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1. **AGRONOMY**

**Measures to Overcome Salt Stress**

Dr. Sahaja Deva  
*Subject Matter Specialist (Crop Production), Krishi Vigyan Kendra, Darsi.*

**Salt stress:** Salt stress is the stress occurred due to enrichment of salts, mainly sodium chloride or sodium sulphate. Salt stress is one of the most serious limiting factors for crop growth and production in the arid regions. About 23% of the world’s cultivated lands is saline and 37% is sodic.

**Measures to overcome salt stress:**

Alleviation of salinity hazards by improving the plant environment.

**Removal of salts from the root zone**

1. Salt Leaching and Irrigation Management  
   and Technology: The soil solution in irrigated fields is frequently more saline than the irrigation water because of evapotranspiration, which leaves the salts from the irrigation water in the soil, and the dissolution of soil minerals. One way to alleviate salinity hazards in crop production is to remove the salts from the root zone by leaching. Salt leaching requires adequate irrigation management, which is based on adding sufficient amounts of water beyond the water requirement for meeting evapotranspiration demands, in order to leach the excess salt from the root zone. It follows that the higher the salt concentration in the irrigation water, the greater the amount of...
water that must be passed through the soil to keep the salt concentration in the root zone at or below a critical level.

2. **Primer and Companion Plants:** Another attractive approach for reducing salt content in the root zone is growing salt-tolerant plants either prior (primer plants) or simultaneously (companion plants) with agricultural crops. The idea behind this approach is that both primer and companion plants take up significant quantities of salt from soil solution, thereby reducing the salt content in the soil, and consequently establish a less saline environment in the root zone for the more sensitive agricultural crops (Colla et al., 2006; Nuttall et al., 2008).

3. **Soil Mulching and Water Treatments:** Covering the soil surface, mainly with plastic sheet or mulch, has been suggested to reduce the adverse effects of salinity, particularly in row crops (e.g., da Costa et al., 2008; Dong et al., 2008; Saeed and Ahmad, 2009; Bezborodov et al., 2010). The mulching is designed to reduce evaporation from the soil surface, and thus decreases salt accumulation in the upper soil layer. However, the interaction between salinity and mulching on plant performance is not always straightforward. The mulch may simply reduce the evaporation regardless of salinity, and thereby increase water availability, which, in turn, improves plant productivity.

Fertilizer Application to the Root Zone

1. **Potassium (K):** Potassium fertilizers are probably the most common fertilizers used to improve plant performance under saline conditions.

2. **Calcium (Ca):** Application of Ca fertilizers to plants under saline conditions could diminish the negative effects of salinity on plant growth, yield and fruit quality.

3. **Nitrogen (N):** Studies on possible interactions between salinity and N fertilization have focused mainly on establishing optimal N application under saline conditions, rather than on its direct prevention of salinity hazards. Nutrient uptake in saline soils might be low due to high concentrations of cations and anions which might compete with the uptake of nutrient ions.

4. **Phosphorus (P):** The possible ameliorative effects of P fertilization on salinity damage in plants have been less studied than those of other nutrients.

5. **Sulfur (S):** Sulfur nutrition has also been shown to reduce the adverse effects of salinity.

6. **Micronutrients:** Fertilization with micronutrients could increase salt tolerance in plants.

7. **Biofertilizers and Manures:** Biofertilizers, such as Nitrogen which contains species of the N-fixing bacteria *Azospirillum* and *Azotobacter*, and Phosphorine which contains the P-dissolving bacterium *Bacillus megatherium* var. *phosphaticum*, interact with salinity. Another way to add nutrients to cultivated soils is through the application of organic manures.

Alleviation of salinity hazards by treating the plant Seed and Young Seedlings Priming and Seed Size

Techniques of seed treatment prior to their sowing (seed priming) are aimed at the initial stage of the germination, but previous to the advanced metabolic and morphological changes in the seeds.

Application of Plant Growth Regulators

1. **Salicylic Acid:** The use of SA to mitigate the adverse effects of salinity on plants has been recommended more than any other growth regulator. SA is well known for its medicinal properties, induction of flowering and retardation of petal senescence, and is associated with disease resistance.

2. **Brassinosteroids:** Brassinosteroids (BRs) have garnered much interest due to their effects of increasing plant tolerance to salt stress and improving development under salinity.

3. **Abscisic Acid:** Salinity stress can also be alleviated in plants using more common hormones, such as ABA, although information on this approach is minimal.

4. **Indole Acetic Acid, Kinetin, and Benzyl Adenine:** Foliar application of IAA and kinetin (Kin) to maize plants exposed to 100 mM NaCl in the nutrient solution alleviates most of the adverse effects of salinity, such as the decrease in...
plant biomass production, chlorophyll content and RWC.

5. **Gibberellins:** Application of Gibberellic acid (GA) has also been found to counteract some of the adverse effects of salinity, such as those on dry matter production, chlorophyll content and RWC of maize plants.

6. **Jasmonates:** Jasmonates are generally considered mediators of defense response signals, such as in flowering and senescence, but they can also play an important role in plant salt tolerance.

7. **Polyamines:** Polyamines are known as elicitors of diverse physiological activities in plants, such as cell division, tuber formation, root initiation, flower development, and fruit ripening; they also have beneficial effects on abiotic stress tolerance.

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### 2. SOIL SCIENCE

**Integrated Management Practices under Salt Stress Conditions**

*Pradeep Singh*, Anurag Malik and Raman Sharma

*CCS Haryana Agricultural University, Hisar-125004.*

Salt stress is a major limiting factor in crop productivity in arid and semi-arid areas of the world affecting 10% of total land area in the world. About 33% of all irrigated lands worldwide are affected by varying degrees of salinity. Increased salinization of arable land is expected to have devastating global effects, resulting in 30% land losses within next 25 years and 50% by 2050.

**General Management Practices**

#### Leaching

Leaching excess salts and maintaining a favourable salt balance remains the best strategy to prevent detrimental salt accumulation in the soil profile. This is achieved by supplying enough water to leach salts below the root zone but not into ground water reserves.

#### Drainage

A prerequisite to use leaching as a management tool is good internal and external drainage. Poor internal soil drainage caused by surface crusting, hardpans and sodic conditions is often managed by tillage and soil amendments. Regular deep ripping is recommended in these situations. When sodic conditions exist an aggressive soil amendment program is required, for example, using gypsum. Surface drainage is important, particularly with furrow irrigation. The increasing use of tile drains in horticultural plantings (and mole drains in vegetable production) is helping to improve internal drainage. A thorough soil survey before planting new areas is strongly recommended.

**Irrigation method**

The irrigation method and volume of water applied have a pronounced influence on salt accumulation and distribution. Flood irrigation and an appropriate leaching fraction generally move salts below the root zone. Similar results can be obtained with a properly managed sprinkler irrigation system. With furrow and pressurized irrigation, soluble salts in the soil move with the wetting front, concentrating at its termination or at its convergence with another wetting front. In furrow-irrigated plots, water movement is from the furrow into the bed via capillary flow. When adjacent furrows are irrigated, salts concentrate in the centre of the intervening bed. Because drip irrigation maintains more constant favourable conditions of soil moisture, plants tolerate higher levels of salinity than with furrow irrigation.

**Fertilizer management**

Many fertilizers contain soluble salts in high
concentrations. Therefore, the nutrient source, rate, timing and placement are important considerations in the production of horticultural crops. Salt indices for most commercial fertilizer products have been reported. For example, KCl has a salt index 205 times that of K2SO4. Generally, band application of fertilizers with high salt indices near seedlings should be avoided. Applying gypsum is a useful management practice for precluding sodium accumulation on the soil’s exchange complex, maintaining soil structure and improving water infiltration. For salt-sensitive crops such as lettuce, apply gypsum well before sowing so that soluble salts released during dissolution do not negatively affect production.

Soil amendments and water treatments

Soil amendments and water treatments often offer a practical and economical means for managing many problems common to saline and sodic soils. Soil applications of amendments are used for initial reclamation and long-term maintenance of soil quality. In general, water applications are intended to alter the chemistry of irrigation water such that no further degradation in soil quality will occur. Rates of amendments used for soil application are typically large and primarily based on economics. Amendments such as gypsum and elemental S have been used for years. Gypsum is primarily used on Na-affected soils as a source of Ca++ ions to displace Na+ ions, which tend to disperse soil particles and restrict water infiltration. The resulting displaced Na+ ions are leached readily from the soil profile. Gypsum is a neutral salt that does not directly reduce pH. However, it can indirectly lower the pH of sodic soils by reducing the hydrolysis reactions associated with Na+ ions on the exchange complex.

Mulching

Mulching with crop residue, such as straw, reduces evaporation from the soil surface which in turn reduces the upward movement of salts.

Deep Tillage

- Accumulation of salts closer to the surface - typical feature of saline soils
- Deep tillage would mix the salts present in the surface zone into a much larger volume of soil and hence reduce its concentration and impact
- Many soils have an impervious hard pan which hinders in the salt leaching process
- Under such circumstances “chiselling” would improve water infiltration and hence downward movement of salts

Incorporation of Organic matter

- Incorporating crop residues or green-manure crops improves soil tilth, structure, and improves water infiltration which provides safeguard against adverse effects of salinity
- In order for this to be effective, regular additions of organic matter (crop residue, manure, sludge, compost).

3. AGRICULTURAL ENTOMOLOGY

Leaf Eating Caterpillar (Spodoptera litura): A Pest of Soybean

Prashant K. Natikar

Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad -580 005

Soybean [Glycine max (L.) Merrill] is a fascinating crop with innumerable possibilities of not only improving agriculture, but also supporting industries. Soybean is a major source of edible oil (20%) and high quality protein (40%). It is a rich source of aminoacids, vitamins and minerals. Soybean oil is used as a raw material in manufacturing antibiotics, paints, varnishes, adhesives, lubricants etc. Soybean meal is used as protein supplement in human diet, cattle and poultry feeds. Soybean is a major oilseed crop of world grown in an area of 113.10 million hectares with production of 283.79 million tonnes in USA, China, Brazil, Argentina and India. In India it is grown over an area of 12.03 million hectares with production...
of 12.45 million tonnes and productivity of 1035 kg/ha. Predominant soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka and Gujarat.

The low productivity of soybean both at national and state level is attributed to abiotic and biotic stresses like drought, weeds, insect pests and diseases. Among these, insect pests often pose a serious threat to soybean production by increasing cost of cultivation and impairing quality of produce in many ways. The luxuriant crop growth, soft and succulent foliage attracts many insects and provides unlimited source of food, space and shelter. Among the insect pests lepidopterans are the most common on a wide range of crops especially on soybean. There is hardly any cultivated plant not attacked by at least one lepidopteran pest. One of the major pests of soybean includes tobacco caterpillar, Spodoptera litura (F.).

The tobacco caterpillar, S. litura is an economically important polyphagous pest in India and is considered as one of the major threats to the present-day intensive agriculture and changing cropping patterns worldwide, next only to Helicoverpa armigera (Hubner). Spodoptera litura is reported to feed on 150 species of plants causing 26-100 per cent yield loss under field conditions. The pest occurs in India, Pakistan, Bangladesh, Sri Lanka, South East Asia, China, Korea, Japan, Philippines, Indonesia, Australia, Pacific Islands, Hawaii and Fiji. The management of pest using chemical insecticides lead to mounting up of the cost of cultivation, environmental pollution development of insecticide-resistant pest strains and menace to natural enemies and other non-target organisms. As well, the continuous use of pesticides has resulted in resurgence of pesticide-resistant insect populations.

