, and equal to (or slightly longer than) the outer tooth. Variations in morphological parameters may be induced by different host densities, whether development occurs in pods or in loose seeds.

**Distribution**

The two most widespread species of bruchid beetle are *C. maculatus* and *C. chinensis*, which are distributed throughout the tropics and subtropics.

**Identification of species**

<table>
<thead>
<tr>
<th>Callosobruchus maculatus</th>
<th>Callosobruchus chinensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two large white spots on the Elytra</td>
<td>Many spots on the Elytra</td>
</tr>
<tr>
<td>Pygidium is prominent</td>
<td>Pygidium is not prominent as that of <em>C. maculatus</em></td>
</tr>
<tr>
<td>No such ridges reported</td>
<td>Has a pair of distinct ridges (inner and outer) on the ventral side of each hind femur, and each ridge has a tooth near the apical end.</td>
</tr>
</tbody>
</table>

**Prevention and Control**

**TRAPS**

- TNAU two in one trap – A combination of probe and pitfall trap which is inserted into the container. The opening should coincide with the outer surface of the grains.

**Natural Enemies**

<table>
<thead>
<tr>
<th>Natural enemies</th>
<th>Types</th>
<th>Life stages</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Anisopteromalus calandrae</em></td>
<td>Parasite</td>
<td>Larvae</td>
</tr>
<tr>
<td><em>Dinarmus basalis</em></td>
<td>Parasite</td>
<td>Larvae</td>
</tr>
<tr>
<td><em>Dinarmus vagabundus</em></td>
<td>Parasite</td>
<td>Larvae</td>
</tr>
<tr>
<td><em>Heterospilus prosopidis</em></td>
<td>Parasite</td>
<td></td>
</tr>
<tr>
<td><em>Lariophagus distinguendus</em></td>
<td>Parasite</td>
<td>Larvae</td>
</tr>
<tr>
<td><em>Pteromalus cerealellae</em></td>
<td>Parasite</td>
<td>Larvae/pupae</td>
</tr>
<tr>
<td><em>Pteromalus schwenkei</em></td>
<td>Parasite</td>
<td></td>
</tr>
<tr>
<td><em>Theocolax elegans</em></td>
<td>Parasite</td>
<td></td>
</tr>
<tr>
<td><em>Uscana lariophaga</em></td>
<td>Parasite</td>
<td>Eggs</td>
</tr>
</tbody>
</table>

No evidence for the above mentioned natural enemies has been accounted in economical scale such as godowns etc.

**Chemical Control** - Fumigation treatment with phosphine, Approved grain insecticides, organophosphates and a admixture of vegetable oil or essential oils can give protection t farm level.

**Cultural Control** - Intercropping maize with cowpeas and not harvesting crops late, Good store hygiene - removal of infested residues from last season’s harvest and Solarization.

**Irradiation** - By ionising gamma radiation

**Peanut Weevil - Careyodon seratus**

**Common name:** Peanut Beetle, Ground Seed Beetle
Geographical distribution:
Cosmopolitan in distribution.
Host plants
- Peanuts (*Arachis hypogaea* Linnaeus),
- Tamarind (*Tamarindus indica* Linnaeus)
- *Acacia* spp.

**Morphology**
- Adults 4-5 mm long, body reddish-brown with darker spots.
- The Prothorax is trapezoid, with dense, grey pubescence.
- The hind legs are enlarged.
- Larva (grub) whitish with a brown head.

**Life History**
- The females lay several hundred eggs, more in shelled groundnut than in tamarind and unshelled groundnuts, gluing them to the shells or kernels. The newly hatched larva burrows straight through the eggshell and pod wall, and eats the kernel, feeding only within a single pod.
- Development requires about 10 weeks at 25°C.

**Economic Importance**
The pest damages peanuts as well as tamarinds. Infestations cause reductions in food value, in the quality of the oil seed germination. Such damage is particularly significant when the peanuts are destined for confectionery purposes. The heat and moisture the insects increases mold growth and the development of aflatoxins in groundnuts.

**Management**

**Monitoring**
The presence of larval emergence holes and of cocoons outside the pods attests to the pest’s presence.

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**Horticultural Methods**
Cleaning grain stores, keeping them airtight, maintaining temperatures below 20°C and hermetically sealed package conserving seed viability. Storing groundnuts in jute bags greatly restricts the movement of adults into and out of bags.

**Chemical Control**
Extracts of several plants such as neem seeds reduced beetle egg hatching and larval development, but had little effect.

**Biological Control**
An application of an isolate of the entomopathogenic fungus *Metarhizium anisopliae* totally reduced emergence and had some a repellent effect on the beetle. Several parasitoids attack the pest in *Acacia* pods, including the pteromalid *Anicalandrae*.

**Pea Seevil - Bruchus Pisorum**

**Morphology**

**Adults**
- 4-6 mm long,
- Body globular
- Black with gray pubescence
- Elytra - Punctate with gray spots, shorter than the abdomen
- Yellow-gray with a dark head, legs reduced.

**Life History**
- **Female**: Lays about 25 eggs on pea pods
- **Adult**: Develop during summer in the stored seeds Remain quiescent
- Single annual generation.

**Economic importance**
Affects 80% of the crop. Undisturbed large pest populations may reduce a stored pea crop to dust.

**Chemical Control** - Pyrethroids and Fumigation

**Biological Control**
- The braconid *Triaspis thoracica* (Curt.) attacks the pest within the seed.
The egg parasitoid *Uscana senex* Grese *Trichopara* parasitism rates and reduced seed damage by 70% in the field.

References
Anonymous: Invasive Species Compendium - Detailed coverage of invasive species threatening livelihoods and the environment worldwide.
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http://www.agri.huji.ac.il/mpeests/pest

6. AGRICULTURAL ENGINEERING

Neutral Electrolyzed Water (NEW): A Novel Sanitizer for Fruits and Vegetables

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ICAR-Indian Agricultural Research Institute, New-Delhi

Introduction
The history of electrolyzed water (EW) in commercial development dates back to more than a century. Although the concept of EW was first developed in Russia, it has been used widely in medical institutions in Japan since 1980 for various purposes including water decontamination, water regeneration, and disinfection. Over time, its use has broadened into various other fields such as livestock management and agriculture (Al-Haq et al., 2002). Electrolyzed water (EW) has been regarded as a new sanitizer and cleaner in recent years. EW is produced from regular water without the addition of any harmful chemicals, except NaCl. The main reason for its popularity is the simplicity of production and application. The acceptance of EW as a sanitizer is evident from its use in a number of applications in various fields including agriculture, medical sterilization, food sanitation, livestock management, and other fields that employ antimicrobial techniques (Huang, 2008). EW exhibits antimicrobial activity against a variety of microorganisms and eliminates most common types of viruses, bacteria, fungi, and spores in a relatively short amount of time (usually within 5 to 20 s) in food products, food processing surfaces, and non-food surfaces.

Process of Production
EW is produced in an electrolysis chamber containing a dilute NaCl solution. The chamber includes a diaphragm, which is used to separate the cathode and anode. As current is passed through the EW generator, whereas voltage is generated between the electrodes, with the voltage and current values set at 9–10 V and 8–10 A, respectively. Upon the onset of the electrolysis process, NaCl dissolves in water and dissociates into positively and negatively charged ions (Na+ and Cl−, respectively) (Huang, 2008). Meanwhile, hydroxide (OH−) and hydrogen (H+) ions are also formed in the solution. The negatively charged ions (OH− and Cl−) move toward the anode where electrons are released and hypochlorous acid (HOCl), hypochlorite ion (−OCl), hydrochloric acid (HCl), oxygen gas (O2), and chlorine gas (Cl2) are generated. However, positively charged ions (Na+ and H+) move toward the cathode where they gain electrons, resulting in the generation of sodium hydroxide (NaOH) and hydrogen gas.

What is NEW?
NEW (Neutral Electrolyzed Water) is an all-natural, organic, non-toxic, non-irritant, environmentally and ecologically safe sanitizing and disinfecting solution. It is produced from the electrochemical reaction of water, salt and electricity. NEW is an oxidizing agent due to a mixture of free radicals present in the solution,
and has an antimicrobial effect.

**Mode of Action**

The bactericidal action of NEW is due to the combination of HOCl and OCl. Once NEW comes in contact with a microorganism, it attacks the bacterial proteins located in the cell membranes. Because of the osmolarity difference (the concentration of ions in the solution versus in the cytoplasm), NEW induces the rupture of cell membranes leading to cell lyses. *(Deza et al., 2007)*

NEW **is Efficient**

- NEW is generated on demand and applied where required to eliminate the logistical concerns of purchasing, transporting, storing, preparing and using traditional chemical applications.
- The elimination of hazardous chemicals translates into reductions in regulatory paperwork, safety training requirements, safety inspections, and liability exposure.
- Eliminates the need to monitor for chlorine dioxide residuals, chlorite, or bromate.
- Provides more effective cleaning ability than other toxic chemicals.
- The higher biocidal capacity relative to traditional chemical solutions permits the use of lower dose rates, lessening the risk for environmental impact.
- The solution is less corrosive than alternate products.
- Reduces the frequency of cleaning within a facility.
- Allows for the disinfection of areas where toxic chemicals are not permitted.

NEW **Saves Money**

- NEW is cost effective due to the fact that many more deliveries of bulk chemicals are required for the same chlorine equivalent generated by a single delivery of salt, a fact that becomes even more critical as fuel costs rise *(Abadiasls et al., 2008)*.
- The capital cost of the on-site Aquaox Device can often be recovered in less than a few years.
- A single unit produces a natural solution to supply an entire facility with numerous cost effective applications.
- Eliminates the need for expensive and potentially toxic chemicals.
- Reduces the costs of purchasing, transporting, storing, preparing and using traditional chemical applications.
- Decreases labor requirements and costs.

NEW **is Safe**

**Safe for Products**

- Addresses public safety concerns.
- All-natural, safe.
- Non-toxic, non-hazardous.
- No storage compatibility issues.
- No residue to rinse.
- No special disposal required.

**Safe for Users**

- No health and safety risks.
- No protective gear required.
- No eye or skin irritation.
- Non-toxic (inhalation, ocular etc).
- Non-hazardous.
- No protective equipment required.

*(source: Taylor, 1999)*

**Overall Conclusion**

- NEW has proven to be a high-level disinfectant, substantially reducing pathogens without the use of costly toxic chemicals.
- NEW effectively destroys microorganisms, they cannot build up resistance to NEW as they can to other sanitizers and disinfectants.
- NEW gives a much quicker inactivation rate of a wider range of microorganisms than traditional chlorination technologies, and therefore decreases the risk of waterborne diseases, outbreaks, and illnesses.
- Hence, this product provides a ‘Green’ solution to help protect the nation’s food supply.
Future Thrust

Studies on enhancing the efficacy of NEW by combination of treatment. Initiation of research work enhancing antimicrobial activity during long term storage of produce.

References


7. AGRICULTURAL ENTOMOLGY

Present Scenario of Bee Keeping in India

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Department of Entomology, Rajasthan college of Agriculture, MPUAT, Udaipur, Rajasthan

Beekeeping is an important activity that supplements and compliments agriculture and provides nutritional and economic security to rural communities worldwide. Even landless people can take up beekeeping as a profession. Beekeeping helps in generating additional income and is an integral part of integrated farming system. In addition to the revenue obtained from honey and other bee products, pollination activities of honey bees are important which contribute to the increased crop yield to an extent of 20-80 per cent. In addition to increasing crop yield through cross pollination, honey bees also increase the biodiversity through pollination and perpetuation of a whole lot of plants in this world, wild or cultivated, in farm fields or forests. Thus bees and pollinators help to maintain biodiversity and a vibrant ecosystem. India comprises seven percent of the world’s flora.

History of Beekeeping in India

Bees, honey and beekeeping have been mentioned in various Hindu Vedic scriptures of India like Rig Veda, Atharva Veda, Upanishads, Bhagavad Gita, Markandeya Purana, Raj Nighantu, Bharat Samhita, Arthashastra, and Amar Kosha. Various Buddhist scriptures like Vinaya Pitaka, Abhidhamma Pitaka and Jataka tales also mention bees and honey. When British attacked the eastern coast of present-day Odisha state in 1842–49, the Kondha tribe is noted to
have used tamed bees against them. But little is known about the techniques used by them for taming. Various tribes in the hilly areas of Manipur and Nagaland used wooden logs or earthen wares for beekeeping. But crude methods of squeezing out honey from honeycombs were used that had possibility of adulterating honey with the beeswax and also killing many bees in the process. A hollow bamboo with a nail attached to pierce the comb has been used by Manipuri tribes. The hollow bamboo would allow flowing of honey to another barrel.

As per Food and Agricultural Organization database, in 2017-18, India ranked eighth in the world in terms of honey production (64.9 thousand tonnes) while China stood first with a production level of 551 thousand tonnes. The report mentions that beekeeping cannot be restricted to honey and wax only, products such as pollen, propolis, royal jelly and bee venom are also marketable and can greatly help Indian farmers. Based on the area under cultivation in India and bee forage crops, India has a potential of about 200 million bee colonies as against 3.4 million bee colonies today. Increasing the number of bee colonies will not only increase the production of bee-related products but will boost overall agricultural and horticultural productivity.

**Economic Significance**

India has a potential to keep about 200 million bee colonies that can provide employment to over 21.5 million people. The Indian apiculture market size was worth INR 16,818 Million in 2018. The market is further projected to reach INR 33,128 Million by 2024, growing at a CAGR of nearly 12% during forecast period (2019-2024). Apiculture involves the study and practice of beekeeping to produce natural honey. In terms of production, these bee colonies can produce over 10 million tons of honey and about 15,000 tons of beeswax. Organized collection of forest honey and beeswax using improved methods can result in an additional production of at least 120,000 tons of honey and 10,000 tons of beeswax. Based on the area under cultivation in India the current figure is about 3.4 million colonies with 115 thousand tones honey production; whereas, Rajasthan accounts for 8500 tonnes honey production.

The practice of keeping bees, in India dates back to ancient times when people hunted honey from feral colonies of the rock bee, the little bee and the Indian hive bee (Kishan Tej et al., 2017). The Indian hive bee was a domesticated species but was kept in wooden logs or walls until the end of 19th Century. After the discovery of movable frames, this design and technique were adopted for Indian hive bee from the western countries.

India is a country which inhabits four major honey bee species; two domesticated species, viz. *Apis cerana* (Indian or Asian honey bee) and *A. mellifera* (European honey bee) and two wild species, viz. *A. dorsata* (rock honey bee) and *A. florea* (dwarf honey bee). Beekeepers in many of the Indian States cultivate *A. cerana*, which hardly accounts for 5 to 10% of total honey produced in India. *A. mellifera* ligustica known as the Italian bee was introduced into India in the 20th century when the beekeeping industry with the native bee, *A. cerana* was badly hit because of the outbreak of tracheal mite, *Acarapis woodi* and Thai sacbrood virus during 1965-1986.

Honey consumption in India has witnessed a strong growth over the last few decades. The per capita consumption of honey, however, still remains low in India compared to a number of developed countries. The low per capita consumption of honey is mainly as a result of the lack of awareness regarding the benefits of honey in diets and the fact that dietary habits in India do not call for the use of honey in a major way. In India, the consumption of honey is mainly in medicines with a relatively lower consumption directly as food. The other key product obtained from bee colonies – beeswax is primarily used in the manufacturing of cosmetics, soaps, pharmaceuticals, etc.

Migratory beekeeping provides good returns to the beekeeper as the returning bees to the hive are maximum, because of abundant flora in that region. In northern India, commercial beekeepers shift the colonies between plains and hills for migratory beekeeping. Ganganagar, Sanghria, Padampur, Bharatpur, Karanpur, Alwar areas of Rajasthan actively engaged in beekeeping and uses flora of Brassica campestris var. sarson and *B. juncea* in months of Oct-Dec mainly. Other than this honeybee also use jeera and azwain crop.
Constrains in Beekeeping

The major constrains in honey production in India are lack of scientific knowledge, Loss of natural habitat of honey bees- mainly due to deforestation, Lack of bee pasturage – plants providing pollen and nectar are diminishing, No financial support, Unorganised sector, Adulteration. Also Honey bee hives are supplied to beneficiaries under various government schemes who are not sufficiently trained to maintain hives and entire money and exercise goes waste as bees abandon the hives in short time. Persisting drought conditions in some districts of Rajasthan. Newly developed crop varieties / hybrids that are poor in nectar source to bees (particularly where mustard, sunflower and eucalyptus are grown) in Northern India. Difficulties in the migration of honey bee colonies due to difficult terrain/ topography, particularly in North East India and lack of coordination among beekeepers during migration of bee colonies leading to particular places resulting in overcrowding of apiaries.