**Biology of Spodoptera litura**

A female moth lays masses of eggs on the undersurface of young leaves. Each egg masses had 300-350 eggs which were arranged in rows up to 3 layers with 0.6 mm in diameter. The freshly laid eggs were pale green in colour and turn yellow on second day. Eggs were covered by brown scales from the body of the female. Caterpillar during its developmental period undergoes five moults and six larval instars. Larva attains 40-45 mm in length; hairless, variable in colour. The total larval period range from 15 to 23 days. The pupa is elongated oval in shape and of shiny red colour. The eyes and the antennal case are prominent. The abdomen has movable incisures with dark spiracles. Pupa is of 15-20 mm long. The adult females and males were hairy and brown in colour. The head, thorax and abdomen were distinct. The antennae and legs were dark brown. Total life span of male and female cut worm vary from 43 to 48 days and 45 to 52 days.

**Host range**
The host range of S. litura covers at least 120 species. Among the main crop species attacked by S. litura in the tropics are Colocasia esculenta, cotton, flax, groundnuts, jute, lucerne, maize, rice, soybeans, tea, tobacco, vegetables (Brassica, Capsicum, cucurbit vegetables, Phaseolus, potatoes, sweet potatoes and species of Vigna. Other hosts include ornamentals, wild plants, weeds and shade trees (for example, Leucaena leucocephala, the shade tree of cocoa plantations in Indonesia).

**Symptoms**
In early stages, the caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance. Later they become voracious feeders making irregular holes on the leaves and finally leaving only veins and petioles. The larvae attack the crop normally in the month of August and September during late vegetative and early reproductive stages of the crop. The soft pods are chewed by the larvae and the thick pods are bored and feed on grain. The habit of larvae is to hide under the plants, cracks and crevices of soil debris during the day time and feeds during night hours. The incidence could be noticed by the faecal pellets left on the leaves. The common signs of infestation include:

1. Irregular holes on leaves initially and later skelatanization leaving only veins and petioles.
2. Larvae feeds on leaves, stems, buds, flowers and fruits.
3. Heavy defoliation.

**Management**
- Collection and destruction of the infested material from the field.
Deep ploughing is required during summer months to expose the pupae.
- Sowing resistant or tolerant varieties.
- Plucking of leaves harbouring egg masses / gregarious larvae and destroying.
- Setting up light traps for adults.
- Install pheromone traps (Spodo-lure) @ 8-10/acre at a distance of 50 m interval for early detection/ mass trapping.
- Spraying NSKE 5 % against eggs and first instar larva.
- Baiting with rice bran 50kg + jaggery 5 kg+ Monocrotophos 36 SL @ 650 ml in 8-10 litres of water in the form of small balls and broadcasting in evening hours in one acre.
- Release of egg parasitoid Trichogramma @ 50,000/ha/week four times.
- Erection of bird perches @ 10-12/ha.
- Use of Castor as trap crop.
- Spraying biopesticide Nomureae rileyi @ 2 g/l to control the caterpillar.
- Release egg parasitoid Telenomus remus @ 50000/ha.
- Spray Spodoptera litura NPV (Nuclear Polyhedrosis Virus) @ 250 LE/ha.
- For the management of grown up larvae spray new insecticide molecules viz., rynaxypyr 20 SC @ 0.2ml or flubendiamide 20 WG @ 0.5 g or Lambda-cyhalothrin 5 EC @ 0.5 ml per liter of water.

4. AGRICULTURE

Understanding the Heterosis Phenomena in Crop Plants

Praveen Kumar*1 and Sonal Kumar2

Heterosis means the superior performance of heterozygous hybrid plants over their homozygous parental inbred lines. When we do the quantitative genetic analysis then heterosis can express the deviation of the hybrid relative to the mid-parent is the relevant value and in evolutionarily term, defined as that the heterozygotes have higher fitness in a population than the homozygotes.

Heterosis was first described by Charles Darwin in 1876 after he observed that progeny of cross-pollinated maize were 25% taller than progeny of inbred maize. The phenomenon was rediscovered independently by George H. Shull and Edward M. East in 1908. Since then, heterosis has been extensively exploited in plant breeding, particularly in maize.

The conceptually heterosis is opposite of inbreeding depression, this is the loss of vigor following related mating. Inbreeding expression can be measured as the reduction in performance in proportion to reduction in heterozygosity. Heterosis is often viewed as maximizing heterozygosity and, in contrast, inbreeding depression is due to reduction in heterozygosity. Inbreeding depression has an important in many settings including agriculture such as in maintenance of heirloom varieties, conservation biology, and also in human health. In any circumstance in which matings occur in small populations and/or assortative mating occurs, there is an increased risk of reduction in vigor and homozygosity of deleterious alleles in genotypic contexts that are otherwise rare in populations.

To explain the heterosis there are three hypothesis

1. Dominance hypothesis: the complementing action of superior dominant alleles from both parental inbred lines at multiple loci over the corresponding unfavorable alleles leading to improved vigour of hybrid plants. Xiao et al. (1995), studied an inheritance of quantitative traits in an intersubspecific cross of rice, found that dominance may be the genetic basis of heterosis in rice.

2. Overdominance: heterosis to allelic interactions at one or multiple loci in hybrids that result in superior traits compared to the homozygous parental inbred lines. Krieger et al. (2010) reported a single-gene model, heterozygosity for a functional allele and a loss-of function allele
at the single flower truss (SFT) locus in tomato results in overdominant for fruit yield. This gene is homologous to Arabidopsis Flowering Locus T (FT) which is involved in the production of the flowering hormone florigen.

3. **Epistasis:** Epistasis interactions between non-allelic genes at two or more loci as main factor for the superior phenotypic expression of a trait in hybrids. Kusterer et al. (2007) used a triple-testcross design in the context of QTL analysis in Arabidopsis to characterize the importance of epistasis for biomass traits. Yu et al. (1997) evaluated inbred F2- derived F3 families from the intraspecific cross Zhenshan97 × Minghu63 and reported a predominance of additive × additive interactions underlying performance for grain yield.

The difficulty in formulating the genetic basis of heterosis because of the dominance and overdominance hypotheses are based only on single-locus theory or we can say involvement of many genes contribute to F1 hybrid. So isolating the contributing factors is not an easy task. Secondly, the multiple genes interact in ways that mask the action of each other in the process of epistasis. Thus, not only do multiple genes present a complicating factor, but also interchange of heterozygosity or homozygosity state of individual factors can influence the impact of other genes. To solve these problems we can study qualitative traits and quantitative traits at the genomic level.

**Reference:**


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**5. AGRICULTURAL ENTOMOLOGY**

**Four Important Diseases of Silkworm**

**J. Alfred Daniel*, M. Mathialagan1, and Dinesh Rajaram Hegde1**

1Senior Research Fellow, Department of Agricultural Entomology, TNAU, Coimbatore

**Introduction**

Silkworm, *Bombyx mori* L is susceptible to mainly four diseases namely; Grasserie, Flacherie, Muscardine and Pebrine. The average silkworm crop loss in India due to diseases is to the tune of 15–47%, while it is 10–15% in other countries like Japan, China and Italy. Out of four diseases, Flacherie is the major killer in India. The incidence of silkworm diseases is more during autumn season (35–47%) than spring (15–20%) in North West India. Generally, bivoltine silkworms are more susceptible to diseases as compared to multivoltine silkworm breed. The important factors responsible for the high disease incidence during autumn season are higher pathogen load, wider fluctuation of temperature between day and night, higher humidity in the late stage of rearing and poor quality of mulberry leaves available for rearing in North West Indian condition. The most popular methods of disease control in silkworm cocoon crop are prophylactic by controlling pathogens in rearing rooms and preventing pathgen entry during rearing. There is no race of *B. mori*, totally resistant or immune to diseases and
pests. Hence, proper disinfection is required to kill all the pathgens present in the rearing environment and to eliminate risk of disease transmission. Proper, effective and strict disinfection of rearing house, its surroundings, appliances and hygienic measures are most crucial as policy of “Prevention is better than cure” is best in silkworm rearing.

**GRASSERIE:**
- **Causative agent:** Bombyx mori Nuclear Polyhedrosis Virus
- **Occurrence:** The disease prevails all through the year but its severity is more during Summer and Rainy seasons.
- **Source of infection:** Silkworm gets infected when it feed on contaminated mulberry leaves. The milky white fluid released by the grasserie larvae, contaminated silkworm rearing house and appliances are the sources of infection.
- **Predisposing factors:** High temperature, low humidity and poor quality mulberry leaves.

**Symptoms:**
- The skin of infected larvae becomes shining before moult and fails to moult.
- Inter segmental swelling appears and the colour of the body becomes yellowish.
- The infected larvae move restlessly in the rearing bed/ along the rim of the trays.
- Infected larval body ruptures easily and turbid white haemolymph oozes out.

**Management:**
- Practice thorough disinfection of rearing house, its surroundings and equipments with any recommended disinfectant.
- Conduct an optional disinfection with 0.3% slaked lime solution when high incidence of disease noticed in the previous crop.
- Practice personal and rearing hygiene.
- Collect the diseased larvae and ensure its proper disposal.
- Maintain optimum temperature and humidity in the rearing house.
- Feed quality mulberry leaf and avoid overcrowding.
- Apply recommended bed disinfectant as per schedule and quantity.
- Feed Amruth as per schedule to control grasserie disease.

**MUSCARDINE**
- **Causative agent:** Among fungal diseases, White Muscardine is common. The disease is caused by Beauveria bassiana.
- **Occurrence:** The disease is common during Rainy and winter seasons.
- **Source of Infection:** The infection starts when conidia come in contact with silkworm body. Mummified silkworms / alternate hosts (most are lepidopteron pests), contaminated rearing house and appliances are sources of infection.
- **Predisposing factors:** Low temperature with high humidity.

**Symptoms:**
- The larvae loose appetite and become inactive.
- Presence of moist specks on the skin.
- The larva vomits and turns flaccid.
- After death, larva gradually becomes hard followed by mummification due to growth of aerial mycelia and conidia over the body and body turns chalky white.

**Management:**
- Disinfect the rearing house, its surroundings and equipments with recommended disinfectant as mentioned above.
- Control mulberry pests in the mulberry garden.
- Pick up diseased larvae before mummification and dispose them by burning
- Avoid Low temperature and high humidity in the rearing house. If required use heater/stove to raise the temperature.
- Regulate bed humidity during rainy season by dusting slaked lime powder during moult.

**PEBRINE:**
- **Causative agent:** Nosema bombycis / different strains of microsporidia.
- **Occurrence:** Non-seasonal
- **Sources of Infection:** Silkworm gets infected through eggs (Transovarian/Transovum transmission) or by eating contaminated mulberry leaf.
Infected silkworms, faecal matter, contaminated rearing house and appliances and alternate hosts (mulberry pest) are the sources of infection.

**Symptoms:**
- Irregular hatching of silkworm eggs.
- Irregular size of the larval body and moulting.
- The infected larva loses its appetite and becomes inactive with wrinkled skin.
- Black pepper-like spots appear on the body of the infected worms.
- White postules appear on the silk gland when examined under microscope with presence of shining oval spores.

**Management:**
- Disinfect the rearing house, surroundings and with recommended disinfectant as mentioned above.
- Conduct strict mother moth examination and surface disinfection of silkworm eggs to produce and rear disease free layings.
- Follow strict hygiene maintenance during rearing.
- Control mulberry pests in and around the mulberry garden.
- Apply recommended bed disinfectant as per schedule and quantity.
- Monitor seed crops constantly to eliminate the microspodian infection.
- Disinfection of rearing house, its surroundings and appliances:

**FLACHERIE:**
- **Causative agent:** Bombyx mori Infectious flacherie virus
- **Occurrence:** The disease is common during Summer and Rainy seasons.
- **Source Infection:** Silkworm gets infected by eating contaminated mulberry leaf. Dead diseased silkworm, its faecal matter, gut juice, body fluid are the sources of pathogen contamination. The infection can also takes place through injuries/cuts/wounds.
- **Predisposing factors:** Fluctuation in temperature, high humidity and poor quality of leaves.

**Symptoms:**
- The larvae become soft and flaccid.
- The growth of infected larvae retarded, becomes inactive and vomit gut juice. The faeces become soft with high moisture content. Sometimes chain type excreta and rectal protrusion also observed.
- Larval head and thorax become translucent.
- When infected with Bacillus thuringiensis symptoms of toxicity such as paralysis and sudden death are observed. After death, larvae turn black in color and gives foul smell.
- Some times, the dead larvae turn red when infected with Serratia sp.

**Management:**
- Disinfect the rearing house, its surroundings and equipments with recommended disinfectant mentioned above.
- Pick up diseased larvae and dispose them by burning.
- Provide good quality leaf grown under good Sunlight and recommended inputs. Do not provide over matured/over stored /dirty leaf to the silkworms
- Avoid starvation, overcrowding and accumulation of faeces in the rearing bed.
- Rear silkworms under optimum temperature and humidity.
- Avoid injury to the larvae.

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6. AGRICULTURAL ENTOMOLOGY

Insect Pests of Fig and their management

Dinesh Rajaram Hegde*1, J. Alfred Daniel and M. Mathialagan
Ph.D Scholars, Department of Agricultural Entomology, TNAU, Coimbatore-641 003.

Introduction
The common fig (Ficus carica L) belonging to family Moraceae is native to the western Asia. It has been grown since ancient times, and is now widely grown throughout the temperate world, both for its fruit and as an ornamental plant. The Fig is small to moderate size semi deciduous tree, growing 6–8 m height with short twisted trunk and crown with irregular branches. The leaves are deeply lobed and thick with a round surface and hairy inner surface. Fig fruit is multiple fruit botanically known as synconium, which consists of fleshy receptacle with narrow aperture at the tip and a number of small flowers lining the inner surface. The fruit is rich source of minerals especially calcium and fibres. Some of the commonly grown varieties of fig grown in India are Poona Anujr, Bellary R.C.R-1, Ganjam Anjur, Diana. There are a few insect pests which known to cause damage to this crop for its successful cultivation which are briefly dealt in this paper.

a. Stem borer: Batocera rufomaculata (Cerambycidae: Coleoptera)
This is the widely distributed pest in India attacking many number of fruit trees. Adult beetles are stout, dark brown longicorn beetles (50–55 mm) with yellowish green pubescence. Prothorax has 2 large kidney shaped orange spots (a characteristic for species identification) and short thick spine like projections one on each side. The adults usually emerge with the onset of monsoons. White, shiny, oval eggs are laid singly in cavities of main branches or stem. The larvae hatch and make entry into tree trunks or branches making zigzag tunnel in the wood. Affected stems show holes from which faecal pellets and chewed wood particles come out and seen leaped below. Later branches wilt and ultimately dry and also fruit bearing is adversely affected. Whenever tree trunk is affected, death of tree is noticed.

Management: A first measure is to remove and destroy all affected branches in the early stages of attack. Care must be taken to avoid injury to the plant while pruning. Keep the orchard healthy following good agricultural practices. Exclude alternatives host trees, such as silk cotton, fig tree and remove the infested branches from the garden to prevent the spread of the pest. Use neem based biopesticide inside the hole. Lantana camera leaf extracts @ 5%. If main stem or trunk is attacked, insert cotton wool soaked in petrol, kerosene or dichlorovos and seal the holes with mud.

b. Fruit fly: Bactrocera spp. (Tephritidae: Diptera)
Development from egg to adult under summer conditions requires about 16 days. The mature larva emerges from the fruit, drops to the ground, and forms a tan to dark brown puparium. Pupation occurs in the soil. About nine days are required for attainment of sexual maturity after the adult fly emerges. The developmental periods may be extended considerably by cool weather. The damage to trees caused by fruit flies result from 1) oviposition in fruit and soft tissues of vegetative parts of certain plants, 2) feeding by the larvae, and 3) decomposition of plant tissue by invading secondary microorganisms. 4) Larval feeding in fruits is the most damaging. Damage usually consists of breakdown of tissues and internal rotting associated with maggot infestation. Infested young fruit becomes distorted, callused and usually drop; mature attacked fruits develop a water soaked appearance.

Management: Tree rotation, enhancement of soil quality, choice of resistant varieties, water management, monitoring/screening, orchard sanitation, mechanical barriers, post-harvest treatment. Prior to harvest (30-40 days) collect and disposed off infested and fallen fruits to prevent further, multiplication and carry-over of population. Ploughing of orchard during November-December to expose pupae to sun’s heat which kills them. Infestation is high, use
bait splash on the trunk only once or twice at weekly interval. To prepare bait splash, mix 100 gm of jaggery in one litre of water managing fruit flies also reduces anthracnose disease and prevents late fruit fall. Mechanical control: 1) Collect and destroy the adult flies 2) Encourage the activity of rove beetles, weaver ants, spiders and birds and bats, 3) Release of parasitoids such as Opius longicaudatus, O. vandenboschi, O. oophilus and Bracon spp.

c) Mealybugs: Drosicha stebbengi (Pseudococcids: Hemiptera)

The life cycle of D. stebbingi starts with egg laying in loose soil around infected trees. Between April and May, purple-colored eggs are laid in egg-sacs comprising mass of wax threads, in the loose soil around (within 2–3 m radius) the infested mango trees. The nymphs emerge with the rise in temperature during January and travel up the trees via stem to feed on cell sap, adjacent to the fruiting parts. Therefore, heavy immature fruit falling occurs. Eggs hatch in December–January and nymphs start ascending the trees to succulent shoots and base of fruiting parts. Adults: the flying males emerge to mate with the flightless mature females while crawling down to the ground for egg laying. Occurring primarily in older, well-shaded groves planted on heavy soils. They will feed on the roots, bark, foliage, and fruit. The mealybug injects toxic saliva while extracting plant sap resulting in defoliation, fruit discoloration, fruit splitting, and fruit drop. Mealy bugs usually gather in large numbers, causing premature leaf drop and twig dieback when they feed. Like psyllids, they secrete honeydew, which attracts black sooty mold.

Management: Cultural control: 1) Prune affected shoots during winter. 2) Destroy ant colonies. 3) Grow attractant plants Bachelor’s Buttons or cornflower (Centaurea cyanus), coriander attract wasps. Mechanical control: 1) Collect and destroy the damaged leaves, twigs and stems 2) Use sticky barrier (5cm length) on trunk Biological control: 3) Coccinellids like R. fumida, chrysopid like Chrysoperla zastrowii silemi and drosophilid like Cacoxenus perspicax

d) Coccid: Pseudococcus lilacinus (Coccidae: Hemiptera)

Adults are flat and oval, approximately 3mm in length, pale yellow and covered with wax. One female can lay an average of 200-300 eggs per cluster.

Management: Sanitation is also important for reducing the pest population by disposing of fallen fruit, which may serve as hosts for the overwintering females. Grow attractant plants for natural enemies: viz., sunflower family, carrot family plants, buckwheat. Control ants and dust which can give the scale a competitive 26 advantage. Mechanical control: 1) Pruning of infested branches and twigs. 2) Collection and destruction of pruned infested material. Biological control: 1) Olive scale is effectively controlled by two parasites Aphytis maculicornis and Coccophagoides utilis. 2) Parasitoids such as Encarsia perniciosa and Aphytis diaspidis cause effective parasitization. 3) Coccinellid predators such as Chilocorus infernalis, Chilocorus rubidus, Pharoscymnus flexibilis check the pest infestation to some extent. 4) Spray dormant oil in late winter before spring.

f) Fig moth: Ephestia cautella (Phycitidae: Lepidoptera)

The eggs are translucent yellow with a sculptured surface. Larva: The larvae range from 1.5-15 mm in length and are light brown with dark brown spots with a sparse covering of hair. Pupae are dark-brown and found within a relatively light pupal case. Adult: The adult forewings are greyish-brown with scattered darker patches. The wing span is 11-20 mm and both fore- and hind-wings have broadly rounded tips and short fringes of hairs. Life cycle:

Management: Mechanical control: 1) Sieving, picking out, or winnowing, 2) It is important to destroy any insects found in the by-products or left-overs immediately. Larvae living inside the grain are only inadequately eliminated. Biological control: 1) Larval parasitoid, Habrobracon hebetor 2) Pupal parasitoid, Antrocephalus mitys 3) Spraying neem oil.

Conclusion

The paper has described the important pests of fig along with damage symptoms and appropriate management practices. Overall, for any crop health, first attention should be given
to preventive measures like sanitation and encouraging the natural enemies in the immediate vicinity of crop.

References:

7. AGRICULTURAL ENTOMOLOGY

Bumble Bees as Pollinators

M. Mathialagan*, J. Alfred Daniel1 and Dinesh Rajaram Hegde1

1Ph.D Scholar, Department of Agricultural Entomology, TNAU, Coimbatore-641 003.

Introduction
Bumble bees play a vital role in pollination of plants. Bumble bees are excellent pollinators of a wide variety of crops although in some plant species they cut a hole in the base of the corolla and "rob" the nectar without affecting pollination. Red clover is an excellent forage crop for bumble bees as it provides forage plants that bloom eight to nine weeks. Read (1983) reported that honeybees foraged for pollen only, but the longer tongued Bombus sp. and anthophorids collected nectar and pollen in Salvia carduacea L. in USA. The genus Bombus comprising 239 known species the world over. Rearing of bumble bees and their utilization in pollinating crops grown in poly houses has taken the shape of industry in western world. In India very little attention was paid in respect of their biology, nest architecture, nesting habitat, domestication of bumble bee colonies artificially and utilization of laboratory reared bumble bees in pollination of crops. The pollination effectiveness of bumble bees makes them important pollinators of specific plant species in this way. The bumble bees play important role in the production of seeds and fruits of cultivated as well as wild flora. Recently, several species of Bombus has been managed in laboratories with the aim to use for pollination of greenhouses tomato in Europe. Sih and Baltus (1987) observed the most important floral visitors on catnip in USA were honey bees (Apis mellifera L.), solitary bees (halictidae) and bumblebees (Bombus spp.). Visitation rate was higher in larger patches for honeybees and bumblebees, but lower for solitary bees.