Honey bees and the organized pollination they ensure shall be recognized as an input in agriculture to enable high level of crop productivity and food security and prevent pollinator decline. Crop varieties of bee friendly crops such as mustard, sunflower, oilseeds, pulses, vegetables, etc., suitable for pollinators shall be encouraged along with Bee friendly farm practices to reduce bee poisoning from poisonous pesticides. Effective coordination between beekeepers and farmers to be ensured.

Average Honey Yield per Year per Hive

<table>
<thead>
<tr>
<th>Bee spp.</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apis dorsata</td>
<td>36 kilograms (79 lb)</td>
</tr>
<tr>
<td>Apis cerana indica</td>
<td>6 kilograms (13 lb) to 8 kilograms (18 lb)</td>
</tr>
<tr>
<td>Apis florea</td>
<td>500 grams (18 oz)</td>
</tr>
<tr>
<td>Apis mellifera</td>
<td>25 kilograms (55 lb) to 40 kilograms (88 lb)</td>
</tr>
<tr>
<td>Tetragonula iridipennis</td>
<td>100 grams (3.5 oz)</td>
</tr>
</tbody>
</table>

References


8. AGROMETEOROLOGY

Yield Estimation

Priyanka Swami
Research Analyst (Agriculture Expert), Mahalanobis National Crop Forecast Center, New Delhi

Abstract

Ever increasing population has increased the demand of food supply, there is immense pressure of increasing yield. This can be achieved in two ways first by increasing the yield and the other by preventing the losses due to biotic and abiotic agents. In recent years we are very much closer to preventing the losses due to biotic agents which includes various diseases and insect-pest through IDM and molecular techniques. When it comes to losses due to abiotic agents which majorly includes losses due to inappropriate weather and physiological disorders we are still lacking behind as these are still difficult to forecast the losses going to occur due to abiotic factors.

Yield estimation is necessary not only for formulating the budget policy of the country but also for the contingency planning. Whenever there are severe losses due to any kind of disease epidemic or weather, it is essential to estimate the yield in advance in order to filling the gap which is going to occur.

Crop yield is necessary, particularly in countries that depend on agriculture as their main source of economy. Such predictions warn the decision makers about potential reduction in crop yields and allow timely import and export decision. Therefore policy of agricultural-economic and yield price are influence by the accuracy and speed crop yield estimation. Crop
yield estimation is very important in national and regional scale (Anup 2005).

Because of the population increment there is a growing need for micro-level planning and particularly the demand for crop insurance (Anup 2005), which increases the need for field level yield statistics.

Crop yield estimation has an important role on economy development (Hayest and Decker, 1996). These predictions warn the decision makers about potential reduction in crop yields and allow timely import and export decision.

Crop yield estimation in many countries are based on conventional techniques of data collection for crop and yield estimation based on ground-based field reports (Reynolds et al.2000). These methods are costly, time consuming and are prone to large errors due to incomplete ground observations, leading to poor crop yield assessment and crop area estimations. In most countries the data become available too late for appropriate actions to be taken to avert food shortage.

**Methods of Yield Estimation**

- Conventional methods
- Remote sensing methods.

**Conventional Methods**

For many years, crop yield estimation has been very important for government. There are many conventional methods to estimate crop yield. These methods are based on field reports. There are two conventional methods to estimate crop yield: empirical-statistical models and crop growth models (Jorgensen, 1994). In a definite region, empirical -statistical models consider crop yield for many years and effective factor on crop yield are found. Then crop yield is related to effective parameter by an empirical equation and the coefficient of each factor is found. Now by these coefficients, crop yield is estimated. Every set of empirical models relate crop yields to one set factors .In the most relations, effective factors are environmental. In those days uses of these methods were not tradition because satellite images were expensive and their spatial resolution was low. From 1990, above disadvantages were removed and high spatial and spectral resolution images were produced and most researches used these methods.

Now, most country uses these methods because there is a big archive of these images and we can use them easily. Now we have images that are produced with electromagnetic wave reflection and different vegetation indices are calculate from these images. These indices are commonly used for real time evaluation of vegetation health and productivity because green mass and content of water, protein...have effect on wave's reflection (Anup, 2005). Crop growth models estimate crop yield as function of complex interaction of different physiological processes with environment. These models estimate biomass production potential by daily crop growth simulator. Running of these methods has too many difficult such as: require too many ground factors, lake of data in a correct form and much cost. Conventional methods have some disadvantages:

- They can not consider over field
- Costly and time consuming
- They are not real time

Conventional methods are often complicated, costly, time consuming and they can not be run in large scale. Therefore it is necessary to use cheaper/faster methods for crop yield estimation.

**Remote sensing Methods**

Remote sensing data has the potential and the capacity to provide spatial information at global scale; of features and phenomena on earth on an almost real-time basis. Remote sensing data has the potential and the capacity to provide spatial information at global scale; of features and phenomena on earth on an almost real-time basis.

They have the potential not only in identifying crop classes but also of estimating crop yield.

Crop growth models focus on complex interaction of different physiological processes with environment. In fact these models describe growth stages. There are many ways to combine crop growth models and spectral observation from satellite data were initially described by MASS(1988) and their classification was revisited by Delecalle (1992). Three methods of data integration have been identified:
Direct use of a driving variable estimated from remote sensing information in the model;

The updating of state variable of the model (for example LAI) derived from remote sensing data;

The calibration of model variables by using satellite images (assimilation method)

The general strategy of the model/observations coupling consists of driving variables or parameters which directly occur in the modeling procedure from radiometric observations.

The direct use of remote sensing data to derive a variable assumes that remote sensing data are available at an adequate time step (from daily to weekly). Due to cloud contamination and intrinsic properties of sensors, this is rarely the case. Therefore, other approaches should be used.

Gaps between dates must therefore be filled by some interpolation procedure. Substitution of a simulated data value by an observed one (actually derived from the observed reflectance) suggests that simulated data is flawed, and therefore the biophysical processes are not well described by the model. But a good description of those processes is required to obtain a consistent estimation of variables such as crop biomass, which cannot be monitored directly by remote sensing.

Assimilation method consists of minimizing the difference between a derived state variable radiometric signal and its simulated. Difference between satellite observed and simulated value is minimized model parameter calibration.

They have the potential not only in identifying crop classes but also of estimating crop yield. Most studies have shown that there is a high correlation between vegetation spectral index extracted from satellite images and the green biomass and yield. Therefore, combining vegetation spectral index and the green biomass and yield can be used to estimate yield before harvesting (Groten, 1993). Agricultural production is a result of complex environmental such as solar radiation, water consumption and etc. Objective is a crop yield estimation method that can estimate crop yield as a function of these factors by minimum time and cost and maximum accuracy.

1. **Remote sensing methods based on Empirical-statistical models**: These methods are based on conventional methods, but here spectral indices are calculated from satellite images and not from ground measurement. Indices such as NDVI which calculation them by conventional methods are timely and consuming.

2. **Remote sensing methods based on water consuming balance model**: These methods estimate crop yield as a function of evaporation fraction during crop growth stages and use water consuming balance model to estimate evaporation fraction. At first whole growth period is divided to ten days sets and then evaporation fraction is calculated in these sets. If the growth period is divided to 30 days sets, some changes in crop water will be ignored also if model runs in daily format; it will be costly and time consuming.

3. **Remote sensing methods based on biomass estimation models**: A simple and useful paradigm for modeling crop yield with remote sensing is derived from Monteith (1972). This model uses biomass to estimate crop yield.

\[
\text{Biomass} = \text{APAR} \times e \quad (\text{Monteith, 1972})
\]

\[
\text{Crop yield} = \text{APAR} \times e \times HI
\]

Where:
- \(e\): the light-use efficiency in units of \(\text{g biomass MJ}^{-1}\)
- \(HI\): harvest index
- \(APAR\): absorbed photo synthetically active radiation

Variability in \(e\) can result from a variety of nutrient, water. Numerous studies have demonstrated that if not water short, and temperature is optimal, \(e\) is a relatively constant property of plants.

In some calculation the effect of temperature and soil moisture is considered for accuracy increment.

Like \(e\), \(HI\) is a relatively constant. Values of this factor are experimentally determined and described in the international literature. It can be calculated from crop information in the last years.

Variability in \(e\) and \(HI\) can result from a variety of nutrient, water, and temperature...
stresses (Russell et al., 1989). APAR is a fraction of PAR2 that absorbed by canopy. Richards and Townley-Smith (1987) indicated that the proportion of water used after synthesis affects the harvest index.

In this chapter crop yield estimation methods were discussed. Conventional methods were based on ground reports. Those were timely, consuming and could not consider over field therefore were prone to large errors due to incomplete ground observations, leading to poor crop yield assessment and crop area estimations (Reynolds et al. 2000).

Remote sensing methods removed above disadvantages simultaneously (X.Mo et al, 2004). Remote sensing methods based on Empirical -statistical models should be calibrated in other regional because factor weights were different in each region and those could not be run in large scale also ignored the effect of another factors.

Remote sensing methods based on water consuming balance model could be run in large scale but those ignored the effect of many parameters such as: solar radiation, photosynthesis magnitude...

Crop growth models were complete models that considered the most effect parameters. They could be run in large scale but entered to much agriculture science details and had lots of parameters. Therefore their runnings were costly and time consuming.

Monteith model considered effect of solar radiation and photosynthesis by APAR calculation and effect of temperature and soil moisture on crop yield. That model had few parameters that could be calculated from satellite images .That model could be run in large scale. Therefore, Monteith model estimated crop yield by maximum accuracy.

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9. PLANT BREEDING AND GENETICS

Pre-Breeding in Rice
S.Anandhi Lavanya and N.Vairam

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Introduction
Pre-breeding for Effective Use of Plant Genetic Resources, as part of a comprehensive strategy to develop a critical mass of personnel skilled in the genetic improvement of crops, this course aims at strengthening capacities at the interface between germplasm conservation and its use in plant breeding.
It is a necessary first step in the “linking genetic variability to utilization” use of diversity arising from wild relatives and other unimproved materials. These activities are a collaboration between the germplasm curator and the plant breeder who need to work together to understand the scope and value of germplasm collections and how new traits from these collections can be bred into new varieties.

**Definition**

Pre-breeding (PB) refers to all activities designed to identify desirable characteristics and/or genes from unadapted materials that cannot be used directly in breeding populations and to transfer these traits to an intermediate set of materials that breeders can use further in producing new varieties for farmers.

**Pre-Breeding for Accessing Novel Genes**

In crop improvement program depends on the availability of sufficient genetic variability, but this variability must be in conventionally usable form. The variability available in any crop germplasm conserved in gene banks for present and future use belongs broadly to the following three groups:

- Cultivated type
- Cross-compatible wild type
- Cross-incompatible wild type

**Major Applications of Pre-Breeding in Crop Improvement**

- Broadening the genetic base, to reduce vulnerability
- Identifying traits in exotic materials and moving those genes into material more readily accessed by breeders
- Moving genes from wild species into breeding populations when this appears to be the most effective strategy
- Identification and transfer of novel genes from unrelated species using genetic transformation techniques.

**Pre-breeding in Rice**

The rice pre-breeding is ultimately provide information to breeders that will enable them to make more efficient use of the genetic diversity of wild rice found within gene banks. The genotyping efforts conducted as part of this work will offer a useful tool for plant breeders hoping to identify genetic material in wild rice species with potential to improve elite rice lines through hybridization.

- Heat tolerance – *O. latifolia*, QTL yield – *O. rufipogon*, R to diseases – several sources
Conclusion
The process of pre-breeding identifies a useful character in unadapted materials, ‘captures’ it’s genetic diversity, and incorporates those genes into a usable form employing different techniques.

Future Prospects
Urgent need for collection, characterization and documentation of wild species, including crop wild relatives, due to increased likelihood of extinction for narrowly adapted and endemic species.

Genome mapping and synteny of the genes sequenced from wheat and barley could be assigned to encoding abiotic stress tolerance and can be utilized for crop improvement.

New breeding strategies and bioinformatics tools are required to use the information gathered from genetic and genome analysis programs for dealing with complex traits more effectively.

Reference

10. AGRIL. ENGINEERING
Ultrasound and its Applications in Food Processing
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Abstract
Consumer demand of nutritious, healthy food products with natural flavour and taste is increasing nowadays. The nutritional value of processed products in terms of vitamins, minerals, essential oils etc. reduces significantly because of higher amount of heat involved in traditional methods of processing. Thenon-thermal processing methods like pulsed electric and magnetic fields, cold plasma, irradiation, and high pressure processing can be useful for mild processing of food. This article aims to provide the brief information about applications of ultrasound in food processing.

Introduction
To date, the application of heat is the most common method for processing food, because of its ability to kill microorganisms and inactivate enzymes. However, heat processing particularly under severe conditions may give rise to chemical and physical changes that impair the organoleptic properties and reduce the content or bioavailability of some nutrients. Therefore, the food industry is constantly searching for emergent mild processing technologies such as high pressure processing, pulsed electric and magnetic fields, etc, not only to obtain high-quality food with “fresh-like” characteristics, but also food with improved or even novel functionalities. The main aims of these non-thermal methods are to reduce the time of processing, energy saving and improving the shelf life of food products with maintaining its nutritional value. One of the such effective mild processing technology is ultrasound.

Classification of Ultrasound
Sound is vibration that transmitted in a medium mostly air, and can be heard by human ear. Human can hear frequencies of 20Hz -20,000Hz. The frequencies <20 Hz are called “infrasound” and >20,000 Hz are called “ultrasounds”. Ultrasounds are classified into two groups. Low energy ultrasounds (frequencies >100 kHz and intensity <1 W/cm²) which are non-destructive that cannot cause physical or chemical alterations in the product. Second group is high energy ultrasound.
(frequencies 18-100 kHz and intensity >1 W/cm²) which cause physical, mechanical or chemical effects on material.

**Principal of Ultrasound**

When ultrasound waves meet a medium, it creates regions of alternating compression and expansion. These regions of pressure change cause cavitation’s/bubbles formation in the medium as shown in Fig 1. These bubbles are larger in size during the expansion cycle, which increases gas diffusion, causing the bubble to expand. When the ultrasonic energy is insufficient to retain the vapor phase in the bubbles then rapid condensation occurs. The condensed molecules collide and create shock waves. These shock waves create regions of high temperature and pressure. The ability of ultrasound to cause cavitation’s depends on ultrasound characteristics (frequency, intensity), product properties (viscosity, surface tension) and ambient conditions (temperature, pressure). The basic parts of ultrasonic systems are power generator which is the source of electrical power supply, the transducer which causes vibrations and a reactor (probe) as shown in Fig 2.

**Applications of Ultrasound in Food Industries**

Ultrasound has wide applications in food industries and some of these are discussed below.

1. **Inactivation of microorganisms and enzymes:** The food industry has generally concentrated on inactivating or killing microorganisms and enzymes as a means of preservation by giving heat treatment. However, heat can reduce some nutrients and organolptic properties of the material. Ultrasounds can effectively used for destruction of microorganisms with retaining nutritional properties of food. Work examined the reduction in light emission from a seawater suspension of rod shaped *Bacillus fisheri* caused by sonication at 375 kHz under temperature-controlled conditions. Mono thermosonication treatments proved to be much more efficient than heat treatment for inactivating enzymes.

2. **Mixing and homogenization:** Ultrasonic vibrations are generated during the flow of a liquid used in homogenization and mixing. The required operating pressure and throughput is determined by the use of different sized orifices or jets and the velocity can be changed to achieve the necessary particle size or degree of dispersion.

3. **Filtration:** The use of ultrasound enables the filtration system to operate more efficiently and for much longer periods. First, sonication will cause agglomeration of fine particles and, secondly, will supply sufficient vibrational energy to the system to keep the particles partly suspended and therefore leave more free ‘channels’ for solvent elution.

4. **Drying:** The use of ultrasonic energy in drying is very promising because it can act without affecting the main characteristics and quality of the products. Different authors reported studies of acoustic drying of a
number of materials using airborne radiation, ultrasonic vibration in contact with food, products immersed in hypertonic solutions, in sugar solutions and in salt brine.

5. Extraction: It is also used in extraction of valuable compounds from vegetables and food products. It is particularly useful in combination with conventional solvent extraction. The beneficial effects of ultrasound derive from its mechanical effects on the process by increasing the penetration of the solvent into the product and enhancing the mass transfer process.

6. Sonocrystallization: Ultrasounds in the range of 20 kHz and up to MHz range is used for crystallization of liquids and melts, which is used in fat fractionation such as separating stearin (high melting) and olein (low melting) from a triglyceride oil. Ultrasonication decreased the crystallization induction times of both triglycerides, increased nucleation rate.