Identification
Bumble bees are large, robust insects with black and yellow coloration. The bumble bee has a black or yellow hairy abdomen which is a character from a carpenter bee which has a black shiny, hairless abdomen. The foraging bumble bee has a large pollen basket on each hind leg that is often loaded with pollen. The bumble bee queens are typically twice as large as workers or males. A female bumble bee has a pointed abdomen with a stinger. Males do not have a stinger and the tip of the abdomen is rounded. The bumble bee (Bombus spp.) comprises a group of several hundred species found primarily in temperate regions. Bumble bees are highly social, like honeybees, but with smaller, less structured nests, consisting of one to five hundred bees. Bumble bees work harder, faster, and at cooler temperatures than honey bees.

Life Cycle
The bumble bee colony us made up of three types of individuals (queen, sexually undeveloped female workers, and males). Bumble bees produce annual colonies in South Carolina. Only the mated queens overwinter. Nests are started in early spring by these solitary, fertilized queens. These queens are often seen feeding on spring flowers or searching for a suitable nest site. Normally, nests are established in an abandoned rodent or bird nest in the ground. The solitary queen begins the colony by collecting pollen and forming it into a small lump. She lays 6-8 worker eggs on this pollen. After 4-5 days, the eggs hatch into larvae, which begin to feed on
the lump of pollen. The young larvae receive all the fats, minerals, proteins, and vitamins that are necessary for the pollen. The queen ore pollen and nectar to feed this first brood cycle. It takes about 21 days to develop from egg to adult. Once the first brood develops, they take over all the colony duties except egg laying. The adult workers defend the colony, collect pollen and nectar, and feed the larvae. Nectar is collected and stored in small sac like “honey pots” built from wax and pollen. The workers enlarge the nest and by midsummer the colony will have 20-100 workers. The colony produces reproductives (new queens and males) in late summer. They leave the nest to take mating flights. The successfully mated queens fly to the ground and hibernate 2-5 inches deep in the soil. The production of reproductives signals the end of the colony’s life. The overwintering queens emerge the next spring to complete the life cycle.

Economic Importance of Bumble Bees

Kumar and Kumar (1998) observed that there are eight different types of insects visiting the Ocimum in bloom. The indigenous honey bee, Apiscerana was the predominant visitor, followed by bumblebees. Proper pollination is needed for optimal fruit set and production. In the past, greenhouse tomato growers had depended on manual pollination, which can be very time consuming. Using bumble bees for pollination is an effective alternative and can completely replace manual pollination. In addition to saving on labor, bumble bee pollination has many advantages.

Tomato Pollination by Bumble Bees

Bumble bees are reared commercially for shipment to growers especially for greenhouse grown crops such as tomatoes which require “assistance” with pollination. Tomato pollen does not loosen easily. Each flower must be vibrant to ensure pollination. Tomato blossoms require slight movement for sufficient pollen from the stamens to fall onto the stigma of the flower. Bumble bees cause movement by hanging upside down on the flower, fastening their jaws onto the staminal tube, and then setting the flower into vibration by activating their flight muscles. This is called “buzz pollination.” These jaw marks will soon appear as a brown discoloration on the blossom assuring the grower that flower has been visited and “set.” Bumble bees are most active in the morning and in the afternoon at temperatures between 50 and 86°F. They function best at temperatures between 59 and 77°F.

Advantages of Bumble Bee in Crop Pollination

The bumble bee is capable of vibrating the flower using the unique "buzz pollination" mechanism. A bumble bee provides a back up pollinator and capable to pollinate crops effectively than other modes of pollination. The bumble bee is less affected by extreme weather conditions than the honey bee. Bumble bees are coolweather operators. Unlike honey bees, bumble bees are active at low temperatures (5°C), in windy conditions and under cloudy skies. The bumble bee is better adapted to perform under confined greenhouse conditions. Bumble bees are notably excellent pollinators in open air, but are especially valuable in greenhouses and plastic tunnels. Many species have longer tongues than honeybees, so they can pollinate flowers with long, narrowcorollas. They are very hairy and their hairs are branched and so are perfect for picking up and transferring pollen. Bumble bees can completely replace manual pollination resulting in less labour costs. In crops, such astomatoes, peppers and blue berries bumble bee pollination results in higher yield as well as larger and higher quality fruits.

Other crops pollinated by bumblebees (some of the crops are pollinated for seeds)

Blue berry/Straw berry, Sunflower, Field beans, Cherry, Cotton, Soya beans, Pear/Peach/Plum, Lucerne, Cucumber, Melons, Closers, Squash, Apple, Buck wheat, Pumpkin, Orange, Turnip, Gourds, Black berry, Peppers, Coriander, Fennel, Lemon, Mustard and Eggplant (Brinjal).

Problems in Utilizing Bumble Bees as Pollinator

Advancement in the field of bombiculture is lacking as compared to other countries where bumble beeindustry has been adopted as entrepreneurial activity and bumble bee colonies are supplied by commercial enterprises to fulfill the need of pollination. Decreasing number of bumble bees due to clearance of waste lands and wild plants as major flora andnesting sites of bumble bees. Systemic pesticides (pesticides that are absorbed through
the roots) may damage the bumble bee population.

Conclusion
Nest architecture studies help in designing artificial domiciles for bumble bees which can be efficiently utilized for pollination of various cash crops under open as well as protected conditions. Bumble bees can be utilized as a backup pollinator for honey bees as it is not infested by Varroa and other diseases known to honey bees. Bumble bee rearing should be enhanced to develop the Bombiculture industry in the country or to conserve the native pollinators.

References

8. BIOTECHNOLOGY

Importance of Phosphorous Use Efficiency in Crop Improvement
Saurabh Pandey* and Sunidhi Mishra

Orthophosphate (H2PO4−, Pi) (the form in which phosphorous uptake by plant occurs) is an essential macronutrient integral to energy metabolism aspect as well as integral component of membrane lipids, nucleic acids, including ribosomalRNA, and therefore essential for protein synthesis. The Pi concentration in the solution of most soils worldwide is usually far too low for maximum growth of crops, including rice. This has encouraged the enormous use of incompetent, polluting, and nonrenewable phosphorus (P) fertilizers in agriculture. Phosphorus use efficiency/PUE (grain or straw yield per unit P uptake) is the important aspect of this problem where higher efficiency relates to better crop yield.

Rice (Oryza sativa L.) is a major source of food for more than 4 billion of the world’s population (Chauhan & Johnson, 2011) and the most significant cereal crop. Notwithstanding its importance as an essential macronutrient, orthophosphate (Pi) is a prominent nutritional constraint to global crop production including rice production. Where high PUE genotypes can provide a solution to this problem.

Crop Pi deficiency is currently improved by the massive application of inorganic soluble Pi-containing fertilizers. Nevertheless, the use of Pi fertilizers is quite inefficient as only about 20–30% of applied Pi is absorbed by crops during their first growing season on new land. Furthermore, agricultural phosphorus (P) run-off also causes eutrophication of aquatic and marine ecosystems and has also led to algal blooms which pollute the marine as well as river ecosystem.

More than 60% of the total amount of P in a rice plant is partitioned to the grains leading to elimination of most of the acquired P when the grain is removed from the field. Phytate, the main storage form of grain P, immobilizes the Zn and Fe, triggering micronutrient deficiencies in humans and mono-gastric animals. Concerns are also evolving over the relationship between humankind’s “P-rich” diets, high blood serum P levels, and a host of associated human health issues including calcium homeostasis, kidney malfunction, cardiovascular disease, ageing, and cancer.

Further predictions on growing Pi-fertilizer demands in future (FAO, 2015)
will additionally worsen global P problems. In future, the development of substitute, supportable, and suitable agronomic approaches to secure residual global P resources although minimizing related environmental and human health problems is of vital importance.

We urgently need alternative and more sustainable approaches to decrease agriculture’s dependence on Pi fertilizers. This can be accomplished by manipulating crops by

- Enhancing the ability of their roots to acquire limiting Pi from the soil (i.e. increased P-acquisition efficiency) and/or
- Increasing the total biomass/yield produced per molecule of Pi acquired from the soil (i.e. increased P-use efficiency).

Improved P-use efficiency may be achieved by producing high-yielding plants with lower P concentrations or by improving the remobilization of acquired P within the plant so as to maximize growth and biomass allocation to developing organs. Membrane lipid remodeling coupled with hydrolysis of RNA and smaller P-esters in senescing organs fuels P remobilization in rice, the world’s most important cereal crop. Plants could achieve enhanced P efficiency through increasing Pi-acquisition efficiency (ability of their roots to take up Pi from the soil) and/or Pi-use efficiency (PUE; proficiency of Pi recycling within the plant itself. One promising area for improvement of crop PUE is to enhance the efficiency of P remobilization from senescing organs to young, developing organs, particularly immature leaves and developing seeds. Maximizing the effectiveness of P-remobilization from senescing organs could make an important contribution to the development of crops that can tolerate Pi deficiency, because senescing organs of most “modern” crop varieties exhibit low P-remobilization efficiencies of <50% (Stigter & Plaxton, 2015). An integral understanding of P remobilization would facilitate development of effective biotechnological strategies to improve crop (including rice) PUE thereby reducing the rate of depletion of nonrenewable rock P reserves.

References

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**9. BIOTECHNOLOGY**

**Plant Thermomorphogenesis: Molecular Aspects**

Saurabh Pandey* and Sunidhi Mishra

*Ph.D. Scholar, National Institute of Plant Genome Research, Aruna Asaf Ali Marg, New Delhi*;
Ph.D. Scholar, Department of Vegetable Sciences, IGKVV, Raipur–492012

Temperature is the key aspect of plant distribution and their growth and development. Being sessile, plants have developed highly responsive sensing mechanism to sense minute alterations in temperature and adjust their growth and development accordingly. The term ‘thermomorphogenesis’ was described as the effects of temperature on plant morphology coined by Erwin and colleagues, in analogy to photomorphogenesis (light-mediated growth). Holistic changes in plant morphology and architecture induced by high temperatures, below the heat-stress range, is altogether can be described as thermomorphogenesis.

The year 2015 is on track to surpass 2014 as the warmest year ever recorded since systematic temperature measurements began more than a century ago. In fact, the 10 warmest years on record all occurred after 1998. Such figures are alarming as it is expected that this will strongly affect plant distribution and survival, and therefore threaten biodiversity. Likewise, crop
productivity will probably suffer greatly from global warming, while food production is required to increase significantly to sustain a growing and more demanding world population. Plant can avoid these by activating mechanisms to adapt growth and morphology through enhanced evaporative cooling, increased convection and direct avoidance of heat flux from the Sun. If understood, the underlying molecular processes of these so-called thermomorphogenesis responses could be attractive breeding targets for improving crops to withstand climate warming (American meteorological society, 2015).

Elongation of the hypocotyl is one of the earliest thermomorphogenic effects seen in seedlings across Arabidopsis accessions in response to high ambient temperature. It has been suggested that hypocotyl elongation moves the sensitive meristematic and photosynthetically active tissues away from heat-absorbing soil and may promote cooling by allowing better access to moving air. Changes in plant morphology initiated by high ambient temperature and by vegetation shade are very similar, indicating the possibility of shared signaling elements.

This idea led to the identification of the bHLH transcription factor PIF4 as a key regulator of thermomorphogenic phenotypes including hyponasty, hypocotyl and petiole elongation. PIF4 (and to a lesser extent PIF5) performs its pivotal function in high-temperature signaling by orchestrating transcriptional changes that subsequently trigger primarily phytohormone-induced elongation responses. Recent findings have suggested important roles for light signaling pathways, the circadian clock, auxin and other phytohormones in PIF4-mediated temperature-induced growth. Furthermore, epigenetic mechanisms appear at the nexus of induction and attenuation of growth acclimation in response to high ambient temperatures. To control thermomorphogenesis, multiple pathways regulate the modulation of PIF4 levels, activity and downstream mechanisms. Thermomorphogenesis is integrally governed by various light signaling pathways, the circadian clock, epigenetic mechanisms and chromatin-level regulation (Nomoto et al., 2012).

Understanding the molecular genetic circuitries underlying thermomorphogenesis is particularly relevant in the context of climate change, as this knowledge will be key to rational breeding for thermo-tolerant crop varieties. Until recently, the fundamental mechanisms of temperature perception and signaling remained unknown. Our understanding of temperature signaling is now progressing, mainly by exploiting the model plant Arabidopsis thaliana. The transcription factor PHYTOCHROME INTERACTING FACTOR 4 (PIF4) has emerged as a critical player in regulating phytohormone levels and their activity.

In addition to thermomorphogenesis, adaptation to high ambient temperature also involves physiological processes such as photosynthetic acclimation, respiration and changes in carbon balance. Meeting future challenges to plant productivity imposed by globally increasing temperatures will require basic research in model plant species as well as applied approaches in crops. Integration of these ends of the spectrum will require directed efforts from the academic plant research community and private companies. Further development of thermomorphogenesis as a research area could ultimately provide efficient and timely leads for the initiation of appropriate breeding efforts to generate much-needed thermos-tolerant crops.

References
Introduction:
Microorganisms when supplied with adequate supplements, optimal growth temperature, pH, oxygen levels, and solute concentrations will develop at a maximum growth rate characteristic for the organism. In reality, conditions that allow for maximal growth rates outside the laboratory are few and far between. Subsequently, most microorganisms live in a constant state of stress. Various stresses are “Thermal”, “Starvation” and “Oxidative”.

Oxidative stress:
Groves and Lucana (2010) defined as “Interference in the balance between the production of Reactive Oxygen Species (ROS), including free radicals, oxides and peroxides and the ability of biological systems to readily detect their presence and detoxify ROS or repair the resulting damage”.

Reactive Oxygen Species (ROS):
1. Highly reactive molecules derived from molecular oxygen through various reactions in the cell system
2. They have unpaired electrons which readily react with bio molecules
3. Unavoidable by products of aerobic life style e.g. H₂O₂, O₂⁻
4. During energy production, the consecutive addition of electrons to oxygen leads to ROS production uncoupled with ATP production

Important ROS:
Superoxide (O₂⁻), Hydrogen peroxide (H₂O₂), Hydroxyl radical (OH*), Nitric oxide (NO), Hypochlorus acid (HOCl), Organic hydroperoxide (ROOH), Peroxynitrite anion (ONOO⁻)

Physiological functions of ROS
• Provide defense against infection in higher organisms
• Involved in the regulation and signal transduction of many antioxidant enzymes
• Hydrogen peroxide activates the transcription factor which in turn initiates many antioxidant genes transcription in E. coli and yeasts.
• ROS cause oxidative damages in many important biomolecules
• Creates mutation in genes as a result of damage in DNA molecule especially hydroxyl radical
• Modify protein molecules by reacting with several amino acid residues rendering the protein functionally redundant

Mechanism of oxidative damage in cells:

Endocellular:

Exocellular:

Source: Storz and Imlay, 1999

Major response mechanisms in microorganisms

1. Antioxidant enzymes: Superoxide dismutase (SOD), Superoxide reductase
Conclusions
- Reactive oxygen species are inevitable consequences of cellular oxidative metabolism leading to oxidative stress on microbes and other organisms endogenously and exogenously
- Organisms have developed mechanisms to counteract the oxidative stress in their environment
- Even anaerobic organisms too have well organised tolerance mechanisms
- Addition of some osmoregulants such as Glycine betaine confers the microbe tolerance to oxidative stress

Future Thrust areas of research
- Understanding of the basic mechanisms of oxidative stress in microbes of our interest
- Plant antioxidants which could confer tolerance/resistance to oxidative stress in microbes ought to be identified
- Techniques which exert less oxidative stress on commercial microbes ought to be distinguished and assessed
- Developing oxidation stress tolerant microbes would enhance the performance of microbes in agriculture and industry

References

11. ENTOMOLOGY

Screening Plants for Insect Pest Resistance and Crop Loss Assessment Techniques

*Sumit Saini*¹ and Vadde Anoosha²

¹ Research Associate, CIB & RC, Faridabad ²Research Associate AINP-PC MPRNL, PUSA, New Delhi

Crop plant or variety is screened against insect pest under question before providing status of resistance to that particular material. Screening for insect resistance is done by two methods 1) under the field and 2) glasshouse conditions. In field larger number of plants can be screened than in glasshouse. Moreover, the material is also exposed to other prevalent insect pest of the area. However, in field screening it is not possible to ensure uniform initial infestation of all the plants in a population. The following techniques are used to promote uniform infestation by an insect pest in the field:

1. Inter planting one row of susceptible variety between two rows of the test material.
2. Screening of the plant material in the insect prone areas.
3. Screening of material in the season when there is heavy infestation of an insect pest.
4. The test material should be grown in the soil having large populations of such insects, in case of soil pests.
5. Transferring equal number of eggs to each plant by hand. This is used in rice for stem borer.

In glasshouse smaller number of plants can be screened than in the field. However, results of glasshouse tests are more reliable than field tests. Glasshouse tests have been conducted in rice to stem borer and in alfalfa to spotted alfalfa aphid. The material found resistant in glasshouse should also be tested under the field conditions.

Methods of estimating the crop losses:
A brief account of the techniques adopted for the assessment of crop losses caused by insect-pests has been given below:
1. Mechanical protection: The crop is grown in enclosures under protected conditions by using anti-insect nets or cotton cloths in order to keep the pests away. The yield obtained under these enclosures is compared with that obtained from infested crop grown under similar conditions. Used for crop losses caused by leaf hopper and whiteflies. The limitation with this method is that the plants generally become weak and pale in enclosures due to changes in micro-environment. Chemical protection: In this case the crop is protected from pest damage by applying chemical pesticides. The yield of treated plot is compared with that of untreated which is exposed to natural infestation. The major drawback in this method is that the crop treated with chemicals may be physiologically affected and hence may vary in yield to some extent.

2. Comparison of yield in different fields: In this case the yield of the crop is calculated per unit area in different fields having different degree of infestation. Correlation between crop yield and level of infestation is worked out to estimate the loss in yield. This technique can be used for estimating crop loss due to different pests over a larger area; however the soil heterogeneity may influence the yield.

3. Comparison of yield of individual plants: In this case the yield of individual plants in the same field is measured and the average yield of healthy plants is compared with the plants showing different degree of infestation and the loss in yield is estimated. The data so obtained can also be used to work out the correlation between yield and infestation level on the bases of the yield of individual plants.

4. Damage caused by individual insect: Preliminary information is obtained from studies on the biology of the pest. The details regarding the amount of damage caused by different stages of pest are worked out and the amount of loss is calculated. This technique is quite convenient in case of leaf feeding insects. However, it is difficult to use this technique over a large area because it is time consuming.

5. Manipulation of natural enemies: Here the pest is controlled by introducing the natural enemies in to the field and the yield is compared with the plot without natural enemies. This technique is also feasible in a small area.

6. Simulation of damage: In this method the pest injury is simulated by removing or injuring the plant parts. The simulated damage may, however, not always be equivalent to the damage caused by an insect. Insects may inject toxins in to the plant rather than producing injury instantly. Feeding on margins of the leaf may not be equivalent to the tissue removed from the centre of the leaf. Furthermore the period of leaf removed may be important, as for example the age, quality and position of the leaf on the plant. Simulated studies have been done on spotted boll worm in cotton in India.

Uses of Crop Loss assessment in crop protection
Assessment of pest damage is useful in pest management in following ways:
- Determine the economic status of a given pest species
- Economic threshold levels and economic injury levels of the pest
- Effectiveness of control measures
- Evaluating the crop or a variety for its reaction to the pests
- Allocations for research and extension in plant protection
- Priority research areas on the bases of relative importance of different pests.
Geographic Information Systems are incredibly helpful in being able to map and project current and future fluctuations in precipitation, temperature, crop output, and more. By mapping geographic and geologic features of current farmland scientists and farmers can work together to create more effective and efficient farming techniques; this could increase food production in parts of the world that are struggling to produce enough for the people around them. GIS can analyze soil data combined with historical farming practices to determine what the best crops to plant, are where they should go, and how to maintain soil nutrition levels to best benefit the plants. Agricultural Geographic Information Systems (AGIS) can map not only topography and crop health, but help solve wider economic issues in municipalities and urban centres that may stem from rural farming practices.

- “It is a computer assisted information system for the acquisition, storage and display of geographic data in a desired manner”.
- GIS is a technology to integrate various social, economical and environmental information’s for decision making process.
- GIS is designed to work with data referenced by geographical coordinates.
- Remote sensing are powerful tools for the collection of the classified spatial data and GIS are powerful tools for the management and analysis of spatial data.

Components of GIS:

1. **Hardware**: Hardware is the computer on which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralized computer servers to desktop computers used in stand-alone or networked configurations.

2. **Software**: GIS software provides the functions and tools needed to store, analyze, and display geographic information.

3. **Data**: Possibly the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data, to manage spatial data.

4. **Live ware**: GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work.

5. **Methodology**: A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization.

**Objectives of the GIS:**

1. Maximize the efficiency of planning and decision making.
2. Provide efficient means for data distribution and handling.
3. It minimize data base duplication.
4. Geospatial data are better maintained in a standard format.
5. Revision and updating are easier.
6. Data and information are easier to search and analysis.
7. Data can be shared and exchanged freely.
8. Better decision can be made.

**Application of GIS technique:**

1. Cadastral, topographic and thematic mapping.
2. Surveying.
3. Remote sensing, image processing and photogrammetry.
4. Earth sciences and geographical application.
5. Assist in decision makers to select alternatives resources.
6. Environmental pollution and natural hazards management.
7. Planning for urban area management, transportation, architecture, conservation and landscaping.
8. To locate wild life habitat and migrational study.

**Need of GIS:**
1. Manipulation, Analysis and Modeling can be effectively and efficiently carried out with a GIS.
2. GIS are helpful to map and project current and future fluctuations.
3. Using technology in making decisions and strategy in the world of intense competition.
4. It protects the data from accidental loss.
5. Allow efficient storage and retrieval for all the input data.