7. Emulsification: Emulsification is the process of mixing two immiscible phases (e.g., oil and water) with the aid of a surface active agent (emulsifier) into homogeneous dispersion. With ultrasonication, the collapse of cavitation releases forms high energy micro jets near interfaces and facilitate emulsification. Compared to mechanical agitation, the use of ultrasound required less amounts of surfactants.

Conclusion
Ultrasounds in food industries is the novel way to maintain the national quality, flavor, color and aesthetic value of food products in environment friendly manner with reduced time, labor, cost, energy and increased production of high value safe food products. A lot of future research is necessary to take the advantage of this emerging technology and to make it popularize in the food industries.

References


generation advancement. SB is most suitable for long days plant along with day neutral plants. Not many successes have been seen with short day plants instead facultative short days plant responds well to speed breeding protocol. SB fits well in breeding pipeline reducing crossing and inbreeding cycle to greater extent thereby doubling the genetic gain.

**Major global Challenges for Plant Breeders**

The growing human population and a changing environmental have raised significant concern for global food security, with the inadequate current improvement rate of several important crops to meet further demands. This slow improvement rate is attributed partly to the long generation times of the crop plants. The introduction of few alleles through rapid breeding cycle seems to be one possible scenario to substantially boost the rate of gain and can help to achieve the ‘2050 challenge’.

**Methods of Speed Breeding:** the speed breeding ‘recipe’ is highly flexible

1. **Speed Breeding I** – controlled environment chamber conditions (John Innes Centre, UK)
   a. Photoperiod : 22Hrs (light)/ 2Hrs Dark
   b. Temperature: 22°C (photoperiod)/ 17°C (Dark)
   c. Humidity : 70%
   d. Light : white LED, fr LED & Ceramic metal halide lamp
   e. Light Intensity : 360–380 (bench ht) & 490–500 (Adult Plant ht) \(\text{mol m}^{-2} \text{s}^{-1}\)

2. **Speed Breeding II** – glasshouse conditions (Hickey Lab, Univ. of Queensland, Australia)
   a. A temperature controlled glasshouse fitted with high pressure sodium vapor lamp
   b. Photoperiod : 22Hrs (light)/ 2Hrs Dark
   c. Temperature: 22°C (photoperiod)/ 17°C (Dark)
   d. Humidity : 70%

3. **Speed Breeding III** – low cost homemade growth room design (Hickey Lab, Univ. of Queensland, Australia)
   a. Photoperiod : 12Hrs-12Hrs (Light-Dark) for 4 wks then increased to 18Hrs-6Hrs
   b. Temperature: 21°C (photoperiod)/ 18°C (Dark)
   c. Light : 7 -8 LED light boxes (Grow Candy)
   d. Intensity : 210–260 (bench ht) & 340–590 (Adult Plant ht) \(\text{mol m}^{-2} \text{s}^{-1}\)

**Advantage of Speed Breeding**

- Multiple generation in one year
- Fast way to obtain fixed homozygous lines through Single Seed Descent method
- Phenotypic selection in early segregating generations
- Rapid introgression genes into elite lines using Marker Assisted Selection
- Allows study of plant – pathogen interaction, flowering time etc.
- Multi- environmental trial across years
- Integrated with genomics selection, genome editing etc.
- High – throughput phenotypic screens for multiple traits
- Exploit gene bank accessions and mutant collection for rapid gene discovery

**Limitation of Speed Breeding**

- Extended photoperiods may cause injury in some crops
- Unlikely to be successful in short-day crops such as maize or rice
- Disease outbreak using controlled environmental conditions
- Plant losses in Single Seed Descent during greenhouse condition
- Increased monetary costs
- Incorporation of relatively simple inherited traits

**Conclusion**

1. Speed breeding may be considered as promising breeding strategy to achieve 2050 genetic gain targets for the four Fs (food, feed, fibre and fuel).
2. Speed breeding can produce up to 6 generation per year for spring wheat, durum
wheat, barley, chickpea and pea and 4
generation for canola instead of 2-3
under normal glasshouse conditions.
3. Phenotyping with speed breeding has
made it possible to conduct up to four
consecutive screens of multiple
quantitative traits annually, compared to
a single screen in the field of durum
wheat.
4. It was proved to be useful to rapidly
transfer genes for multiple disease
resistance traits into two-rowed barley
cultivar Scarlett or pyramiding these traits in
elite breeding material.
5. The combination of speed breeding
techniques and a single seed decent breeding
strategy was found successful in reducing
generation time of full-season maturity
peanut cultivar from 145 to 89 days for
developing new cultivars compared to
conventional systems.

12. AGRICULTURAL ENTOMOLGY

Fascinating Facts about Fireflies
Niranjanadevi J*

Introduction
Luminous fireflies are a roadside
attraction group of insects which act as
environmental indicators and indicate the
quality of surrounding milieus (Ramesh,
2020). The name "firefly" is a little
misleading. Fireflies are nocturnal members
of Lampyridae (Greek means "to shine") a
family of winged beetles. But "firebeetles"
doesn't have the same ring to it. There are
more than 2,000 species of fireflies. And only
some of those species have the ability to light
up. Fireflies belong to the glow-worm family
Lampyridae of which there are more than
two thousand species throughout the world,
especially in the tropics. It is hypothesized
that different species of fireflies emit
different wavelength regions because of
slight differences in their enzyme structures
(Gohain et al., 2012).

Fireflies are just one type of
bioluminescent species
Fireflies are beetles in the family Lampyridae
and are known to give conspecific light signals for
courtship and predation (Lewis and Cratsley,
2008). The relationship between fires flys and
humans has been marvelous from ancient days,
and this is exemplified in the historical cultural
traditions of Southeast Asia, particularly Japan
(Nagoaka), Taiwan (Alishan) and India
(Purushwadi), indicating the importance of
fireflies in ancient days. Over the centuries, firefly
luminescent genes have been used in myriad
applications, including biomedical, toxicological,
and disease propagation studies (Fallon et al.
2018). The principal components involved in
firefly luminescence emission are luciferase and
luciferin and ATP-Mg$^2+$; the biochemical reaction
of firefly luminescence was documented
previously (Marques and da Silva 2009). Luciola
praeusta is one of the well
studied fireflies in
Southeast Asia and especially in India. It was
recently identified as Ab.
chinesis (Ballantyne et al., 2019). Morphologically, Abs.
chinesis belongs to the family Lampyridae. It is
usually found along marshy areas, freshwater
canals, paddy fields and shrubs. The dorsal
appearance of Abs. chinesis is identical to some
other fireflies, namely Curtos costipennis (Fu
et al., 2012), Pteroptyx maipo (Ballantyne et al.
2011) and Absocondita sp. (Ballantyne et al. 2013);
only ventral body segments and the elytral apex
arrangement differentiate these species.
Bioluminescent fireflies have been well studied in
regions other than India (Viviani and Santos
In India, bioluminescent emission of fireflies *Abs. chinensis* (Rabha et al., 2017) and *Asymmetricata circumdata* (Goswami et al., 2015) are well understood from the northeastern region. The peak wavelengths of steady-state yellow luminescence spectra from *Abs. chinensis* and *A. circumdata* were detected at 562 nm (Barua et al. 2009) and 570 nm (Goswami et al. 2015), respectively. The bioluminescence spectra of other species of Indian fireflies *Photinus pyralis, Phengodes lacticollis* and *Photuris pennsylvanica* were also recorded on a glass spectrograph (Saikia et al. 2001). Also, the luciferase enzyme, an important catalyst in the chemical reaction of luminescence emission of *Abs. chinensis*, was recently isolated, and was found to have a molecular weight of 64 kDa, higher than other commonly studied firefly species (Muthukumaran et al. 2014).

**Fireflies are Energy Efficient**

Fireflies' lights are the most efficient lights in the world. One-hundred percent of the energy created is emitted through the light. In comparison, an incandescent bulb emits 10 percent of its energy as light and a fluorescent bulb emits 90 percent of its energy through light. Fireflies' efficiency is partly done to luciferin's heat resistant properties.

The emission spectrum of firefly of an Indian species *Luciola praeusta* (Fig. 2) by a spectrometer, it is found that it emits light ranging from 537 nm (green) to 592 (yellow) nm giving peak value at 562 nm (yellow) (Gohain et al., 2009).

**Their Light Shows are Mating Acts**

Most of the fireflies flying around are males looking for a mate. Each species has a specific light pattern that they use to communicate with each other. Once a female spots a male she likes, she will respond with the same light pattern. Usually females are perched on plants, waiting for a mate.

**Some Species Synchronize Their Flashing**

Scientists aren't sure why fireflies do this, but some theories include competition or to make them more noticeable. If a bunch of male fireflies are flashing the pattern at the same time, they are more likely to attract females. The only species of fireflies in America that do this are the *Photinus carolinus*. They live in the Great Smoky Mountains and the U.S. National Park Service organizes watch parties for the shows.

**Not all Firefly Light Looks the Same**

Each species has their own specific color of light they produce, some glow blue or green while others glow orange or yellow.
They Taste Disgusting

Unlike cicadas, these summer bugs should not be cooked, baked or grilled. If you do try to eat a firefly, it will probably taste bitter. The beetles can even be poisonous to some animals. When fireflies are attacked, they shed drops of blood. The blood contains chemicals that create the bitter taste and poison. Most animals have learned this and avoid munching on fireflies.

Fireflies Sometimes Practice Cannibalism

When fireflies are still in the larvae stage, they snack on snails. Usually as they mature, they move away from meat. Scientists believe adult fireflies live off of nectar and pollen or they don’t eat at all. But others, especially the Photuris fireflies enjoy their own kind. Photuris females often eat males of other genera. They attract the unsuspecting males by mimicking their light pattern.

Their Numbers are Declining

There are several reasons why firefly populations are declining, including climate change and the harvesting of luciferase from them, light pollution and habitat destruction. When firefly habitats are destroyed for roads or other construction, they don’t migrate to a new spot, they simply disappear.

Conclusion

The studies on this particular species were not attempted in south India. Particularly in the current scenario of climate change, the Abs chinensis population around Southeast Asia is known to be declining gradually. Despite the numerous studies on the application of fireflies, documentation on the population trend in firefly species is lacking and need to be explored it.

Reference


13. AGRICULTURAL ENTOMOLOGY

Do Insects sleep?

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Introduction

Sleep is essential for proper brain function in mammals and insects. During sleep, animals are disconnected from the external world; they show high arousal thresholds and changed brain activity. Sleep deprivation results in a sleep rebound. Research using the fruit fly, Drosophila melanogaster, has helped us understand the genetic and neuronal control of sleep. Genes involved in sleep control code for ion channels, factors influencing neurotransmission and neuromodulation, and proteins involved in the circadian clock. The neurotransmitters/neuromodulators involved in sleep control are GABA, dopamine, acetylcholine, serotonin, and several neuropeptides. Sleep is controlled by the interplay between sleep homeostasis and the circadian clock. Putative sleep-wake centers are located in higher-order brain centers that are indirectly connected to the circadian clock network. The primary function of sleep appears to be the downscaling of synapses that have been built up during wakefulness. Thus, brain homeostasis is maintained and learning and memory are assured.

Insects Do Sleep

So, by most reports, the answer is yes, insects do sleep. Insects clearly rest at times and are aroused only by strong stimuli: the heat of day, the darkness of night, or perhaps a sudden attack by a predator. This state of deep rest is called torpor and is the closest behavior to true sleep that bugs exhibit.

Sleep is a fascinating behavioral state whose function still remains unclear. Humans spend about one-third of their life sleeping, and many other mammalian species such as (o)possums (Didelphis marsupialis, Lutreolina crassicaudata, Trichosurus vulpecula), kangaroos (Megaleia rufa) or kangaroo rats (Potorous apicalis), tree shrews (Tupaia glis), hedgehogs (Erinaceus europaeus), beavers (Aplodontia rufa), chipmunks (Tamias striatus), golden hamsters (Mesocricetus auratus), and rats (Rattus norvegicus) spend more than half of their life sleeping (Campbell and Tobler, 1984; Tobler, 1995). Although short sleepers such as elephants (Elephas maximus, Loxodonta africana), horses (Equus caballus), donkeys (E. asinus), tapirs (Tapirus terrestris), cows (Bos taurus), and sheep (Ovis aries) show consolidated sleep periods of only 3–5 h per 24-h cycle, sleep nevertheless appears to be an essential part of animal life. In the sleep state, animals are disconnected from the external world, owing to elevated sensory thresholds, at considerable risks and costs to the individuals. During sleep,
animals cannot forage or take care of their young. Nor can they escape from potentially life-threatening situations. Thus, there must be a vital benefit of sleep. Indeed, a life without sleep seems impossible. Prolonged sleep deprivation in rats results in death (Rechtschaffen et al., 1989). Also, humans with fatal familial insomnia eventually die within one to two years (Cortelli et al. 1999). Humans present impaired cognitive performance after only one day of sleep deprivation, and longer sleep deprivation results in hallucinations and alalia (speech delay), indicating the importance of sleep for proper brain function. Sleep is similarly important for invertebrates, including insects. In honey bees (Apis mellifera), sleep deprivation at night impairs the precision of waggle dance signaling (Klein et al., 2010) and reduces the probability of successfully returning to the hive the following day (Beyaert et al., 2012). In fruit flies (Drosophila melanogaster), sleep deprivation causes defects in short- and long-term memory (Seugnet et al., 2011) but significantly improves learning and memory (Dissel et al., 2015). Because the insect brain is simpler than a mammal’s brain, the study of sleep in insects promises new insights into its neuronal basis and functional role. Here, discussed about our current understanding of sleep in insects.

The Genetic and Molecular Basis of Sleep

Genes that affect sleep across species can be categorized as genes that (a) code for ion channels, (b) affect neurotransmission and neuromodulation, and (c) affect circadian rhythms (Chung et al., 2017).

Outlook

Although much work has been done and a large number of contributions have been made, sleep remains a fascinating state that is not completely understood. Further studies in the fruit fly have the potential to unravel the precise brain areas involved in sleep control as well as the molecular mechanisms of sleep need. Studies in other insects, which have a rich behavioral repertoire, will help resolve the physiological mechanisms of sleep. It will also be most interesting to know the depth at which migratory locusts (Locusta migratoria) or monarch butterflies (Danaus plexippus) sleep and what happens to their brain during migration. If researchers involved in the sleep field focus on the inherent strength of insect systems, not only will their results be of interest to entomologists, but they may also be relevant to a greater audience.

Reference


14. BIOTECHNOLOGY

Bio-Fortified Fruit Crops: A Way to Overcome Malnutrition

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“Biological fortification” or “Bio-fortification” refers to the process of increasing nutritional value of the crops with higher bioavailability of the nutrients to the animals including humans using several methods such as agronomic practices, modern biotechnological tools, and conventional plant breeding. The majority of the population of under-developed and developing countries is overwhelmed with the problem of undernourishment and famine. Biofortification of crops is a promising approach for combating the undernourishment problem. A report of FAO, International Fund for Agricultural Development, and World Food Program in 2015 revealed that about 792.5 million people of the world are undernourished, among them 780 million people belong from underdeveloped and developing countries. Excluding this problem, approximately 2 billion of the world population experience another type of malnutrition referred to as “hidden hunger,” caused because of eating food with is poor in essential micronutrients necessary for appropriate development and functioning of the human body. Vitamin A deficiency (VAD) dominant in underdeveloping countries among women’s and children’s which causes >600,000 deaths/year globally among children less than 5 years of age. The key micronutrients including vitamin A, iodine, iron, zinc and selenium, whose deficiency, are major among the undernourished population. Fruits are a vital source of vitamins, antioxidants, micronutrients, macronutrients and are also contained several medicinal properties. Therefore, bio-fortification of fruits crops for a specific deficient nutrient can facilitate in reduces the problem of undernourishment to a larger level besides its other valuable characteristics.

Strategies to Achieve Bio-fortification:

Bio-fortification of any crop can be performed using three methods: agronomic practices, conventional breeding, and transgenic developments.

Conventional Breeding:

It is a more sustainable, publically accepted and cost-effective approach other than two methods. In which the natural genetic variation observed in the crop species can be explored to improve the crop plants. The first step is the identification of crop species with a higher level of nutrients and the use of suitable breeding strategies to transfer targeted traits in the crop plants.
Transformation

This approach is very useful when limited or lack of genetic variation among the genotypes, or among plant species or when the crop is not suitable for conventional plant breeding because of sexuality incompatibility, sterility, etc; e.g. banana) for enhanced nutrient contents. It involves isolation, transformation, and expression of candidate gene underlying enhancement of nutrition level and bioavailability. It allows the use of candidate genes from within species or different genera. But associated regulatory hurdles limited its application.