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13. AGRONOMY

**Organic Farming Practices in Mitigating Greenhouse Gas Emissions and Climate Change**

1Rohini, N. Meti. 2Prakash G. and Prathima A. S
3Department of Agronomy, UAS, Raichur-
2Department of Agronomy, UAS, GKVK, Bengaluru-

Greenhouse gas (GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. The most abundant greenhouse gases in atmosphere are carbon dioxide, methane, nitrous oxide, ozone, CFCs and water vapour. Increased concentration of greenhouse gases in atmosphere causes greenhouse gas effect leading to global warming and climate change. Global mean temperature has increased by 0.74° during last 100 years. Temperature will increase by 1.8-6.4°C by 2100 A.D. Hence, there is a need to reduce greenhouse gas emission from various sectors. Among the various sectors, agriculture contributes 10-12% of greenhouse gas emission due to indiscriminate use of pesticides, deforestation and overgrazing thus organic farming is claimed to be the most suitable approach in mitigating greenhouse gas emission. It emphasizes on recycling of natural resources and use of low external inputs and also organic farming is a resilience system for adaptation to climate change.

**Mitigation of methane emission**

Wassmann and Phatak (2007) reported that application of compost resulted in the lowest methane emission (65.87 kg ha⁻¹) and net reduction of 34.12 per cent whereas maximum methane emission was recorded in rice straw application (92.10 kg ha⁻¹).

Lakshmanan et al. (2012) reported that combined application of organics and blue green algae not only recorded higher yield (3685 kg ha⁻¹), but also found to emit less methane (30.03 mg m⁻² day⁻¹) in paddy cultivation as compared to application of organics alone (58.54 mg m⁻² day⁻¹).

Mai et al. (2016) revealed that the application of biochar @ 4.15 t ha⁻¹ resulted in the lowest methane emission (391 kg C ha⁻¹) whereas combined application of NPK + compost emitted the highest methane (894 kg C ha⁻¹).

**Mitigation of nitrous oxide emission**

Kumar et al. (2000) reported that the application of neem cake, neem oil and nimbin resulted in lower percentage of nitrous oxide emission (10-21, 15-21 and 25-35 %).

Jinyang Wang et al. (2012) concluded that biochar incorporation significantly decreased the nitrous oxide emission and also found to be increased yield in rice-wheat cropping system.

Quynh et al. (2014) revealed that the combined composting of digestate with biochar and rice straw (D+B+RS 5:0.3:1) showed significantly reduced nitrous oxide emissions.

**Mitigation of carbon dioxide emission through carbon sequestration**

Basavanagouda (2000) reported that
significantly higher soil organic carbon 0.74 per cent was recorded when lucerne was grown as cover crop followed by Stylosanthes in maize crop.

Huimin Yan et al. (2007) reported that practicing no-tillage on 50 per cent of the arable lands and returning 50 per cent of the crop residue to soils would lead to an annual soil C sequestration of 32.5 Tg C year⁻¹.

Pushpa Devi et al. (2015) reported that the soil organic carbon pool was greater in zero tillage system (30.29 Mg C ha⁻¹) as compared to that of the conventional tillage (25.45 Mg C ha⁻¹).

Conclusion

- Nutrient management through organic sources reduces the greenhouse gas emission.
- No tillage operations along with crop residue incorporation increases carbon sequestration.
- Soil organic carbon can be increased by the combined application of FYM, green manure and compost.

References


14. AGRICULTURAL ENGINEERING

Advantages and Disadvantages of Simulation and Optimization Models

Neeraja J1 and Premkumari2

M Tech Scholar1, PhD Scholar2 Deptt. of Farm Machinery and Power Engineering, CAE, UAS, Raichur

In previous article the details of description and classification of biomass supply chain (BSC) models was given. Now in this present article the advantages and disadvantages of BSC models is been presented.

Simulation models

Advantages

1. They offer a high modelling flexibility (flows, events, priorities, waiting times, resource conflicts ...).
2. Stochastic events can be handled easily using built-in random generators.
3. Large and complex supply chains can be modelled and their dynamics appraised.
4. Models are relatively easy to understand and can be modified by competent users.
5. A broad choice of simulation software is available on the market.

Disadvantages
1. A detailed description of the chain must be provided (processes, flows, events ...).
2. The running time can be huge for large supply chains or long time horizons.
3. No optimization is possible in a simple way.
4. They cannot take decisions about chain structure (e.g., facility location).
5. Model errors are hard to find (the user always gets indicators at the end, even if they are fancy).

Optimization models

Advantages
1. They provide a high-level, abstract and compact specification of the problem at hand.
2. Their resolution indicates the best possible decisions for one or several criteria.
3. Powerful commercial and public-domain solvers are available.

References

15. AGROBIZNESS MANAGEMENT

AGRI-UDAAN

Neelamma R Kolageri¹, Sreevidyarani S. Sajjan²
PhD Scholars, Dept. of Agribusiness Management¹², UAS, Dharwad.

Agriculture is an important part of Indian economy. It plays vital role in the economic growth and development of the economy, it contributes about 50 percent of the employment among the rural population who depend upon the agriculture. Agricultural exports constitute 10 percent of the country’s exports and is the fourth-largest exported principal commodity category in India. Over the years the interest in agriculture among people found declining. The reduced interest may be contributed by many factors like changing interest among youth, agriculture found as less profitable profession, changing climatic conditions, season based farming, urbanisations and industrialisation, more risk in agriculture marketing. Therefore Indian has opened up a platform to attract young minds to open up their innovative ideas with respect to rural and agricultural aspect and help the farmers. Government has opened a platform to execute the innovative ideas by young minds by providing financial support. AGRI UDAAN is such a platform where the innovative ideas can be executed. It is six-month programme where in shortlisted agristartups with innovative business models will be mentored and guided to scale up their operations. Shortlisted startups stand a chance to get up to 25 Lakh rupees funding assistance. The idea behind this scheme is to attract the young minds to think on rural India and agriculture aspects which makes value addition in the farmer’s produce. AGRI UDAAN has focused some important areas to put young minds into deep thinking. Areas like Sustainable inputs, Precision /Smart agriculture, innovative food technology, supply chain technology, soil, water and weather tech, ICT and IoT.
(Information Technology) in agriculture, AgriFintech, Animal Husbandry, Urban/Vertical Farming, Agri-Biotech, Post-Harvest Technology, Farm Fresh Retail, Farm Mechanisation. The AGRI-UDAAN programme is operated by Hyderabad-based ICAR-National Academy of Agricultural Research Management (NAARM). The ICAR-NAARM’s technology incubator, a-IDEA along with IIM Ahmedabad’s Centre for Innovation. The programme will help into operations of agri value chain for effective improvement in agriculture. AGRI UDAAN will reach out to agristartups through accelerator programme in several cities. Among all the models 40 startups will be shortlisted for the programme for the first round. They will pitch their ideas to a panel of evaluators. Post evaluation about 8 to 12 startups will be selected for the final, capacity-building workshop. The shortlisted cohort will undergo a capacity building (CB) workshop in ICAR-NAARM. The startups will be trained in different aspects of technology commercialisation, product validation, business plan preparation, risk analysis, customer engagement, finance management, fund raising etc. The startups will also be provided with mentors. The accelerator programme will culminate with the demo day/investors meet at Hyderabad and Mumbai.

16. AGRICULTURE ECONOMICS

Demonetization and Its Impact on Indian Economy

Harkesh Kumar Balai1 and K.C. Bairwa2

1Ph.D. Scholar, Rajasthan College of Agriculture, MPUAT, Udaipur. 2Assistant Professor (Agricultural Economics), College of Agriculture (AU), Jodhpur.

Introduction

Demonetization is a process by which a series of currency will not be legal tender. The series of currency will not acceptable as valid currency. The Indian government had demonetised bank notes on three occasions—once in 1946 after that in 1978 and 2016. In all three cases, the goal was to combat tax evasion by "black money" held outside the formal economic system. In 1946 pre-independence money hoped demonetization would penalize Indian businesses that were concealing the fortunes amassed supplying the Allies in World War II. In 1978, the Janata Party coalition government demonetised banknotes of 100, 500 and 1000 rupees, again in the hopes of curbing and black money.

The same thing happens with the Rs. 500 and Rs. 1000 note demonetization. The Hon’ble Prime Minister of India, in an unscheduled live televised address to the nation on November 8, 2016 at 20:15 p.m. Indian Standard Time (IST) declared circulation of all INR 500 and INR 1000 banknotes of the Mahatma Gandhi Series as invalid with immediate effect Issuance of new denomination notes of INR 2000 and not INR 1000, the conversion of black money would be curbed.

Need for Demonetisation

High denomination notes were known to facilitate generation/ circulation of black money. Total number of bank notes in circulation rose by 40 percent between 2012 and 2016 and increase in number of notes of INR 500 denomination was 72.65 percent and for INR 1,000 denomination was 111.19 percent during this period.

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Source: RBI report 2017

Impact of Demonetization:

(A) Positive Impact

1. Human trafficking: Nobel laureate Kailash Satyarthi and others working to fight human trafficking said that the note ban had led to a huge fall in sex trafficking. Satyarthi said the demonetisation would be effective in
combating exploitation of children as well as corruption and would be a great obstacle to traffickers. However, 2 months later he expressed his disappointment on Rs 2000 notes being pushed into human trafficking in absence of other concrete steps.

2. **Radical groups:** The Demonetization has badly hit Maoist and Naxalites as well. The surrender rate has reached its highest since the demonetization is announced. It is said that the money these organizations have collected over the years have left with no value and it has caused them to reach to this decision.

3. **Hawala:** Traditional system of transferring money used in Arab countries and South Asia, whereby the money is paid to an agent who then instructs an associate in the relevant country or area to pay the final recipient.

**(B) Negative Effects**

1. **Cash shortage:** The scarcity of cash due to demonetisation led to chaos, and most people holding old banknotes faced difficulties exchanging them due to endless lines outside banks and ATMs across India, which became a daily routine for millions of people waiting to deposit or exchange the 500 and 1000 bank notes since 9 November.

2. **Deaths:** Several people were reported to have died from standing in queues for hours to exchange their old banknotes. Deaths were also attributed to lack of medical help due to refusal of old banknotes by hospitals. As of 15 November 2016, the attributed death toll was 25 and 33 deaths as of 18 November.

3. **Stock market crash:** The day after the demonetisation announcement, BSE SENSEX crashed nearly 1,689 points and NIFTY 50 plunged by over 541 points. By the end of the intraday trading section on 15 November 2016, the BSE SENSEX index was lower by 565 points and the NIFTY 50 index was below 8100 intraday.

4. **Transportation halts:** After the demonetisation was announced, about 800,000 truck drivers were affected with scarcity of cash, with around 400,000 trucks stranded at major highways across India were reported. While major highway toll junctions on the Gujarat and Delhi-Mumbai highways also saw long queues as toll plaza operators refused the old banknotes.

**Impact on Agriculture:** No Harvest, No sale, No cash, No purchase of seeds/ fertilizers as they don’t use NEFT/net banking, debit/credit card, No swipe machines in rural areas, Fields are ready for sowing but farmers are unable to purchase seeds/ fertilizers/diesel for sowing. No further sowing Fruits and vegetables which are perishable in nature are getting unused/un-sell due to no trade in mandis, Farmers are unable to pay to labours.