Agronomic practices

This method of bio-fortification is simple, cheaper and it is a short-term measure. Within certain limits externally apply deficient nutrients directly to the crop plants through the application of fertilizer either by soil or by foliar application to increase mineral accumulation. The extent of success in this method proportionally depends on the mobility of mineral elements in the plant as well as in the soil. The factors like mineral mobility, application methods and its accumulation in a plant which limits its application in crop plants. Minerals like zinc, selenium, and iodine are highly mobile in nature so its fortification through fertilizer application in more feasible. It only works if the mineral deficiency in the fruit reflects the lack of that mineral in the soil and if the mineral fertilizer contains minerals that are rapidly and easily mobilizable.

Bio-fortified Fruit Crops

1. **Banana:** In Asia and sub-Saharan Africa plantain and banana is a staple food crop and it is observed a low level of iron and pro-vitamin A, caused to iron and vitamin A deficiency in the population. Therefore, bio-fortified plantain and banana with a higher level of iron and pro-vitamin would help to resolve the problem of undernourishment to a greater extent. But, a conventional breeding strategy has limitations due to due to its cross incompatibility and sterile nature. In such case, transgenic development can be a solution. For these reason banana genotypes with higher levels of pro-vitamin A banana have been identified and this trait has been transformed to the cultivated Cavendish banana. Five varieties (Lai, Bira, Apanu, To’o, and Pelipita,) rich in pro-vitamin A were released by HarvestPlus for African countries.

2. **Apple:** Apple is an important source of antioxidants and nutrients offer healthy life to humans. To enhance its antioxidant contents, a gene stilbene synthase from grape has been transformed into apple, which improves the synthesis of resveratrol.

3. **Mango:** Mango is a great source of vitamin C, β-carotene, and many other important antioxidants. Indian Agricultural Institute released several improved mango hybrids with higher level of β-carotene, vitamin C, and TSS content which includes Pusa Peetamber, Pusa Lalima, Pusa Shreshth, and Amrapali.

4. **Grape:** Grapes have high vitamin C, mineral content and polyphenolic compounds and antioxidants that provide health benefits. Nutrient bio-fortification in grapes has been performed through hybrid breeding. The Indian Agricultural Institute has released improved grape hybrids including Pusa Navrang which contains higher amount of minerals antioxidants and TSS.

5. **Pomegranate:** Pomegranate is also a rich source of polyphenolic compounds, antioxidants and minerals. A Lal, hybrid developed by NRC, Pomegranate, Solapur is rich in vitamin C, zinc and iron as compared to compared most cultivated varieties.

6. **Pumpkin:** Bio-fortified pumkin for enhanced Provitamin A and Carotenoids was released in Brazil.

Conclusion and Future Perspectives

It is recognized that biofortification is a cost-effective, promising agricultural approach to enhance the nutritional quality of food/fruit crops ultimately reduces malnourished populations across the world. The production of biofortified food/fruit crops with enhanced nutrient contents such as higher in zinc, provitamin A, iron, and Se content are supplying adequate levels of these micronutrients that are often lacking in the diets of the developing countries. A bio-fortified crop has an incredible
bright future as these have the ability to remove micronutrient malnutrition among billions of poor people, especially in the developing countries.

References

15. BIO-TECHNOLOGY

Why Bt-Brinjal Needed for Indian Farmers?
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Introduction
Brinjal is a poor man’s vegetable due to its popularity among low-income consumers and small farmers. Often called a king of vegetables and is found in the dishes of almost all homes in India, despite income levels, food choices, and social status. It is high in nutrition and low in calories, the vegetable has an excellent source of vitamins B and C, fiber, phosphorus, folate, and calcium. India grows brinjal on nearly 550,000 hectares land, it makes the second major producer after China with a 26% of world production. It is an important cash crop of >1.4 million resource-poor, small and marginal farmers. Brinjal is a drought-tolerant crop that can yields well even under drought conditions, grown nearly all parts of the country. West Bengal (30% production share) is major brinjal cultivating state followed by Orissa (20%), and Gujarat (10%) and Bihar (10%).

Despite its popularity between resource-poor and small farmers, brinjal farming is often high input-intensive, particularly due to insecticide uses. Brinjal crop is prone to attack of diseases and insect pests, the main severe and destructive pest is fruit and shoot borer (FSB) (Leucinodes orbonalis). FSB feeds on brinjal and it is widespread in all brinjal cultivating states. It creates a severe problem due to its higher reproductive potential. FSB larvae bore into fruits and tender shoots, impede plant growth, so fruits become unfit for human consumption and inappropriate for the market. Fruit damage as high as 95% and losses of up to 70% in commercial farming. Farmers protest in Maharashtra arrives soon after the government of Haryana uprooted genetically engineered brinjal crops from a farmer’s field. Several farmers illegally planting Bt brinjal is an offense that violates the Indian Biodiversity Act 1998. Organized farmers union demanding the commercial release of Bt brinjal, which farmers believed that reduces the cost of production. Commercialization of Bt brinjal variety has drawn support and criticism. The moratorium on Bt brinjal was the unfortunate move taken by the Indian government. But Bangladesh has used India’s research results to effectively cultivate Bt brinjal.

What is Bt brinjal?
Bt brinjal is a genetically engineered crop plant or genetically engineered pest-resistant brinjal plant, which synthesizes an insecticidal protein to combat pests like fruit and shoot borer. The transformation of one or more novel genes in the background of a brinjal variety to get novel trait through genetic engineering is called transgenics brinjal or genetically modified brinjal crop plant (GM brinjal). Bt brinjal contains the cry1Ac gene from a soil bacterium called *Bacillus thuringiensis*, driven by the cauliflower mosaic virus 35S (CaMV35S) promoter, which makes sure the cry protein produced in all the brinjal crop tissues crops throughout its life. The aad and nptII are selectable marker genes were used. Bt brinjal plant is intended to provide the resistance against lepidopteran insects like the brinjal fruit and shoot borer (Leucinodes orbonalis).
Attempted Commercialization of Bt-brinjal in India

In 2005 India’s dominant seed company, Maharashtra Hybrid Seed Company Ltd. (Mahyco) developed an event EE-1. The event EE-1 was introgressed through plant breeding methods into local varieties. In 2009 a second expert committee (EC-II) inspected the biosafety and trial data. They concluded that enough trials and safety tests had been carried out. EC-II recommended commercialization of Bt brinjal to the Genetic Engineering Appraisal Committee (GEAC). The GEAC allow Bt brinjal for commercialization on 14 Oct 2009. But after public outcry and concerns raised by some scientist, Anti-GMO activist, and farmers, the Indian government announced a moratorium on its commercial release until additional, unspecified tests were performed.

The Necessity of Bt-brinjal to Indian Farmers

Lack of resistance against FSB in brinjal germplasm and limited success with traditional management strategies along with a hybridization program enormous use of pesticides lead to the development of resistance against pest and harmful effects of pesticide residues on the environment, health of farmers and consumers.

The Economic Loss of Brinjal Crop due to Shoot and Fruit Borer Infestation

Brinjal production is comparatively low due to monophagous pest shoot and fruit borer infestation a major constraint to yield. Borer infestation of 78.66% on top shoots in the vegetative stage and after that moved to flowers and fruits with infestation getting 67% in fruiting stage. Brinjal shoot and fruit borer is an extremely dangerous pest of brinjal. It reduces the yield up to 80% by making holes in shoots and in fruits thereby lowers the aesthetic value of the fruits so loss gets twice. This pest is generally disperses West Bengal, Maharashtra, M.P, Bihar. A single caterpillar might destroy 4-6 fruits. Extensive use of pesticide applications also increases to the cost of non-Bt brinjal farming.

Socioeconomic, Environmental and Health Benefits of Bt-Brinjal

Supporter of Bt technology consider that the Bt brinjal will have positive effects on the health of farmers, consumers, environment, and the Indian economy. Field trials carried out on research farms performed by ICAR and MAHYCO suggested a 42% pesticide decrease and doubling of production was possible. The number of damaged fruits observed ranged from 2.5% to 20% in Bt brinjal to 24% to 60% in non-Bt varieties. Adaption of Bt brinjal, lessen the costs of marginal and small farmers by 25-80%, mainly due to the decrease in pesticide application. The profit of Bt brinjal translates to an average increase of 166% over popular open-pollinated varieties (OPVs) and 116% in marketable fruits over conventional hybrids. Additionally, the major decrease in insecticide application decreases the farmer’s exposure to insecticides and leads in a considerable decline in pesticide residues on brinjal fruits. Expert has calculated that Bt brinjal will provide farmers a net economic profit from Rs.16,299 to Rs.19,744/acre with national profit to India more than $400 million/year.

Conclusion

Bt brinjal has huge potential to benefit both farmers, consumers, and country. Results of studies submitted to regulatory authorities in India prove that Bt brinjal propose the opportunity to offer efficient control against Shoot and fruit borer, and reduces insecticide input by more than 50%. Bt-brinjal also provide more marketable fruit than non Bt-hybrids and open-pollinated varieties.

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16. VETERINARY SCIENCE

Natural Remedies against Ringworm in Ruminants
Krutika Khiratkar and Dr. Swati Umap
Mumbai Veterinary College, Mumbai, Maharasra

Ringworms are hairless, circular skin lesion caused by fungal infection affecting the keratin of skin and hair. Cattle, sheep and goats are mainly affected; also horse and humans can get the infection.

Causative Agent
Trichophyton verrucosum is the principle agent affecting cattle with other types of fungi while sheep and goats are mainly infected by two types of fungi – Trichophyton verrucosum and Microsporum.

Transmission
This spore forming fungi is resistant to ordinary cleaning by the detergent so stays in the shed and acts as a source of infection for others affecting the animals in winter season. Direct contact with the infected animal is most common route.

Young animals and calves are mainly infected by this fungi causing lesions around the eyes, on the ears and back. While adult cattle are rarely infected and show infection in immuno-compromised state when exposed to infected young stock. Sheep and goats are rarely infected.

Clinical SIGNS
- This typical fungal infection shows grey-white areas of skin with powdery texture and scant hair lesions are mostly circular.
- With time the severe lesion becomes thickened with scales and leaves raw bleeding surface when removed.
- In sheep, 4-6 cm diameter scabs can be seen on the wool covered part of the body.
- When this wool cover is removed, one can see the underlying skin as inflamed and bleeds readily.

It is a self-limiting disease and resolves in weeks but the animal infected acts as a source of infection for other animals.

By using some natural remedies this infection can be treated: (Scrape the infected area properly and clean it before using these remedies)

1. **Apple cider Vinegar**: having natural acids and probiotics, apple cider has high healing properties. Apply the apple cider vinegar with cotton ball on the clean scraped area. Apply it regularly thrice a day till the area heals.

2. **Waste oil/axe Grease**: after scraping and cleaning the infected area, apply the waste oil on that part ad let it dry completely before leaving the animal into the shed. Direct application of the oil can be done, with small portions at a time till the area begins to clear.

3. **Bread Soda and Paraffin oil**: it is the best remedy for calves. After cleaning the area apply the mixture directly on the area and let it dry completely before leaving the animal into the herd.

4. **Others Oils**: Tea tee oil, coconut oil having various properties works for ringworm infection also. Direct application of these oils
Prevention

• Management practises plays a crucial role for the control of this infection.
• Animals showing lesions should be separated immediately to stop the spread of infection.
• The fungi spores being resistant reside in the shed, so disinfection and cleaning of the shed and premises should be done properly.
• Over-crowding should be avoided.
• Increased exposure to sunlight and maintaining of the animals on dry lot should be done to prevent the re-infection.
• Proper nutrition should be provided that is rich in vitamin A, zinc and copper that helps in raising the resistance of the animal.
• Vaccination of all the animals should be performed by using Bovilis Ringvac™.
• Initially the whole herd and new animals introduced in the herd should undergo the vaccination. A course of two vaccinations is given i.e 10-14 days apart.
• While in closed herds, only young calves should be re-vaccinated at 2 weeks of age and second injection given 10-14 days apart.
• Quarantine of all new animals should be done for at least of two weeks.

References

17. AGRICULTURE

Natural Ways to Fight Ectoparasites in Dogs
Krutika Khiratkar and Dr. Swati Umap
Mumbai Veterinary College, Mumbai, Maharashtra

Pet animals have become a very important part of our life. Dogs, specifically are the most attractive and adorable pets. Humans and dogs have a special relationship from the early ages. So healthcare and management of these furry animals is a necessity. Owners go through various problems while maintaining the animal. As going to a veterinarian often is not feasible and cost effective.

Common symptoms observed in dogs for ectoparasitic infestation are

• Fever
• Irritation, Restlessness
• Intense scratching
• Loss of hair in various areas all over the body.
• Various skin eruptions, which can be crusty and ooze out pus or may bleed.
• Head shaking or scratching of ears

Precautionary measures to be taken

• Do not allow the dog to lick the
• All natural products used some be in pure form.
• Products should be applied or administered in hygienic conditions.
• In extreme cases, consult the veterinarian.

1. Fleas: Fleas are the major issue concerned with animal. It stays on the animal's body mainly on dogs and cats. These fleas bite the animal which leads to the itching rash and
bleeding. The animal scratches itself at various areas like ear, head, back and tail area causing red spots and inflammation. A flea cause allergies like (flea allergic dermatitis) and also transmits various diseases like bubonic plague, Murine typhus affecting humans and pets. Preventing fleas is an important and difficult task. Several natural ways are present by which fleas can be controlled.

**Natural Remedies**

- Fleas can be controlled by rubbing small amount of the lemon or orange juice on the dog's body that will not allow the fleas to settle on the body.

- Also by adding a small amount i.e. a teaspoon of apple cider vinegar in quarter amount of dog’s water can also help in preventing the flea’s infestation.

- Applying neem oil or eucalyptus oil (nilgiri oil) on the dog’s body can prevent fleas.

- Give brewer's yeast to dogs with small amount of garlic in it.

2. **Ticks:** Ticks are commonly found on dog’s body. Ticks burrow their heads in the animal skin and suck up the blood till their body is full and drop off which causes anaemic condition in dogs. Ticks are the major source of various diseases like babesiosis, anaplasmosis, Lyme disease, tick paralysis, erlichiosis. By some natural ways these ticks can be prevented.

**Natural Remedies**

- Tobacco- It has an insecticide activity due to the presence of active component Nicotine. Rubbing the tobacco leaves directly on animal's body or juice of tobacco leaves can be applied on the dog's body which will prevent the ticks.

- Mint leaves- Has great defence activity against ticks. Add 10 teaspoons of apple cider vinegar in warm water, mix juice of two lemons in it. Soak 10-15 mint leaves in this solution for overnight. Strain the mixture next day and spray it on the dog's body. Do it for 2 months to get rid of ticks completely.

- Neem leaves/oil- Neem leaves or oil used for ticks has protective action. Just rub little amount of neem oil on your pets body gently or you can also give bath to the pet with neem leaves in warm water.

- Cloves- Having anti-inflammatory and antibacterial properties cloves are effective against ticks. Mix 3 camphor crystals and 3 dried cloves in 1 litre of ethanol/ alcohol till it fully dissolves. Add 1 cup of apple cider vinegar to it. Spray this mixture on your pet's body, let it stay for 2 hours and then rinse with water.

- Lemon- Has citric acid which helps preventing the ticks. Mix juice of lemon along with the pulp and peels in 1 cup of water. Simmer for few minutes and add this mixture in regular bath water which will act as a disinfectant solution. Or take a slice of lemon and put it in boiling water and leave it overnight. Sponge this solution on specific areas troubling the Dog.

3. **Mites:** Skin irritation caused due to mites is known as ‘ mange’. Mites are tiny parasites residing on the animal’s body. Usually mites are normally present on the animal’s body and don’t cause any side effects unless the dog’s immune system is compromised. When their population increases, this leads to itching and inflammation on animal’s body and dogs having compromised immune system suffer badly. Four types of mites have been identified i.e. sarcoptic mites, demodecosis mites, otodectus cynotis, and cheyletiella yasguri. Mites can cause skin as well as ear infection (specifically in cats).

**Natural Remedies**

- Apple cider vinegar – mix half cup of apple cider vinegar and half cup of borax in warm water. Dissolve the borax completely. Apply this solution on your pet’s body and infected areas except mouth and eyes. Do not allow the animal to lick the solution as it can be harmful.

- Olive oil – apply olive oil on the affected areas of the animal which will help to get rid of mites.

- Honey - Has anti-oxidant and antiseptic action and applying honey on the affected areas will help to get rid of mites.
Prevention
Ectoparasitic infestation in dogs is very difficult to manage as these ectoparasites gets easy entry on the dog’s body. Housing Management plays an essential role for controlling these ectoparasites.

- Wash or clean your dogs bedding on regular basis.
- Bath your animal on regular basis and water should not go into dog's ear as it can lead to ear infections.
- Regular grooming should be done.
- Combs, brushes of the dogs should be cleaned before every use to prevent the spread of ectoparasites.
- Clean the ears of the dog once per month.
- Give a healthy diet to your animal so as to maintain its immune system.
- Deworming of the animal should be done regularly.

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18. HORTICULTURE

Post Harvest Technology of Aloe Vera
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Harvesting
A crop once planted gives production up to five years. For maximum yield the crop is cut after 9-10 months of planting. During this period mature leaves are more juicy, weighty and fresh. Too much old leaves do not give good quality gel and its quantity is also decreased. Very new and immature small leaves also contain least quantity of gel. For production of juice mature leaves of appropriate size are cut from the base and are hung for 5-6 hr. keeping cut portion downside. By doing this whole juice of leaf trickles down. For obtaining gel the leaves are cut open longitudinally and the white coloured transparent gel is scrapped with the help of knife for further processing. For other uses, whole plant can be cut from the base or take out along with root and dried. Crop should be harvested in the morning hours. Before five years the crop should not be eradicated by roots. After cutting the leaves the crop is again sprouted and gets ready for harvest by next year. This process may be continued till 5 years.

Storage
For the purpose of gel or juice the plant has to be used immediately after cutting of leaves. Under this situation the need of storage does not arise. But in many ‘Ayurvedic’ preparations whole plant is used in dried form. For this, it may be stored after drying the whole plants. Since its leaves contain pulp and more than 90% water, they take long time to dry. For fast drying they may be dried in over fitted with fan. While drying the temperature of oven should not exceed 60°C, and preferably it should be between 50 and 60°C. The plants should not be kept in the oven immediately after harvest. Before keeping in the oven they should be dried in open air in the sunlight for some time to reduce the moisture level of the leaves. Excess moisture at high temperature...
in the oven may decompose some important plant constituents. The dried plant material may be kept in jute bags for one year.

**Drying of Leaves**

Aloe leaves contain 80-90 per cent moisture and need to be dried under open sun. For this, the leaf is transversely cut into 10-12 small pieces and spread on the yard. The leaves hardly take a week to get fully dried when left under the sun. Leaves should be uniformly dried by constant stirring of leaves. Improper drying causes blemishes, fungal infections and moulds which reduced the marketability. One kg of dry leaves could be obtained by drying 80kg of fresh leaves (Drainage ration of 1.25 per cent).

**Processing and Product Development**

Aloe vera is considered to be nature’s miracle by people all over the world because it possesses numerous medicinal properties. As more and more people are learning about the benefits of aloe vera, the demand for aloe vera products are also on the rise. Although making aloe vera gel is quite simple and can be easily prepared at home, it cannot be trusted completely if one needs to use it for internal consumption. This is because while making aloe vera gel at home, there are chances that the aloin or latex gets mixed into the gel accidentally, making it unreliable for consumption as aloin is laxative in nature and can cause stomach problems. In this case, it is best to rely on aloe vera products which are prepared through a careful process. Let us take a look how exactly aloe vera processing is done.

**Selection of Leaves**

The first step in the process of making aloe vera gel is harvesting of the aloe vera leaf. Only the leaf that is fully matured (2-3 years old) is chosen for aloe vera processing. An important thing that has to be followed is that aloe vera plant once harvested must immediately go through the process of preparing the gel. This is because more time the aloe vera plant is kept without processing, the more its quality starts deteriorating. However, if aloe vera is not used immediately, it should be placed in a refrigerator within 4-6 hours after harvesting.

**Cleaning**

Once the aloe vera leaves are harvested, it has to go through a severe cleaning process. In most aloe vera processing companies, the aloe vera leaves have to go through a series of soak tanks, high pressure sprayers and scrub brushes to wipe out any unwanted remains that can deteriorate the quality of the end product.

**Processing**

Aloe vera processing can be divided into three main steps which include crushing, grinding and pressing of the whole leaf. Most manufacturing companies make the use of aloe vera processing equipments for extracting whole leaf aloe vera gel. First, the tip as well as the base of each aloe vera leaf is removed and it is cut into small pieces. These aloe vera pieces are placed in a grinding unit where they are crushed till they achieve a soup like consistancy. This aloe vera liquid is then transferred into cleaned and sanitized stainless steel tanks. After this, the large pieces of pulp present in the liquid are removed with the help of a de-pulping extractor.

**Filtration**

The liquid that is obtained in the end goes through the filtration process. This is important to separate the aloin or latex from the liquid, along with the microscopic remains of sand, leaves and other such particles. The filtration process is done with the help of a press filter which possess various carbon coated plates. These plates have the ability to absorb the latex from the aloe vera liquid. This process is repeated until the whole liquid is free from almost 99% of aloin. After this, the liquid goes through a press filter that contains 5 micron filter paper several times, until it is completely devoid of latex. Finally, the aloe vera liquid is purified through the cold filtration process.

**Stabilization**

The stabilization of the aloe vera liquid or gel that is obtained after processing is extremely important. This is because processed aloe vera is bound to get oxidized, thus making it unusable. Stabilization of aloe vera gel or liquid can be done through various techniques including cold processing as well as heat treatment processing.

Cold processing is done by using enzymes like catalase and glucose oxidase in the aloe vera
gel to stop the production of aerobic organisms. Another cold processing method is to expose the aloe vera gel to ultraviolet rays. On the other hand, heat treatment processing involves pasteurization of the liquid at a high temperature. Another aloe vera gel stabilizing method is by adding preservatives and additives like potassium sorbate, sodium benzoate, vitamin E, citric acid, etc. in the gel.

Needless to say, aloe vera processing is definitely complex. However, it is quite essential to make the aloe vera gel or juice effective and safe for topical application as well as internal consumption.

19. HORTICULTURE

High Density Planting and Meadow Orchard System in Fruit Crops

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High Density Planting

High density planting technique is a modern method of fruit cultivation involving planting of fruit trees densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operation. Control of pests and diseases, weeds and pruning of tree canopy can be carried out by machine. Irrigation and fertigation are automatically controlled. Such system produces precocious cropping, high and regular yields of good quality fruits and low labour requirement to meet ever rising production costs.

Introduction

It is well known that the diversity in soil and climatic conditions in India permits growing of a large variety of tropical, subtropical and temperate fruits in different regions, due to which India is regarded as a horticultural paradise. In recent year, the concept of fruit production is undergoing a change where emphasis is being given to higher production per unit area. High density planting or meadow orchard system is the fastest way of reducing the gestation period and increasing the productivity of the orchards. The choice of the system of planting in the orchard depends on topography, crop, variety, plant density, production technology to be followed.

Concept of High Density Planting and Meadow Orcharding in Fruit Crops

1. Accommodation of the maximum possible number of the plants per unit area to get the maximum possible profit per unit of the tree volume without impairing the soil fertility status is called the high density planting.

2. High density orchards were first planted in Europe at the end of the 19th century and since then there are a decline in traditional orchards with low densities.

3. The underlying principle of a HDP is to make the best use of vertical and horizontal space per unit time and to harness maximum possible return per unit of inputs.

4. In other words, it is the planting of more number of plants than optimum through manipulation of tree size. Meadow Orchard System is a new concept of planting which has been developed in guava for the first time in India at CISH, Lucknow.

5. The Meadow Orchard is a modern method of fruit cultivation using small or dwarf tree with modified canopy.

6. Better light distribution within tree canopy increases the number of well illuminated leaves.

7. Fertilizer dose, spacing, growth regulation by the training and pruning, use of the mechanical devices etc. may also be tried either singly or coupled with other crop management practices for a successful adaptation of these concepts.

8. It also promotes rate of photosynthesis that leads to high yield per unit area.

9. Basically, the availability of a dwarf plant is
the first and foremost prerequisite for establishing any high density or meadow orchard.

**Why High Density Planting**

1. The available land area for the fruit cultivation is becoming a limiting factor.
2. Rapid urbanization, Fragmentation of land holding, Industrialization.
3. High management cost.
4. Restriction on water use.
5. Labor problems.
6. Maximum possible returns with the minimum costs in the shortest possible time.

**Different Types of Planting**

**Low Density Planting:**

1. Non intensive system, age old planting system, trees planted at wide spacing, accommodating about 100-250 plants/ha.
2. Dwarfing rootstock not used.
3. Trees acquire commercial production potential after 10-15 years of planting.
4. Output from orchard during early 10-15 years is less.
5. Less input and care intensive, holds popularity among growers.

**2. Medium Density Planting**

1. Highly minimized distance covering 250-500 plants/ha.
2. Proper pruning undertaken to manage tree in desirable shape.
3. More care intensive, labour requirement is more, obtained yield is also more.
4. Lead in output reliable growers to produce amenable fruit crops like pomegranate, citrus, guava, papaya, banana, etc.

**3. High density planting**

- Relies heavily on rigorous training and pruning.
- Maintenance of pruning is very heavy.
- Dwarfing rootstock and chemicals also used in this system.
- Yield as well as expenses per unit area is high.

**4. Meadow Orcharding**

- Meadow-grassland, also known as Ultra-high density planting.
- 10,000-1,00,000 plants/ha in order to maintain tree form, sever top pruning is practiced similar to mowing of grassland.
- Plants intended to produce yield after 2 years age.
- Heavy use of growth regulators as well as pruning.

Table: 1- Spacing at different planting system in fruit crops

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Crop</th>
<th>Normal spacing (m)</th>
<th>HDP spacing (m)</th>
<th>Meadow spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mango</td>
<td>7.5 X 7.5 - 12.5 X 12.5</td>
<td>3 X 2.5 - 5 X 5</td>
<td>2.5 X 2.5 - 3 X 1</td>
</tr>
<tr>
<td>2.</td>
<td>Banana</td>
<td>2 X 2 - 2 X 3</td>
<td>1.5 X 1.5 - 1.8 X 1.8</td>
<td>1.2 X 1.2 - 3 X 0.5</td>
</tr>
<tr>
<td>3.</td>
<td>Citrus</td>
<td>6 X 6 - 8 X 8</td>
<td>3 - 6 X 3 - 4.5</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Papaya</td>
<td>2 X 2 - 3 X 3</td>
<td>1.8 X 1.8</td>
<td>1.2 X 1.2 - 1X1</td>
</tr>
<tr>
<td>5.</td>
<td>Gauva</td>
<td>6 X 6 - 8 X 8</td>
<td>3 X 3 - 3 X 1.5</td>
<td>2X2 - 2X1</td>
</tr>
<tr>
<td>6.</td>
<td>Sapota</td>
<td>10 X 10</td>
<td>5 X 5</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Aonla</td>
<td>10 X 10</td>
<td>5 X 5</td>
<td>-</td>
</tr>
<tr>
<td>8.</td>
<td>Apple</td>
<td>10 X 10</td>
<td>3 X 0.75 - 0.87</td>
<td>3 X 0.37 - 0.60</td>
</tr>
</tbody>
</table>

**Components of HDP and Meadow**

- Dwarf scion varieties
- Dwarf rootstock varieties
- Training and pruning
- Suitable crop management practices
- Use of bio-regulators
Planting Density
- Thereafter, 2 shoots arising from each primary branch at a distance of 60-75cm from main stem is allowed to form secondary and likewise the tertiary branches.
- After start of bearing in plants, shoots arising from secondary and tertiary branches are given 15-20 cm deep pruning soon after fruit harvest.
- Spray of 1% urea combined with 0.2% Blitox-50 or any other copper fungicide should be done soon after pruning.

Use of Bio-regulators
- Prolonging dormancy
- Reducing vegetative growth
- Flowering
- Reducing fruit drop

Adoption of Suitable Crop Management Practices
- Mulching
- Fertigation
- Organic farming
- INM
- IPM

Planting Density
- Even though a small canopy with a high number of well-illuminated leaves is efficient in photosynthesis but it is very poor in light interception, which leads to low potential yield per hectare.
- Light interception could be improved by increasing tree density.
- An optimum tree density is the level of density which is required to facilitate optimum light distribution and interception leading to high photosynthesis. As a result, yield per hectare is maximized.
- An optimum light interception is a factor of plant form, planting density, tree arrangement and leaf response to light for photosynthesis.
- Optimum light interception can be defined as a level of light intercepted by an orchard system above or below which, the economic yield will be reduced.

Planting Geometry
- Planting system is a combination of tree arrangement and plant form.

Training and Pruning
- Training and pruning are effective tools in HDP and meadow orcharding by virtue of their impact on shape and size control of the tree.
- The training begins when the tree is first planted and continues throughout its productive life.
- Proper tree forms, branch angle and limb spacing in itself aids in growth control.
- First training is done after one growing season.
- Each plant is allowed to maintain single stem (main stem) with upward growth upto 60-80 cm and then four scaffold branches are allowed in four directions to make the tree frame.

Dwarf Scion Varieties
Table: 2-Dwarf Scion Varieties

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Crop</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mango</td>
<td>Amrapali</td>
</tr>
<tr>
<td>2.</td>
<td>Sapota</td>
<td>PKM-1, PKM-2</td>
</tr>
<tr>
<td>3.</td>
<td>Apple</td>
<td>Red spur, Star Crimson Spur, Gold Spur, Well Spur, Oregon Spur, Silver Spur, Red Chief, Hardi Spur</td>
</tr>
<tr>
<td>4.</td>
<td>Peach</td>
<td>Red heaven, Candor</td>
</tr>
</tbody>
</table>

Dwarf Rootstock Varieties
Table: 3-Dwarf Rootstock varieties

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Crop</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mango</td>
<td>Vellaikolumban (Alphanso), Olour (Himsagar and Langra)</td>
</tr>
<tr>
<td>2.</td>
<td>Gauva</td>
<td>Pusa srijan, Psidium friedrichsthalianum, Aneuploid-82</td>
</tr>
<tr>
<td>3.</td>
<td>Citrus</td>
<td>Trifoliate orange, Sour orange, Citranges</td>
</tr>
<tr>
<td>4.</td>
<td>Apple</td>
<td>M4, M7, M9, M26, MM106, M27 (Ultra-dwarfing)</td>
</tr>
<tr>
<td>5.</td>
<td>Pear</td>
<td>Quince</td>
</tr>
</tbody>
</table>
Tree arrangement in HDP system must have sufficient alleyways for movement of farm machinery.

The way trees are arranged also determines the light distribution pattern and light interception level.

Single hedge row and double hedge row system and square system having enough alley space is being practiced in developed countries for HDP

Mechanization

Another component in high density fruit planting is the system automation which contributes to high production efficiency.

One of the important farm operations that can be automated is irrigation and fertigation vis-à-vis indiscriminate mechanical pruning.

In fact, irrigation and fertigation have been identified as one of the key factors for the success of high density orchards.

Plant should not be kept under stress after pruning therefore, assured irrigation coupled with fertigation is essential after pruning and during fruit development in high density orchards.

Table: 4. Comparison between Traditional system and HDP/Meadow system of fruit growing

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Attributes</th>
<th>Traditional system</th>
<th>HDP/ Meadow system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tree numbers</td>
<td>Few large trees/ha (150-200 trees/ha)</td>
<td>Many small trees/ha (500-1,000,000 trees/ha)</td>
</tr>
<tr>
<td>2.</td>
<td>Bearing</td>
<td>After two years</td>
<td>From first year</td>
</tr>
<tr>
<td>3.</td>
<td>Production</td>
<td>Lower yield</td>
<td>Higher yield</td>
</tr>
<tr>
<td>4.</td>
<td>Managemen t</td>
<td>Difficult to manage due to large tree size</td>
<td>Easy to manage due to small tree size</td>
</tr>
<tr>
<td>5.</td>
<td>Labour requirement</td>
<td>Requires more labour</td>
<td>Requires less labour</td>
</tr>
<tr>
<td>6.</td>
<td>Production</td>
<td>Higher cost of</td>
<td>Lower cost</td>
</tr>
</tbody>
</table>

| 7. | Harvesting | Difficult | Easy |
| 8. | Quality     | Large canopy, poor sunlight penetration and poor quality fruits. | Small canopy, better air and sunlight penetration, mini. disease incidence and high quality fruits with good colour development |

Merits of HDP/Meadow

- Best utilization of land and resources.
- Higher yield per unit area with quality fruits.
- Facilitate better utilization of solar radiation and increase the photosynthetic efficiency of the plant.
- It is amenable to modern inputs application techniques such as drip irrigation, fertigation, mechanization etc.
- Early economic returns.