**Advantages of Demonetization**

- The biggest advantage of demonetization is that it helps the government to track people who are having large sums of unaccounted cash or cash on which no income tax has been paid because many people who earn black money keep that money as cash in their houses.
- Since black money is used for illegal activities like terrorism funding, gambling, and money laundering and also inflating the price of major assets classes like real estate, gold and due to demonetization all such activities reduced.
- Another benefit is that due to people disclosing their income by depositing money in their bank accounts government gets a good amount of tax revenue.

**Disadvantages of Demonetization**

- Banks and ATMs which are the only medium to change the old currency units to new currency units
- If the costs of printing of new currency are higher than benefits then there is no use of demonetization.
- If people have not kept cash as their black money and rotated or used that money in other asset classes like real estate, gold and so on then there is no guarantee that demonetization will help in catching corrupt peoples

**Conclusions**

The advantages are much dominating and it will be in the long term interest of our country.
comfortably outweighing the disadvantages. Government need to take all the necessary steps so as to ensure that there will be a smooth flow of currency exchanges. It would turn into chaos if government takes no necessary steps to circulate money correctly. It will make a massive change in our economy. We congratulate the entire government and those hidden brains of our democracy who brought this decision.

Reference

17. AGRICULTURE ENTOMOLOGY

Ants as Sutures
Ramya. N * Mogili Ramaiah
ICAR-Indian Agricultural Research Institute (IARI), New Delhi

Ants are eusocial insects belong to family Formicidae of order Hymenoptera. Ants are known for their myriad diversity and distribution worldwide. Ants are the major group of insects in entomotherapy from dates back. Humans across the world used them as anesthetic, analgesicaphrodisiac and for treating many liver related problems. Besides these uses ants are used as natural sutures to stitch the wounds.

The use of ants as sutures dates back to prehistoric period. The first record use in the Artharvaveda, circa during 100 BC. They were using them as sutures to stitch the intestinal wounds after surgeries, so it evidence that it’s had been in practice sometimes from far before that. From Indian practices it was learnt later in the Mediterranean region. Arabian medicine translated the Hindu literature in 600AD and from there it spreads to parts of Europe and it persists till the end of 17th century.

Mandibles of ants belong to genus Atta, Camponotus and Eciton are used as natural sutures for stitching the wounds in South America, Europe, Mediterranean region and India. The practice of using ants as sutures as history from early Egyptian and Greek civilization. People in some villages of Kongo and around Africa still using these ants as natural emergency suture when nothing else available.

Method of suturing by ant:
The mandibles of the ants are big and strong enough to be used in the suturing. They hold the back of the ant and line up the jaws of the ants along the wounds. Once the ant jaws sutured on both sides of wound, the body of ant cut by leaving only head and jaws. Jaws act as Natural sutures and infection was prevented by the bactericidal substances produced by their mandibular glands (Gudger, 1925). The mandibles are removed after about 3 days when the wound get healed completely.

Status of ants as sutures
Around 1500 AD their use has been decreased as some eminent surgeons rejected them.
Theodoric rejected the Arabian medicine, de chauliac rebuff that as they were rejected by body, Fabricius felt the jaws become relaxed too much after the death of ants or ants body removal. More than that by that time the silkworm gut sutures become the common and easily available as it difficult to get the ants in all seasons and locations. Very few recorded references we get regarding this because it is an established fact already and the old literatures are in different languages, so it’s difficult to get the translations of those. However the ants are still in use as instant sutures in some parts of the world.

Conclusion
Ants are known for many amazing features and it is the familiar fact to the entomologist. However it is surprising to know the medicinal features of ants that too as suture is really an astonishing thing. Ants in the medicine field is known from prehistoric periods. Their mandibles serves as instant natural sutures to heal wounds. It’s an amazing fact to know that people in some parts of world are still using this technique of suturing. However the scientific study has not been through in this field and it is need to investigate the risk in this treatment. This type of investigations helps to discover the use of the ant mandibles in one or the other way in medicine and it may also help in maintaining the biodiversity of ants by changing people perspective towards ants from destructive to useful insects too.

References

18. HORTICULTURE

TILLING: A Novel Approach for Vegetable Crop Improvement
Koushik Saha and Arindam Das
Ph.D Scholars, Division of Vegetable Crops, ICAR-IIHR, Bengaluru-560089, Karnataka.

TILLING (Targeting Induced Local Lesions in Genomes)
TILLING is a general reverse genetic technique that combines chemical mutagenesis with PCR based screening to identify point mutations in regions of interest. (McCallum et al., 2000). TILLING is a powerful technology that employed heteroduplex analysis to detect which organism in a population carry single nucleotide mutation in specific genes. TILLING was introduced in 2000, using the model plant Arabidopsis thaliana. TILLING can also be used to detect naturally occurring SNP in genes among the accession, variety or cultivar and study the gene function, or to detect genetic marker in population. TILLING has since been used as a reverse genetics method in many plants such as corn, wheat, rice, soybean, tomato and lettuce.

Procedure
iTILLING
A new approach to the TILLING method that reduces costs and the time necessary to carry out mutation screening was developed for Arabidopsis and it is called iTILLING, individualized TILLING (Bush et al., 2010).

EcoTILLING
EcoTILLING is a molecular technique that is similar to TILLING, except that its objective is to uncover natural genetic variation as opposed to induced mutations. Many species are not amenable to chemical mutagenesis; therefore, EcoTILLING can aid in the discovery of natural variants and their putative gene function. This approach allows one to rapidly screen through many samples with a gene of interest to identify naturally occurring SNPs and / or small INDELS. The method has proven to be successful to detect DNA polymorphisms
including variations in satellite repeat number. Furthermore, in highly heterozygous outcrossing species, EcoTILLING can be used to determine heterozygosity levels within a gene fragment. EcoTILLING reduces the time and effort for SNP discovery generally required by weeding out identical haplotypes. Therefore, this method does not require one to sequence all individuals in a population to identify polymorphisms, which can be a burdensome expense and time consuming. It also has the advantage of detecting multiple polymorphisms in a single fragment because CEL I will digest only a small proportion of the heteroduplexes at a single position (Barkley et al., 2008).

De-TILLING

Fast neutron mutagenesis often results in kilobase-scale DNA deletions. As a new knockout technique to obtain deletion mutants for target genes, a strategy to screen for rare deletion mutants in large fast neutron mutagenised populations was first developed by Li and co-workers and demonstrated in Arabidopsis and rice. It combines fast neutron mutagenesis and high-throughput PCR screening, named as “Deleteagene” (Delete-a-gene). This strategy has been further developed and named deletion-TILLING, or de-TILLING (Kurowska et al., 2011).

Generation of novel variants through TILLING

1. **Enhanced shelf life of melon:** Enhanced shelf life was the goal for research in *Cucumis melo* (Dahmani et al., 2010). TILLING screening in melons were performed for 4,032 M2 plants and 11 genes related to fruit quality were chosen. In total, it has identified and confirmed by sequencing 134 induced mutations in an 18.3-kb total length of tilled amplicons. A detailed investigation was performed for CmACO1–ACC oxidase 1, the enzyme that catalyses the last step of ethylene biosynthesis and is connected with the shelf life of fruit. One mutation out of the seven detected in this gene, G194D, occurred in a highly conserved amino acid position and an assumption was made using crystallographic analysis that it affects the enzymatic activity. A phenotypic analysis confirmed this assumption that the mutant showed a significant delay in ripening and yellowing, with improved shelf life (Kurowska et al., 2011).

2. **Lettuce Improvement by TILLING:** To identify genes underlying important traits for sustainability and product quality, a TILLING population of four thousand individuals from the lettuce cultivar ‘Saladin’ was developed and DNA as well as seed samples were collected. TILLING has also been used to increase the shelf life of lettuce plants (Mou, 2012).
3. **Pea:** In a separate study of pea (*Pisum sativum*), which also fixes nitrogen and is a member of the legume family, TILLING was applied to identify an allelic series of mutations in five genes with a total of 60 mutants identified. Some of the mutations discovered in the LE gene, which encodes 3β-hydroxylase, were further characterized and determined to affect internode length. Mutants were backcrossed to the wild type and the segregation of the mutations and their respective phenotypes were examined (Triques *et al.*, 2007).

**References**


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**19. HORTICULTURE**

**Role of Plant Quarantine in Pest and Disease Management**

Arindam Das and Koushik Saha

*Ph.D Scholars, Division of Vegetable Crops, ICAR-IIHR, Bengaluru-560089, Karnataka*

**Introduction**

Plant diseases have caused severe losses to humans in several ways. Starvation and uprooting of families resulted from the Irish famine caused by potato late blight (*Phytophthora infestans*). A valued resource was lost with the virtual elimination of the American chestnut by chestnut blight (*Cryphonectria parasitica*) and direct economic loss (one billion dollars) occurred in one year to American corn growers from southern corn leaf blight (*Cochliobolus maydis* and Anamorph *Bipolaris maydis*). Many plant diseases cause less dramatic losses annually throughout the world but collectively constitute sizable losses to farmers. Many strategies, tactics and techniques used in disease management can be grouped under one or more very broad principles of action. The first principle (prevention) includes disease management tactics applied before infection (i.e., the plant is protected from disease), the second principle (therapy or curative action) functions with any measure applied after the plant is infected (i.e., the plant is treated for the disease). An example of the first principle is enforcement of quarantines to prevent introduction of a disease agent (pathogen) into a region where it does not occur.

**Quarantines**

The quantum of import and export of plant commodities have been increased during the recent years, there is a distinct possibility of moving insect pests and diseases from their original native habitation to new location. To prevent the introduction of exotic pests, diseases and weeds from foreign countries or within country, legal restrictions are enforced commonly known as Quarantine. Plant
Quarantine regulatory measures are taken at the national level (Domestic Quarantine) as well as international level (Foreign Quarantine). The enforcement of the quarantine measures is supported by legal enactments, called quarantine laws. Effective implementation of quarantine is highly emphasized for manage of pests, which in turn helps in maintaining the productivity of crops. Analysis of pest risk in plant introduction is essential to decide as to whether a particular planting material could be permitted entry or not. The attitude towards 'entry status' of a material may be liberal or conservative depending on the risks involved in its introduction. If risks are low, quarantine would be liberal in permitting the entry. However, if risks are very high, the material may be denied entry. Pest risk analysis should also consider factors, such as availability of trained personnel, efficacious detection techniques, treatments at the point of entry quarantine, knowledge about the life cycle of the pest, existence of races and strains, world distribution, modes of transmission, factors favouring establishment and spread of pests/pathogens and availability of safeguards.