Demerits of HDP/Meadow

- Initially become little costly than conventional system.
- Economic life span of the orchard becomes lower.
- Chance of reduction in fruit size and weight.
- Intercultural operation becomes difficult.
- Maintenance of plant architecture becomes a tedious job.

Conclusion

HDP and meadow orcharding gives higher yield as well as returns/unit area due to increasing the no. of trees/unit area. It is possible by regular pruning and use of bioregulators for maintaining the size and shape of the tree. Mango planted at spacing of 5m x 5m (Kesar and Alphanso) and 3m x 1m (Keitt) gives higher yield under HDP and meadow, respectively. Guava planted at spacing 2.5m x 2.5m and 3m x 6m under HDP and 2m x 1m under meadow gives
higher production as well as more income in Allahabad Safeda and L-49. Citrus gives higher production when planted at 6m x 3m spacing under HDP. For HDP in banana is planted at 1.0 x 1.2m spacing gives better yield in cv. Rajapuri.

# 20. AGRONOMY

## Principles, Reasons and Benefits of Organic Farming

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### Introduction

Organic farming is a technique, which involves cultivation of plants and rearing of animals in natural ways. This process involves the use of biological materials, avoiding synthetic substances to maintain soil fertility and ecological balance thereby minimizing pollution and wastage. In other words, organic farming is a farming method that involves growing and nurturing crops without the use of synthetic based fertilizers and pesticides. Also, no genetically modified organisms are permitted. It relies on ecologically balanced agricultural principles like crop rotation, green manure, organic waste, biological pest control, mineral and rock additives. Use of pesticides and fertilizers if they are considered natural and avoid the use of various petrochemical fertilizers and pesticides.

Organic farming is a production management system excluding of all synthetic off-farm inputs but rely upon on-farm agronomic, biological and mechanical methods like crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection etc which promotes and enhances biodiversity, biological cycles and agro-ecosystem health. (Meena et al., 2013)

As per the definition of the USDA study team on organic farming “organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection”.

International Federation of Organic Agriculture Movements (IFOAM), an international organization established in 1972 for organic farming organizations defines goal of organic farming as: “Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved...”

FAO suggested that “Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using onfarm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs”

### 1905 to 1924 - Organic Agriculture Begins in Central Europe & India

Organic agriculture began more or less simultaneously in Central Europe and India. The British botanist Sir Albert Howard, often referred to as the father of modern organic agriculture, works as an agricultural adviser in Pusa, Bengal, (now in Bihar), where he documents traditional Indian farming practices, and came to regard them as superior to his conventional agriculture science. In the United States, J. I. Odale begins to popularize the term and methods of organic growing, particularly to consumers through promotion of organic gardening.

### 1939 - First Use of the Term "Organic Farming"

The first use of the term "organic farming" is by Lord Northbourne. The term derives from his

**Four Principles of Organic Farming**

**Principle of Health**: Organic agriculture must contribute to the health and well being of soil, plants, animals, humans and the earth. It is the sustenance of mental, physical, ecological and social well being. For instance, it provides pollution and chemical free, nutritious food items for humans.

**Principle of Fairness**: Fairness is evident in maintaining equity and justice of the shared planet both among humans and other living beings. Organic farming provides good quality of life and helps in reducing poverty. Natural resources must be judiciously used and preserved for future generations.

**Principle of Ecological Balance**: Organic farming must be modeled on living ecological systems. Organic farming methods must fit the ecological balances and cycles in nature.

**Principle of Care**: Organic agriculture should be practiced in a careful and responsible manner to benefit the present and future generations and the environment.

As opposed to modern and conventional agricultural methods, organic farming does not depend on synthetic chemicals. It utilizes natural, biological methods to build up soil fertility such as microbial activity boosting plant nutrition.

Secondly, multiple cropping practiced in organic farming boosts biodiversity which enhances productivity and resilience and contributes to a healthy farming system. Conventional farming systems use mono cropping that destroys the soil fertility.

**Reasons for Organic Farming**

The population of the planet is skyrocketing and providing food for the world is becoming extremely difficult. The need of the hour is sustainable cultivation and production of food for all. The Green Revolution and its chemical based technology are losing its appeal as dividends are falling and returns are unsustainable. Pollution and climate change are other negative externalities caused by use of fossil fuel based chemicals. In spite of our diet choices, organic food is the best choice you’ll ever make, and this means embracing organic farming methods. Here are the reasons why we need to take up organic farming methods:

1. **To accrue the benefits of nutrients**: Foods from organic farms are loaded with nutrients such as vitamins, enzymes, minerals and other micro-nutrients compared to those from conventional farms. This is because organic farms are managed and nourished using sustainable practices. In fact, some past researchers collected and tested vegetables, fruits, and grains from both organic farms and conventional farms. The conclusion was that food items from organic farms had way more nutrients than those sourced from commercial or conventional farms. The study went further to substantiate that five servings of these fruits and vegetables from organic farms offered sufficient allowance of vitamin C. However, the same quantity of fruits and vegetable did not offer the same sufficient allowance.

2. **Stay away from GMOs**: Statistics show that genetically modified foods (GMOs) are contaminating natural foods sources at real scary pace, manifesting grave effects beyond our comprehension. What makes them a great threat is they are not even labeled. So, sticking to organic foods sourced from veritable sources is the only way to mitigate these grave effects of GMOs.

3. **Natural and better taste**: Those that have tasted organically farmed foods would attest to the fact that they have a natural and better taste. The natural and superior taste stems from the well balanced and nourished soil. Organic farmers always prioritize quality over quantity.

4. **Direct support to farming**: Purchasing foods items from organic farmers is a surefire investment in a cost-effective future. Conventional farming methods have enjoyed great subsidies and tax cuts from most governments over the past years. This has led to the proliferation of commercially
produced foods that have increased dangerous diseases like cancer. It’s time governments invested in organic farming technologies to mitigates these problems and secure the future. It all starts with you buying food items from known organic sources.

5. **To conserve agricultural diversity:** These days, it normal to hear news about extinct species and this should be a major concern. In the last century alone, it is approximated that 75 percent of agricultural diversity of crops has been wiped out. Slanting towards one form of farming is a recipe for disaster in the future. A classic example is a potato. There were different varieties available in the marketplace. Today, only one species of potato dominate. This is a dangerous situation because if pests knock out the remaining potato specie available today, we will not have potatoes anymore. This is why we need organic farming methods that produce disease and pest resistant crops to guarantee a sustainable future.

6. **To prevent antibiotics, drugs, and hormones in animal products:** Commercial dairy and meat are highly susceptible to contamination by dangerous substances. A statistic in an American journal revealed that over 90% of chemicals the population consumes emanate from meat tissue and dairy products. According to a report by Environmental Protection Agency (EPA), a vast majority of pesticides are consumed by the population stem from poultry, meat, eggs, fish and dairy product since animals and birds that produce these products sit on top of the food chain.

This means they are fed foods loaded with chemicals and toxins. Drugs, antibiotics, and growth hormones are also injected into these animals and so, are directly transferred to meat and dairy products. Hormone supplementation fed to farmed fish, beef and dairy products contribute mightily to ingestion of chemicals. These chemicals only come with a lot of complications like genetic problems, cancer risks, growth of tumor and other complications at the outset of puberty.

**Benefits of Organically Grown Food Items and Agricultural Produce**

- **Nutritional, poison-free and tasty food:** The nutritional value of food is largely a function of its vitamin and mineral content. In this regard, organically grown food is dramatically superior in mineral content to that grown by modern conventional methods. A major benefit to consumers of organic food is that it is free of contamination with health harming chemicals such as pesticides, fungicides and herbicides. There are reasonably consistent findings for higher nitrate and lower vitamin C contents in conventional vegetables (Woesee et al., 1997).
- **Lower growing cost:** The economics of organic farming is characterized by increasing profits via reduced water use, lower expenditure on fertilizer and energy, and increased retention of topsoil. To add to this the increased demand for organic produce makes organic farming a profitable option for farmers.
- **Enhances soil nourishment:** Organic farming effectively addresses soil management. Even damaged soil, subject to erosion and salinity, are able to feed on micro-nutrients via crop rotation, intercropping techniques and the extensive use of green manure. The absence of chemicals in organic farming does not kill microbes which increase nourishment of the soil. Biodynamic farms had better soil quality: greater in organic matter, content and microbial activity, more earthworms, better soil structure, lower bulk density, easier penetrability, and thicker topsoil (Reganold et al., 1993); agricultural productivity doubled with soil fertility techniques: compost application and introduction of leguminous plants into the crop sequence (Dobbs and Smolik, 1996; Drinkwater et al., 1998; Edwards, 2007).
- **More energy efficiency:** Growing organic rice was four times more energy efficient than the conventional method (Mendoza, 2002). Organic agriculture reduces energy requirements for production systems by 25 to 50 percent compared to conventional
chemical-based agriculture (Niggli et al., 2009).

- **Carbon sequestration**: German organic farms annually sequester 402 kg Carbon/ha, while conventional farms had losses of 202 kg (Clark et al., 1999; Küstermann et al., 2008; Niggli et al., 2009).

- **Less water pollution**: In conventional farms, 60 percent more nitrate are leached into groundwater over a 5-year period (Drinkwater et al., 1998).

- **Environment-friendly practices**: The use of green pesticides such as neem, compost tea and spinosad is environment-friendly and non-toxic. These pesticides help in identifying and removing diseased and dying plants in time and subsequently, increasing crop defense systems. Organic farms' biodiversity increases resilience to climate change and weather unpredictability (Niggli et al., 2008). Organic agriculture reduces erosion caused by wind and water as well as by overgrazing at a rate of 10 million hectare annually (Pimentel et al., 1995).

- **Organic farming is a source for productive labour**: Agriculture is the main employer in rural areas and wage labour provides an important source of income for the poor. Thus, by being labour intensive, organic agriculture creates not only employment but improves returns on labour, including also fair wages and non-exploitive working conditions. New sources of livelihoods, especially once market opportunities are exploited, in turn revitalize rural economies and facilitate their integration into national economies.

- **Better Nutrition**: As compared to a longer time conventionally grown food, organic food is much richer in nutrients. Nutritional value of a food item is determined by its mineral and vitamin content. Organic farming enhances the nutrients of the soil which is passed on to the plants and animals.

- **Helps us stay healthy**: Organic foods do not contain any chemical. This is because organic farmers don’t use chemicals at any stage of the food-growing process like their commercial counterparts. Organic farmers use natural farming techniques that don’t harm humans and environment. These foods keep dangerous diseases like cancer and diabetes at bay.

- **Free of poison**: Organic farming does not make use of poisonous chemicals, pesticides and weedicides. Studies reveal that a large section of the population, fed on toxic substances used in conventional agriculture, have fallen prey to diseases like cancer. As organic farming avoids these toxins, it reduces the sickness and diseases due to them.

- **Organic foods are highly authenticated**: For any produce to qualify as organic food, it must undergo quality checks and the creation process rigorously investigated. The same rule applies to international markets. This is a great victory for consumers because they are getting the real organic foods. These quality checks and investigations weed out quacks who want to benefit from the organic food label by delivering commercially produced foods instead.

- **Lower prices**: There is a big misconception that organic foods are relatively expensive. The truth is they are actually cheaper because they don’t require application of expensive pesticides, insecticides, and weedicides. In fact, you can get organic foods direct from the source at really reasonable prices.

- **Enhanced Taste**: The quality of food is also determined by its taste. Organic food often tastes better than other food. The sugar content in organically grown fruits and vegetables provides them with extra taste. The quality of fruits and vegetables can be measured using Brix analysis.

- **Organic farming methods are eco-friendly**: In commercial farms, the chemicals applied infiltrate into the soil and severely contaminate it and nearby water sources. Plant life, animals, and humans are all impacted by this phenomenon. Organic farming does not utilize these harsh chemicals so; the environment remains protected.
• Longer shelf–life: Organic plants have greater metabolic and structural integrity in their cellular structure than conventional crops. This enables storage of organic food for a longer time.

Organic farming is preferred as it battles pests and weeds in a non-toxic manner, involves less input costs for cultivation and preserves the ecological balance while promoting biological diversity and protection of the environment.

Key Features of Organic Farming
• Protecting soil quality using organic material and encouraging biological activity
• Indirect provision of crop nutrients using soil microorganisms
• Nitrogen fixation in soils using legumes
• Weed and pest control based on methods like crop rotation, biological diversity, natural predators, organic manures and suitable chemical, thermal and biological intervention
• Rearing of livestock, taking care of housing, nutrition, health, rearing and breeding

Care for the larger environment and conservation of natural habitats and wildlife

Reference

21. AGRICULTURAL MICROBIOLOGY

Role of Microorganisms in Soil Fertility
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Soil is a renewable natural resource. The maintenance and restoration of its basic quality is a prime objective. We see the living world above the soil but soil is also pulsating with life underneath. This was unknown to us till 1838 when Sir J.B. Bossingault, a French Agricultural Chemist, found legumes obtained N from soil and suggested microbial OM decomposition accumulated Nitrates; linking it to the sphere of Soil fertility. Fifty years later Beijerinck isolated bacteria from nodules of legume roots.

Some of the direct and indirect roles of microorganisms (MOs) in maintaining the soil fertility are encapsulated as follows:

• Microorganisms help in soil formation and enriching the soil with nutrients, enzymes, etc. MOs are the active soil forming factors.
• Soil microbial biomass constitutes nearly 2-4 % SOM and help in plant nutrient transformations. The organically bound plant nutrients to their mineral form are transferred to their inorganic/plant available form through various processes mediated by MOs.
  Ex- N by Nitrosomonas, Nitrobacter, etc; S by Desulfovibro; P solubilisation by Aspergillus, Bacillus, etc
• Microbial applications in soil have socioeconomic implications, INM and contribute to the sustainable development approach.
Ex- Rhizobium culture application in legumes; Azotobacter application in field crops, vegetables, etc

- MOs used in soil testing for assessment of nutrient deficiencies like P, Zn, Mo, etc
- Ex- Aspergillus niger is a biological indicator of available K, P, Mg in soils; Azotobacter for K and P, etc
- Evaluation of soil fertility by the methods like dehydrogenase activity, CO₂ evolution method, etc whose values are an indication of soil fertility.
- Antibiotic effects of some MOs help to overcome diseases.
  Ex- Streptocyclin against Citrus canker
- MOs act as bio control agents of plant pathogens which help to heal the soil sickness and maintain the soil health and fertility.

Microorganisms are instrumental in building the soil fertility and maintaining the soil health. They mediate various processes and maintain equilibrium of life in the ecosystem.

“The role of infinitely small is infinitely large.”
Louis Pasteur

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22. AGRIBUSINESS MANAGEMENT

Food Waste Management
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Food is one of the three fundamentals for life. Yet, its importance is often neglected. Food waste management has been in the limelight for a while for various reasons as in new business opportunities, lesser waste, more food for more people etc,. Whatever the reason maybe the good news is the world has started to notice the missing piece. Food waste can’t be eliminated to nil but can be managed optimally.

Food loss and Food waste often times are regarded the same though there is a line that separates them. Food loss in general is the loss in quality or quantity of food along the production and distribution channels. However food waste is a component of food loss and refers to the spoilage or wastage of food due to reasons such as poor management, neglect, ignorance among others. Many studies had pointed that food loss mostly occurs in the upper steam of the supply chain while food waste occupies the lower stream. Evident statistics showed that developing countries account for more food loss while the developed countries are responsible for food wastage.

According to the FAO (2018), food loss and waste occurs on a magnum scale of 1.3 billion tons which could feed Three billion people. The industrialized countries account for food loss value (680bn USD) while developing countries share is around 310 bn USD. Fruits, vegetables and root tubers have the highest wastage rates. In developing countries 40 per cent of loss occurs at post-harvest and processing stages whereas in industrialized countries >40% of losses at the retail and consumer levels. In India, almost one lakhs crore INR worth of food is being wasted every year (Clean india journal,2018). According to Reuters, India wastes around 40 per cent of the total food produced.

While it is good to ponder over the statistics, it is equally imperative to investigate the myriad reasons behind this. Based on various studies, In
the developed countries, the main scenarios that favor FWL are as follows

- Production of excess food. As the manufacturer / retailer doesn’t want to say no to a customer demand (which is highly fluctuating), orders more of a product to keep stock. This means the demand for the product increases even more up the chain. Hence, more is produced and more is wasted.

- High quality standards and visual appearance (mostly at the retail level). This has led to most of the fresh fruits and vegetables getting wasted. Malformed / slightly discolored fruits / vegetables are not preferred by customers which eventually constitute to food waste.

- The cost of discarding a product is always cheaper than reusing it.

- The main reasons that lead to Food Waste / Loss in the developing countries are
  - Poor infrastructure- Lack of proper storage, transport, cold chain facilities etc.,
  - Low and inefficient processing facilities.
  - Poor and improper handling of the produce leading to decreased nutritional value and loss in quantity and quality.
  - Lack of Marketing facilities and infrastructure.

Food losses during harvest and in storage leads to reduced income for small farmers and apparently higher prices for consumers. The hidden wastes that are a victim to the FWL include the lands used for cultivation, water, all other resources involved in producing the products.

Considering the consequences of food waste and loss, the world has started to take notice of it. People, organizations and Governments are trying to tackle the problem in various ways. Some of the measures may be such as enacting a law for recycling, developing markets for disfigured /ugly / discolored fruits and Infrastructure development technological innovations to reduce food waste. Several organizations and NGOs are creating awareness, conducting campaigns; serve as food banks etc. for reducing food waste. Food banks serve the purpose of the extra going to the needy rather to the landfills. For example, certain restaurants even pay the customers for not wasting food. Reducing the food wastage by redistributing the unsold food, recycling, composting etc., can be a step toward combating global hunger crisis.

By 2050, the world population is estimated to reach 9 billion which is a lot of people to feed with the same resources or more precisely shrinking resources. Unless steps are taken to manage the resources and the food waste for betterment, there will be chaos. Necessity is the mother of all innovations. Companies are trying to innovate even with the non-edible food wastes such as biodegradable bags from crustacean wastes.

### Conclusion

In conclusion the consequences of Food wastage might be not fully understood today, but with the growing population (1.7bn by 2050 - India) it would be a huge challenge. The responsibility to curb global hunger and reduce food wastage lies not just with the organizations and the Governments; it lies with the individuals too.

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India is the second largest producer of fruits and vegetables. But according to 2015 data given by Ministry of Food Processing Industries, there is around 4.48-15.88 percent of post-harvest losses in fruits and vegetables because of poor post harvest handling conditions and due to its perishable nature (MOFPI, GOI, 2015). There are several methods of preservation like drying, smoking, freezing, canning and bottling etc., But in these methods fruits and vegetables lose their natural physical appearance and are also not available in their fresh form. Later food wrapping using plastic polythene cover and coating with chemicals came into usage. But these methods were not much acceptable by the consumers since it posed serious eco and health concerns.

As per Food and Health survey conducted by International Food Information Council in 2011, 2014, 2015 and 2016, consumers are increasingly concerned about chemicals in their food and hence they prefer food with no chemicals where as they are demanding food which are fresh and healthy. And hence to fulfil this demand of less usage of chemicals as preservatives in fruits and vegetables, more attention is now being paid in search of natural components as preservatives and one such new and novel technique which involves natural components as preservatives is herbal edible coating.

Herbal edible coating provides protective edible coating to fruits and vegetables and acts as barriers for air, CO₂, O₂ and also for moisture and they also produce similar effects as in modified atmosphere storage. And by incorporating natural components possessing antimicrobial, antifungal and antibacterial activity, fruits and vegetables can be preserved for long time from microbial contamination. (Lin and Zhao, 2017).

Components of Edible coating (Dhaka and Upadhyay, 2018)

There are five components of edible coating and they are

- Polysaccharides Ex: Starch, Pectin, Cellulose derivatives, Chitosan, Alginate
- Proteins Ex: Soy protein, Whey protein, Casein, Collagen, Egg albumin, Gelatin
- Lipids Ex: Essential oils, Bee wax, Mineral oil, Vegetable oil, Carnauba wax, Paraffin
- Resins Ex: Shellac, Wood resin, Coumarone indene
- Composite These are blend of polysaccharides, lipids, proteins or resins

There are mainly five methods of application: (Kore, 2017)

1. Dipping
2. Brushing
3. Spraying
4. Fluidized bed coating
5. Panning

Method of Application Depends on

- Characteristics of the food
- Coating materials
- Intended effect of coating
- Cost

Advantages : (Kore, 2017)

- Herbal edible coating method is environment friendly and it will reduce waste and also solid disposal problem
- By incorporating some of nutraceuticals into herbal edible coatings, it increases efficiency of edible coatings
- It provides same effect as modified atmosphere storage by modifying internal gas composition
It also helps in retention of colour, freshness, reduces weight loss and helps in maintaining firmness.

Dis-advantages :(Prasad et al., 2018)

- Excess coating leads to anaerobic respiration and there by results in abnormal ripening.
- If it fails to be a good barrier to water vapor then incidence of microbial spoilage will be more.
- Allergic reactions might be possible when edible coatings are mixed with other coating materials.
- Excess usage of coating leads to development of off flavour, off aroma and off taste.

Conclusion

Post harvest losses of fruits and vegetables are a matter of concern for all those nations whose economy is based on agriculture and horticulture. Hence in this era where chemical additives are eating the health of consumers, herbal edible coating technology is relatively convenient and safe measure in preservation of fruits and vegetables. It is totally harmless to the environment and considered as a green alternative to synthetic coatings and other postharvest chemical treatments.

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24. SOIL SCIENCE

Pressurized Argon Treatment on Quality and Shelf Life of Minimally Processed Products

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Introduction

In recent years there has been considerable increase in demand of minimally processed fresh fruits and vegetables coupled with convenience and safety. In modern generation consumers demand the ready to eat products with high quality characteristics like flavour, colour, aroma, texture and overall appearance. Minimally processed (MP) fruits and vegetables are fresh fruits and vegetables processed to increase their functionality without greatly changing their fresh like properties including nutrients and appearance. The processes used for preparing fresh-cut fruits and vegetables like trimming, peeling, cutting, shredding and grating induce mechanical injury in the tissue increasing metabolic activity like respiration rate, ethylene production and water evaporation, accelerating deterioration during gestation period (transportation and retailing) and consequently shortening their shelf life. So many technologies are developed for preservation of minimally processed fruits and vegetables like edible coating, refrigeration, modified atmospheric packaging comparing with these technologies pressurized argon treatment is advanced technology with maximum extension of shelf life of minimally processed products along with maintaining quality.

As comparing with all the inert gases argon is emerging in food preservation because it is cheaply available, 38 % denser than air so it
replace oxygen completely and it forms more stable argon clathrate hydrate structure. It preserve the packed fresh food by replacing oxygen. Pressurized argon treatment maintains cell integrity by inhibiting the lipid oxidation. This technology effectively inhibit the malic dehydrogenase and tryosinase enzymes which are key enzymes for respiration metabolism and browning of fresh produce, pressurized gas interfere with enzymatic oxygen receptor site so it inactivate the enzymatic reactions by this it extends the shelf life and maintains quality of ready to eat fresh fruits and vegetables.

**Mechanism**

Inert gases like xenon (Xe), neon (Ne), krypton (Kr), argon (Ar) and nitrogen (N₂) when dissolved in water at high pressure, low temperature they form water cage like structure by forming hydrogen bonds between water molecules and this forms structure like pure water ice and it stable above 0 °C. argon gas occupies in microspores of the cells , it completely replace the oxygen from the cell there by it reduces the metabolic activity and it inhibit the oxidation of ascorbic acid by making unavailability of oxygen to the cells. After the pressurized treatment products are packed in polyethylene bags with modified atmospheric condition. Comparing with all inert gas xenon is more soluble in water and readily forms the clathrate hydrate structure But it is more expensive so it used only in laboratory experiment. Argon is more available with low cost and solubility in water is excellent so now a days it is using more in food preservation. For this pressurized treatment temperature, pressure and exposing time select based on the preliminary experiment. It varies with products.

Ex :- For apple 150 MPa pressure,4°C temperature and 10 minutes exposing time is ideal condition for pressure treatments.

Here water molecule acts as host and gas acts as guest molecule , when pressurized argon gas apply in moisture contained food it forms cage like water structure and gas occupied center place of the structure so it is stable up to some days. By forming cage like structure:

- It reduces the intercellular moisture content
- It reduces water mobility
- It increase the viscosity of water
- It reduces the water activity so it make unfavourable condition for growth of microbes like bacteria, mould and yeast
- It reduces water loss
- It maintains maximum total soluble solid content by reducing respiration rate and ethylene production. These to process consume more soluble solid content by hindering these processes it reduces loss in soluble solid content
- It Inhibit the enzymatic and non enzymatic reactions, so it protects the product from browning

Ex: - It inactivate the enzymes like polyphenol oxidase and peroxidase which causes browning in fresh cut apples

- Argon gas can be used to preserve alcoholic beverages
- Extending the shelf life of packed foods :- Argon is used to displace oxygen and moisture containing air in packaging material to extend the shelf-lives of the contents

**Conclusion**

Minimally processed fruits and vegetables have high respiration rate, ethylene production and creates favorable atmospheric condition for growth of micro-organism which leads faster deterioration of quality and decrease in shelf life of minimally processed fruits and vegetables.

By application of pressurized argon can form argon hydrate in cells which reduces water evaporation, displaces the oxygen, inhibit intercellular water movement resulting in reduced enzymatic browning and maintains natural flavour, nutrients in minimally processed products.

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## 25. BIOTECHNOLOGY

### Biochips: An Overview of Miniaturized Laboratories

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**Introduction**

In the 21st century, a significant impact on all aspects of diagnostic testing has been through the micro miniaturization of analytical procedures. This has enabled complex clinical testing to move from central laboratories into non-laboratory settings (lab-on-a-chip and personal laboratories). The major driver of decentralized testing has been the development of biochips. Biochips are collections of miniaturized test sites arranged on a solid substrate onto which many biomolecules are attached with high density. It has facilitated the convergence of electronics with the life sciences, and integrated on-chip various bioassay operations, such as sample preparation, analysis, separation, and detection (Chakrabarty et al., 2010).

![Transducer Signal Processing Output](image)

The actual sensing component (or the "chip") of a biochip platform is the microarray. The microarray is a dense, two-dimensional grid of biosensor deposited on a flat surface. DNA, RNA, proteins, and even living cells are being employed as sensing mediators on biochips. In addition to the microarray, transduction and signal processing devices are integrated into a biochip to translate the actual sensing event into a format understandable by a computer and finally a human. Numerous transduction methods can be employed including surface plasmon resonance, fluorescence, and chemiluminescence. The sensing and transduction techniques chosen, depend on factors such as price, durability, and reusability.

**Classification**

At present, the common biochip is divided into three categories (Yi-zhen et al. 2009)

1. **DNA Microarrays:** The detection of distinct deoxyribonucleic acid (DNA) sequences is important because of its application in diagnostics and genomics. The advent of the DNA microarray overcame the problems of prior technologies, such as low hybridization efficiency, poor sequence discrimination, time-consuming and labor-intensive procedures. DNA Microarrays are ordered sets of known oligonucleotide sequences (probes) immobilized on precisely defined locations of a solid substrate. The sensing operation is based on the hybridization process, which is one of the most powerful and useful techniques in molecular genetics. Hybridization involves the joining of a single strand of nucleic acid with a complementary probe sequences through H-bonds. A single-stranded DNA molecule will seek out its complement in a complex mixture of DNA containing large numbers of other nucleic acid molecules. The sensitive, discriminating detection of a hybridization event is an important feature of a successful DNA microarray. Most DNA chips use fluorescence methods for detection, but some also rely on electrochemical methods.

2. **Protein Microarrays:** Protein microarrays were developed due to the limitations of
using DNA microarrays for determining gene expression levels in proteomics. The quantity of mRNA in the cell often doesn't reflect the expression levels of the proteins they correspond to. A Protein microarray (or protein chip) is a high-throughput method used to track the interactions and activities of proteins and to determine their functions. Protein chip consists of a support surface such as glass slide, nitrocellulose, bead or microtiter plate to which an array of capture proteins is bound. Probe molecules typically labeled with a fluorescent dye are added to the array. Readout systems based on fluorescence, chemiluminescence, mass spectrometry, radioactivity or electro-chemistry are used to detect complex formation within each micro spot. Such miniaturized and parallelized binding assays can be highly sensitive, and the extraordinary power of the method is exemplified by array-based gene expression analysis.

3. **Microfluidic Biochip:** Microfluidic biochips (also known as lab-on-a-chip) are an alternative to conventional biochemical laboratories, and are revolutionizing many applications, such as such as molecular biology procedures, DNA analysis, proteomics (the study of proteins) and clinical pathology (diagnostic of diseases). A typical microfluidic biochip contains microchannels, which allow liquid samples to flow inside the chip but also integrates measuring, sensing and actuating components.

**The Future of Biochips**

Biochips promises to bring genomics, the study of all the genes in existing organisms, out of the research laboratory and into the everyday practice. The biochip space lies at the intersection between high technology chip manufacturing, signal processing, software skills, and more traditional molecular biology and genomics. The market for biosensors and biochips is interdisciplinary and growing and has applications in many-core research areas. As this fast-maturing field already boasts sales of products, biochips are likely to have a significant business future. We can expect that advances in microfluidic biochip technology will enable the miniaturization of devices that will allow a highly sensitive analysis of complex biological interactions in real-time that too with a low-cost perception.

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**26. AGRICULTURE**

**Brown Manuring – A better Version of Green Manuring**

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**Introduction**

Increasing cost of cultivation and lesser availability of inputs are the present scenario of agriculture. In India, prime focus is on re-defining farming practices in coalition with development or conservation of resources. This
could lead to an ecologically safe and economically viable agriculture in the context of changing scenarios of climate, labour availability and resource scarcity. There are many options available, among them 'brown manuring' is becoming a recent trend developed for paddy eco-system and is also becoming a popular technique in agriculture.

Traditionally, farmers grow green manure crops before rice culture and incorporate it by puddling before transplanting rice seedlings and this requires many tillage operations along with loss of soil moisture; additional irrigation water and fuel costs for incorporation of green manure. Since there is water scarcity during peak summer, farmers have not been able to take full advantage of green manuring in rice growing season. So, Brown manuring could be the alternative practice to the green manuring.

**What is Brown Manuring**

Brown manuring is simply a ‘no-till’ version of green manuring, using an herbicide to desiccate the crop before flowering. In this technique, sesbania or other green manure crops are grown in standing cereal crop and are killed with the help of herbicide for manuring where the plant residues are left standing in the field along with main crop without incorporation/in-situ ploughing until its residue decompose itself in the soil adding organic manure beside weed suppression by its shade effect. The post-emergence herbicide spray on green manure leaves results in loss of chlorophyll in leaves turning brown in colour and so referred as ‘brown manuring’. This is very much suitable for lighter soils which are prone to erosion and simultaneously reduce incidence of weeds.

**History of Brown Manuring**

It was first started in the Lock hart district of New South Wales, Australia in 1996. It was employed as a practice against the herbicide resistant rye grass population in winter crops of Australia. Rye grass was planted as cover crop with the intention of spraying it out prior to weed seed set which assisted in rotation of herbicidal groups, maintaining ground cover, preventing weed seed set and adding valuable nitrogen from atmospheric fixation by the legume, as well as providing agronomic benefits of improved soil health and water holding capacity to the soil in a cropping system.

**Suitability of Crops for Brown Manuring**

Any legume crop can be grown for brown manuring. Legumes like greengram, cowpea, sunhemp, alfalfa and desmodium have good foliage and rapid growth and are more suitable as they are fast growing leading to higher biomass accumulation within a short period of time.

**Advantages of Legumes**

It competes with weeds and reduce their growth by taking more available resources due to higher growth rate.

Lesser nitrogen requirement as it is aided by atmospheric nitrogen through symbiotic relationship with bacteria present in their nodules.

Prevent the loss of water due to evaporation, hence help in water conservation.

**Crop which Permits Brown Manuring**

- Rice
- Maize
- Wheat
- Sugarcane

**Practical Applications of Brown Manuring**

Brown manuring is a practice where plant material is returned to the soil to improve soil fertility, availability of nutrients, soil porosity, Cation Exchange Capacity, aggregation of soil particles and to reduce bulk density of soil. It also conserves the soil water, reduces weed and disease burdens and has potential to increase soil organic carbon which in turn help to offset greenhouse gas emissions.

Furthermore, Brown manuring has its positive impact on soil physico-chemical properties viz., soil structure, organic carbon, bulk density and pH of the soil. Brown manuring
significantly increases Organic carbon (0.55%), soil hydraulic conductivity and decreases bulk density. Weed suppression and improvement of soil properties with sesbania brown manuring in turn leads to enhanced productivity and profitability of the crops. Brown manuring is estimated to replace 25% of nitrogenous fertilizer demand with enhanced soil health and environmental security.

27. ENTOMOLOGY

Red Palm Weevil – Management Practices

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Introduction

The red palm weevil (Rhynchophorus ferrugineus) is one of the important pests of coconut in India. It is also known as Asian palm weevil or Sago Palm Weevil and is originated from tropical Asia. This species of red palm weevil is reported to attack 19 palm species worldwide. The weevil was first reported on coconut palm, Cocos nucifera from South Asia. Red palm weevil can spread over a long distance with movements of infected plants.

Systematic Position

• Phylum – Arthropoda
• Class – Insecta
• Order – Coleoptera
• Family – Curculionidae
• Genus – Rhynchophorus
• Species – ferrugineus

Hosts

• Coconut palm
• Date palm
• Oil palm
• Sago palm
• Wide range of ornamental palms

Life History

Egg

The female lays 200-300 eggs in cavities or cut injuries of the trunk. It is smooth, whitish in colour. Incubation period is 2-5 days.

Grub

YellowishWhite colour grub with brown head. It is apodous (legless) and present inside the infected trunk portions. It becomes full grown in 36 - 78 days.

Pupa

Pupates use chewed fibrous material (Fibrous cocoon) which are present inside the trunk itself and adult emerges from it within 14 – 30 days.

Adult weevil

The adults of the red palm weevil are typical weevils. The head extends with a long thin rostrum that holds the antennae and tiny mandibles. Weevil is reddish brown in colour with dark spots on thorax. Male has long snout with tuft of hairs.
Damagesymptoms

Early infestation shows a few small holes with protruding chewed fibrous material and oozing out, of a brownish liquid, from such holes. In advanced stage of attack the central shoot shows sign of wilting and large number of larvae, pupae and adults present inside the infected shoots. In case of severe infestations, the inside portion of trunk is completely eaten it become full of rotting fibres and leads to loss of foliage. In case of young palms the top withers while in older palms the top portion of trunk bends and ultimately breaks at the bend (wilting). Sometimes the gnawing sound produced by the feeding grubs inside will also be audible.

Management

- Remove the infected plants from coconut gardens to prevent further damage
- Avoid the cutting of green leaves below 120cm to prevent successful grub movement through cut end
- Seal infected portion with cement or tar
- A solution of 1% Pyrocone E (a mixture of Pyrethrin 1 part + Piperonyl butoxide 10 parts) or 1% carbaryl is injected through a topmost hole.
- Place mud pots containing sugarcane molasses (2½ kg) or toddy (2½ litres) mixed with 5ml acetic acid and 5g to attract adult weevils
- Longitudinally split of tender coconut stem/logs 30 numbers in one acre to trap adult red palm weevils in large numbers
- Install pheromone trap (Ferrolure) @ one trap per ha.

28. AGRICULTURE

Molecular Approaches for Nitrogen Use Efficiency in Cereals

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Why Nitrogenous Fertilizer?

Nitrogen is 4th most essential element of plant after C, H and O. It involves in biochemical functions like, major component of chlorophyll, amino acid, enzyme, energy transfer Compound (ATP), nucleic acid (DNA, RNA).

What is Nitrogen Use Efficiency (NUE) ?

The efficiency of uptake (NUpE) and the efficiency with which the N absorbed is utilized (NUtE) to produce grain, are the two primary components of N use efficiency (Moll et al., 1982). Nitrogen Uptake efficiency (UpE) is ratio of plant or shoot N content to N supply. While, Nitrogen Utilization Efficiency (NUE) is ratio of grain mass and plant (or shoot) N content (NUE) is estimated at about 33%, with NUE’s of 42 and 29% in developed and developing countries (Raun and Johnson 1999). There is scope to improve the NUE within adapted germplasm by up to 20% (Foulkes et al., 2009). As a Plant breeder must produce varieties that absorb N more efficiently and use it more efficiently to produce biomass.

Fate of Nitrogen Use

Nitrogen use by plants involves two main steps: Uptake and Utilization. Utilization can be further compartmentalized as Assimilation and Translocation or remobilization.

N-Uptake

Plant roots have uptake systems for both NO₃ and NH₄ with different affinities. Plants adapted to low pH, flooded wet land – ammonium. Plants adapted to higher pH and more aerobic soils – nitrate (Maathuis, 2009). No₃ uptake at the root level - Two nitrate
transport systems have been shown to coexist in plants and to act coordinately to take up nitrate from the soil solution. NRT1 gene family mediates the root low-affinity transport system (LATS). NRT 2- High-affinity transport system (HATS). (Tsay et al., 2007). NH₄⁺ uptake occur by AMT gene, with 6 genes belonging to the same family of ammonium transporters were found in Arabidopsis (Gazzarini et al., 1999).

Nitrogen Management in Various Crop

(A). During vegetative growth, N is taken up by the roots and assimilated to build up plant cellular structures. After flowering, the N accumulated in the vegetative parts of the plant is remobilized and translocated to the grain. In most crop species a substantial amount of N is absorbed after flowering to contribute to grain protein deposition. The relative contribution of the three processes to grain filling is variable from one species to the other and may be influenced under agronomic conditions by soil N availability at different periods of plant development, by the timing of N fertilizer application, and by environmental conditions such as light and various biotic and abiotic stresses. (B) The relative contribution (%) of N remobilization and post flowering N uptake in different crops. Rice utilizes mostly ammonium as an N source, whereas the other crops preferentially use nitrate. Note that in the case of oilseed rape, a large amount of the N taken up during the vegetative growth phase is lost due to the falling of the leaves. (Fig. 1)

**Molecular and Genetic Engineering Approaches**

Development of genetic varieties with improved nitrogen use efficiency (NUE) is essential for sustainable agriculture. In rice, we developed a growth system, wherein N was the growth-limiting factor, and identified N responsive genes by a whole genome transcriptional profiling approach. Some genes were selected to test their functionality in NUE by a transgenic approach. One such example with positive effects on NUE is an early nodulin gene OsENOD93-1. This OsENOD93-1 gene responded significantly to both N induction and N reduction. Transgenic rice plants over-expressing the OsENOD93-1 gene had increased shoot dry biomass and seed yield. This OsENOD93-1 gene was expressed at high levels in roots of wild-type (WT) plants, and its protein product was localized in mitochondria. Transgenic plants accumulated higher concentrations of total amino acids and total N in roots. A higher concentration of amino acids in xylem sap was detected in transgenic plants, especially under N stress.

![Fig. 1. Schematic representation of nitrogen management in various crops. (Hirel et al. 2007)](image-url)

In situ hybridization revealed that OsENOD93-1 is expressed in vascular bundles, as well as in epidermis and endodermis. This work demonstrates that transcriptional profiling, coupled with a transgenic validation approach, is an effective strategy for gene discovery. The knowledge gained from this study could be applied to other important crops (Yong et al. 2009).

Monitoring nitrogen use efficiency (NUE) in plants is becoming essential to maintain yield while reducing fertilizer usage. Optimized NUE application in major crops is essential for long-
term sustainability of agriculture production. The precise identification of 11 major chromosomal regions controlling NUE in wheat that co-localise with key developmental genes such as Ppd (photoperiod sensitivity), Vrn (vernalization requirement), Rht (reduced height) and can be considered as robust markers from a molecular breeding perspective. Physical mapping, sequencing, annotation and candidate gene validation of an NUE metaQTL on wheat chromosome 3B allowed us to propose that a glutamate synthase (GoGAT) gene that is conserved structurally and functionally at orthologous positions in rice, sorghum and maize genomes may contribute to NUE in wheat and other cereals. We propose an evolutionary model for the NUE locus in cereals from a common ancestral region, involving species specific shuffling events such as gene deletion, inversion, transposition and the invasion of repetitive elements (Quraishi et al. 2012).

Krapp et al. (2005) showed that coordinated regulation of carbon and N biochemical pathways is necessary to optimize plant development. Many interactions exist between these two biochemical pathways, for example during the synthesis of amino acids, nucleic acids and a large number of secondary metabolites. Three major enzymes are responsible for cyclic assimilation of ammonium into amino acids in the biochemical pathway of NH₄⁺ assimilation: glutamine synthetase: GS; glutamate synthase: GoGAT; and glutamate dehydrogenase: GDH. They are involved in assimilation and recycling of mineral N catalyzing ATP-dependent conversion of glutamine into glutamate using ammonia as substrate. Glutamine synthetase exists in multiple enzyme forms, the chloroplastic isozyme being encoded by one gene (GS2) and the cytosolic form by three to five genes, depending on plant species (Bernard and Gallais, 2008). Moreover, Habash et al. (2007) reported that, in wheat, GSr activity increased at later stages of leaf development and could be thus considered as one of the key genes involved in N remobilization in senescent leaves. GS2, which maps within another metaQTL identified on chromosome 5D in the current analysis, plays a vital role during the vegetative stage. It is the predominant isozyme in leaf mesophyll cells, assimilating ammonia originating from nitrate reduction and photorespiration. GS1, co-locating with metaQTL mapped on chromosome 6A, is an orthologue of OsG S1 in rice. Cytosolic GS has multiple metabolic functions such as assimilating ammonia into glutamine for transport and distribution throughout the plant. Here, we report the cross-genome map-based identification of a GoGAT gene that is conserved on wheat chromosome 3B, rice chromosome 1, sorghum chromosome 3 and maize chromosomes 3–8. GoGAT catalyzes the reductive transfer of the amide group of glutamine to 2-oxoglutarate to form two glutamate molecules.

Conclusion

- Plant roots have uptake systems for both NO₃⁻ and NH₄⁺ with different affinities.
- Plant NUE is the integration of NUpE and NUtE, and is governed by multiple interacting genetic and environmental factors.
- Improving NUE either through genetic engineering or marker assisted breeding is still at the stage of proof of concept.
- Useful gene-based markers to breeders for the production of genetically modified plants or for marker assisted selection (MAS).

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29. **AGRICULTURE: FOOD TECHNOLOGY**

**Fruit Leather**

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Fruit leathers are dehydrated fruit based products which has goodchewy and tasty made by pouring pureed fruit onto a flat surface by drying. When dried, the fruit is pulled from the surface and rolled it gets the name “Leather”. Due to its novel and attractive structure for being products that do not require refrigeration, they constitute a practical way to incorporate fruit solids suitable especially for children and adolescents.

**Advantages of Fruit leather:** Fruit leathers allow leftover ripe fruits to be preserved. Moreover, fruit pulp left from making jellies, for more time (in reduced volumes) may also be converted into leathers. In recent years, their popularity has increased, transforming from a homemade preparation into an industrial product.

**Need for Production of Fruit Leather:** With the changing consumer attitudes, demands and emergence of new market products, it has become imperative for producers to develop products, which have nutritional as well as health benefits. In this context, fruit has excellent digestive and nutritive value, pleasant flavor, high palatability and availability in abundance at moderate price. The fresh fruit has limited shelf life therefore, it is necessary to utilize the fruit for making different products to increase its availability over an extended period and also stabilize the price during the glut season. Fruit can be consumed fresh or can be processed into juice, nectar, pulp, jelly, slices in syrup, fruit bar or dehydrated products, as well as being used as an additive to other fruit juices or pulps. Excellent salad, pudding, jam, jelly, cheese, canned fruit, RTS, nectar, squash, ice cream and toffees are made from fruit.

There has been greater increase in the production rate of these fruits over the years, and this may be due to their increased consumption pattern in the tropics. It is common experience that 20-25% of the fruit is completely damaged and spoiled before it reaches the consumer. Therefore, to utilize the produce at the time of glut and to save it from spoilage; the development of low cost processing technology of fruit is highly required. It will also generate more
opportunities of self-employment by starting small scale processing unit or cottage industry that will be remunerative to the growers. Thus, the preparations of fruit pulp with simple technology and its utilization in the form of pulp and leather have a great scope. Found that the cost of production of pulp is only Rs. 11/kg which is a raw material for fruit leather. Leathers can also be made from a wide variety of fruits including pawpaw, banana and sweet potato.

Process: Over-ripen fruits are selected, diseased, culled, malformed fruits are discarded. Fruits are washed thoroughly with running water, its peel was removed manually. Pulp is extracted through pulper and sieved to get fine pulp, ingredients like sugar, salt, citric acid etc., are added and mixed well. Trays are smeared with fat, fine pulp was poured on trays and subjected to initial drying for 8 hours; later surface dried sheets are put together in 3 layers pressed and finally dried again for 8 hours at 50°C. Fruit leather is wrapped by using butter paper and stored in dry plastic jars.

Conclusion

Fruit leathers are best sugar based fruit products which have good shelf life. More technology should be required for development of fruit leather in terms of over ripen fruit handling, preservation, processing and packing methods. Wide varieties of fruits can also be used in preparation of fruit leathers. Production of fruit leather can overcome in reduction of fruit wastage losses.

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Mulching with organic materials has been very long and beneficial for plant growth but plastic mulches widely replaced them. However they are not suitable when the consideration is given to environment pollution. Paper mulches are the solution for the environmental problems due use of plastic mulches. Several kinds of paper material have been used for mulching in different vegetable crops. Kraft paper have been used most commonly for mulching. Paper mulches may lower soil temperature as compared to black plastic mulch or bare soil. Oil treatment in paper mulches may improve its capacity to conserve soil moisture. Black paper mulch and black polyethylene mulch can be equally effective in controlling weeds. Paper mulches are less durable as compared to plastic mulches because they get easily destroyed with wind or rain. In future paper mulches with better strength and developing properties for mulching is needed.

Mulching is a very old practice which had been used by farmers and agriculturists since a long time for improving soil conditions by covering the soil surface with different kinds of materials. Plant growth is encouraged in a better way with the improvement of physical environment of the soil. Using mulch on the soil surface adds organic matter to it reduce weed growth and also checks soil erosion to some extent. Several kinds of mulches had been used to control weeds and to improve plant health. In the ancient times mulching with organic matter was done along with stones, pebbles, gravels, volcanic ash and cinder as well as other lithic materials. These methods are not only reduces the evaporation but also decreases runoff of upper soil layer by wind or heavy flow of water. No doubt mulching with organic materials has been very long and beneficial for plant growth but plastic mulches widely replaced them and are very common in vegetable production these days. A ideal mulch should be made by a renewable material, biodegradable, durable, permeable to rain and huge winds. It should suppress weed growth, maintain soil temperature and moisture and checks evaporation. Also it should be cost effective and easily manageable and should be easy to put in the field. Paper mulches are better option for mulching because they can be easily decomposed and incorporated into the soil whereas plastic mulches have problem of disposal. Although, paper mulches are more expensive than plastic mulches, life span is shorter and can be destroyed easily with heavy rain and wind.

Materials Used for Paper Mulches

Paper is a thin material produced by pressing together moist fibres of cellulose pulp derived from wood, rags or grasses, and drying them into flexible sheets. Several kinds of material have been used for mulching in different vegetable crops. Kraft paper have been used most commonly for mulching. Commercial mulch papers are also available as colored and uncolored. All the paper mulches which are used for mulching and are not covered with polyethylene can be used for mulching in organic farming as these are biodegradable and can be ploughed into soil. Durability of paper mulch have a direct effect on the degradability of the mulch. It was found that newspaper degraded most rapidly, followed by shredded newspaper and straw mulch was slowest in degradation [Sanchez et.al, 2008]. The paper started degrading from the sides of the paper and allowed weeds to grow on edges. The major disadvantage of the material was that it degraded so rapidly and was not effective for a long period.
paper mulch is its degradation from edges. Durability of paper mulch depends on the quality of paper, soil and weather conditions.

**EFFECT OF PAPER MULCH ON YIELD**

Mulching with paper may increase yield and can also improve fruit quality as the fruit does not get a direct contact with soil. For example, the yield of head lettuce was significantly higher when paper mulch was used in a warm and dry season [Brault *et al.*, 2002]. The benefit from different types of mulches also depends upon weather conditions in which they are used. For example, paper mulch gave best result in the rainy season as compared to plastic and straw mulch for increasing yield of tomato [Radics and Bognar, 2004].

These days, plastic mulches are more economical than all other mulches. However, they are not suitable when the consideration is given to environment pollution. The availability of paper and high cost of paper mulch is a major problem for large scale field production of vegetable crops. More extensive use of paper mulches could bring the production price closer to plastics, but hardly to the level to compete with them if only the price of mulch is considered. Paper mulch can be left in the soil after the crop ends without any environmental concerns, so its valued gets increased as compared to plastic mulch particularly in the presence of increased environmental awareness. The major problem with the paper mulches is their durability. Paper mulches are less durable as compared to plastic mulches because they get easily destroyed with wind or rain. Paper mulches with better strength and developing properties for mulching is needed, because many paper products tested so far tend to degrade too fast. Because of the environmental problem caused by the use of plastic mulches, it is not too difficult to forecast that there will be great demand for cheaper better and cheaper paper mulches that are environmentally trouble free.

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