**Review of Domestic Quarantine Regulations**

The legislature measures to prevent the introduction and spread of destructive pests of crops are operative through the "Destructive insect and pest act, 1914". The domestic quarantine regulations are operative by the central government through powers vested under section 4A, B & D and section 5 authorizes the state government to enact similar regulations and section 5A provides for the penalties. The first domestic quarantine notification was issued by central government in 1944 against fluted scale (Icerya purchasi) and San Jose scale (Quadraspidiotus perniciosus) in 1953. The government of India in 2003 has notification of a new plant Quarantine Order (PQ Order) to harmonized India’s regulatory frame work with the International Plant protection Convention (IPPC) and internationally accepted standard and the tenets of the SPS agreement of the World Trade Organization (WTO). Cottony cushion scale, woolly aphid, San Jose scale, golden cyst nematode of potatoes, the giant African snail are some exotic pest introduced into India and cause extensive damage before the PQ Order 2003. To prevent the spread of Banana bunchy top virus disease from states of Assam, Kerala, Orissa, Tamil Nadu Govt. of India issued a notification in 1951. A notification was issued by the central government in 1959 against potato wart (Synchytrium endobioticum) prohibiting the movement of potato from the states of West Bengal. In order to prevent the spread of apple scab (Venturia inaequalis) from state Himachal Pradesh, central government issued a notification in 1977 prohibiting export of planting materials of apple from Himachal Pradesh. In general, risks are more with the introduction of vegetative propagules than with true seed. In case of true seed, risks are more with deep-seated infections than with the surface borne contamination of pests/pathogens. Again, risks are far greater with pathogens like viruses, downy mildews, smuts and many bacteria carried inside the seed without any external symptoms. When vegetative propagules are introduced, rooted plants, and other underground plant parts like rhizomes, suckers, runners, etc. carry higher risks than bud wood, scions and un-rooted cuttings. In any case, bulk introductions are always risky as thorough examination and treatment in such cases is very difficult and planting area is far too large to prevent the establishment and spread of the introduced pest/disease. Based on these factors, plant quarantine regulates the introductions as follows: Complete embargo/prohibition, Post-entry quarantine, Restricted and Unrestricted.

**Agencies involved in Plant Quarantine in India**

Presently there are total 26 different quarantine stations located at 10 Airports (Amritsar, Mumbai, Kolkata, Hyderabad, Chennai, New Delhi, Patna, Tiruchirapally, Trivandrum, Varanasi), 9 at Seaports (Bhavnagar, Mumbai, Kolkata, Cochin, Nagapatnam, Rameshwaram, Tuticorin, Vishakapatnam) and 7 at Land Frontiers (Amritsar railway station, Attari-Wagha Border, Attari-Railway station, Bongaon-Benapoli border, Gede Road railway station, Panitanki, Kalimpong).

**Inspection Procedures in quarantine station**

Visual inspection, X-ray test, washing test, Sedimentation test, Incubation test, Grow out test, Serological methods: (a) ELISA (Enzyme Linked Immuno-sorbant Assay) (b) DIBA (Dot
Immuno-binding Assay) (c) ISEM (Immuno-sorbant Electron Micro Scopy) (d) Latex agglutination test, Nucleic acid hybridization and Polymarised chain reaction (PCR).

References


20. PLANT BREEDING AND GENETICS

Association Mapping in Plants: An Introduction

Ram Narayan Ahirwar¹ and Shaukeen Khan²

Department of Genetics and Plant Breeding, ¹IAS, BHU, Varanasi-, ²MPUAT, Udaipur, Rajasthan

This article highlights the importance of association mapping (AM) for genetic studies of quantitative traits in all major crops. This mapping study in plants became possible due to the availability of DNA-based molecular markers and a variety of sophisticated statistical tools that are evolving regularly. Presently, genetic linkage (also called as bi-parental mapping) and genome-wide association mapping (GWAS) are the two useful techniques to detect and characterize the major or minor QTLs responsible for many traits in crops. Mapping a nucleotide sequence for a specific and selected trait offers an opportunity to plant breeders to apply marker assisted selection (MAS) for improvement of plant architecture. The yield contributing traits are mainly controlled by many loci and their molecular characterization and genetic mapping is called quantitative trait loci mapping (QTL-mapping). Molecular mapping for different traits in plant populations to determine robust markers and their subsequent use is imperative for varietal improvement programmes through an effectively use the appropriate genetic resources. The goal of gene mapping is to find neutrally inherited and closely linked molecular markers due to location within or in close proximity of the genes governing the quantitative traits. In bi-parental mapping, the accuracy of mapping a gene or QTLs depend on the size of mapping population, genetic variation and number of molecular markers used. However, most of the QTLs reported from bi-parental mapping population are not robust and stable. Hence, we observed low resolution, only two alleles are addressed, more time required for developing mapping population and more costly. Due to various limitations of the conventional bi-parental linkage mapping, linkage disequilibrium (LD) based association mapping offers an alternative approach to overcome the limitations of bi-parental approach, which is more attractive to grab the best out of crop genetic resources. In Association Mapping approach, a collection of variable lines is scanned to understand marker-trait associations using linkage disequilibrium (LD) which is non-equilibrium association between different alleles at various loci and varies across plants chromosomes.

The potential high resolution in identifying a QTL controlling a trait of interest is the primary advantage of AM as compared to linkage mapping. AM has the potential to identify more and superior alleles with detailed marker data in a large population which can be utilized immediately in breeding. Furthermore, AM uses breeding populations including diverse and important materials in which the most relevant genes should be segregating. To obtain similar power of detection, the sample size and structure do not need to be large as for linkage studies. Finally, AM has the potential not only to identify and map QTL but also to identify causal polymorphisms within a gene that are responsible for the difference between two phenotypes. Association mapping is useful to...
uncover association between inter-individual genetic variants, mostly single nucleotide polymorphisms (SNPs) that show the strongest association to the traits of interest.

The general steps of association mapping analysis are: (1) Selection of diverse genotypes that may include, land races, elite cultivars, wild relatives and exotic accessions to form the mapping population or panel; (2) a comprehensive and precise phenotyping is done over the traits such as, yield, stress tolerance or quality related traits of the selected genotypes in multiple repeats and years/environments and record précised phenotypic data; (3) the genotypes are then scanned with available molecular markers (AFLP, SSRs, SNPs); (4) quantification of the extent of LD for a chromosome and/or a genome using molecular marker data of the mapping panel; (5) assessment of the population structure and kinship (coefficient of relatedness between each pair of individuals) are determined to avoid false positive; (6) Finally, genotypic and phenotyping data are correlated using appropriate statistical software allowing tagging of molecular marker positioned in close proximity of gene(s) underlying a specific trait.

Mainly two types of association mapping are done in plants including genome-wide studies and candidate-gene studies. Genome-wide association mapping involves screening a selected population of germplasm with a large set of molecular markers believed to be dispersed throughout the genome. This set of markers is used to estimate the population structure and tested for significant association with a trait of interest. Marker coverage is dependent on the researcher’s resources as well as the extent of linkage disequilibrium in the population under study. Candidate-gene association mapping generally consists of two sub-sets of molecular markers. The first set of genetic markers is selected to accurately estimate the population structure with as few markers as necessary. The second subset of markers targets regions of the populations genome thought to be important in the traits of interest. Association mapping has been used for the study of the genetics of many traits in plant species i.e., disease resistance, drought tolerance, flowering time, days to heading, kernel size, kernel colour etc. The conclusion drawn from this article is that the mapping with segregating populations is a powerful approach for evaluating two alleles with low resolution. In contrast, association mapping can evaluate numerous alleles with high resolution.

References

21. AGRICULTURAL ENTOMOLOGY
Medicinal Value of Tulsi, (Ocimum tenuiflorum) and Management of their Major Pest

1Umesh Das, 2Supriya Okram
1,2 Ph.D. Scholar, Department of Agril. Entomology UBKV, Pundibari, Cooch Behar (W.B.), 736165

Introduction
Tulsi (Ocimum tenuiflorum) or holy basil is a sacred plant of India. This plant has great spiritual, medicinal and therapeutic value in Hindu belief. Hindus regard it as an earthly manifestation of the goddess Tulsi; she is regarded as a great worshipper of the god Vishnu. Usually, plant leaves or dal are offered in every hymn and ritualistic worship of Vishnu and his incarnation Lord Krishna. Traditionally, In India, Tulsi is planted in the
center of the central courtyard of Hindu houses. Tulsi *Ocimum tenuiflorum* belongs to family - Lamiaceae is widely distributed in Indian subcontinent with two varieties *viz.*, Krishna tulsi and Shritulsi. There are about 160 species of the genus *Ocimum*. Its hybrid is now being cultivated in about 2000 hectares of land in India (Balyan & Pushpangadan, 1988) as ayurvedic and medicinal plant. Its leaves, stem, shoots, flowers, seeds and roots have tremendous economic importance in epidemiology and industry. Tulsicrop is attacked by several sucking insect pests like lace bug *Cochlochilabullita* (Stål), whitefly *Aleurodicus dispersus* Russell, *Diaulurodedspell.* and aphid *Macrosiphum* but *C. bullitaa* and *A. dispersus* found throughout the year while aphid appeared occasionally in December-January (Sathe et al., 2014). Leaf roller, lace bug, etc. reported by Panda, (2005).

**Medicinal uses:** Tulsi has many traditional health uses, including treatment of eczema, psoriasis and aging effects. It is also used as an antibiotic, digestion aid, an immune system booster, an anti-inflammatory, insect bite, teeth disorder, excretory organ stone and a stress reducer. In its native India, tulsi is considered a sacred plant and no household work would be there without the plant. Its leaves, stem, shoots, flowers, seeds and roots have tremendous economic importance in epidemiology and industry.

**Possible side effects:** The use of tulsi while pregnant or breast-feeding could potentially be harmful to your unborn child. Use of tulsi is discouraged while pregnant or nursing. Avoid tulsi when even considering getting pregnant. Men and women trying to procreate are also warned to avoid tulsi because of possible problems with fertility.

**Major pestsof tulsi and their management**

1. **Aphids**

   **Damage symptoms:** Aphids are soft bodied insects remains on underside of leaves or stems of plant; usually green or yellow in color. If aphid infestation is heavy it may cause leaves to yellow or distorted, necrotic spots on leaves or stunted shoots; aphids secrete a sticky, sugary substance called honeydew which encourages the growth of sooty mold on the plants. Growth of sooty mold affects the photosynthesis activity of plant.

   **Management:** When aphid population is limited to just a few leaves or shoots then the infestation can be pruned out to provide control; check transplants for aphids before planting. Use tolerant varieties if available. Reflective mulches such as silver colored plastic can deter aphids from feeding on plants. Sturdy plants can be sprayed with insecticides are generally only required to treat aphids if the infestation is very high. Spray with *Immidachlorid 17.8 SL @ 1.5 ml per liter of water*. Insecticidal soaps or oils such as neem oil also can use for control of aphids.

2. **Lace bug**

   **Damage symptoms:** Severely damaged leaves became heavily discolored and fall off. The lace bugs tend to reproduce profusely on new growth and nymphs invariably remain on the plant throughout the season. With their inherent water stress during the dry season, the plants wilt at a much faster rate when *C. bullitaa* infestation is present.

   **Biology**

   **Egg.** The dark brown coloured eggs are oblong and slightly tapered towards the opercula end. Eggs are usually laid either in cluster or singly into the plant's tissue leaving only the opercula exposed.

   **Nymph.** The nymph is yellowish with red eyes upon hatching but soon turns into pale brown. It goes through five instars to attain adult stage. Spines and pronotum become more prominent after second instars.

   **Adults.** Adult offlace bug has lacy wings with brown swollen part at the discoidal area. The costal margin is relatively curved outwards and very slightly concave. The adults have a prominent hood-like pronotum that covering their head. Body and wings with
lacework are dark-brown in colour.

**Management**

Water can dislodge the lace bug from the plants. This can be shown during the rainy season, less damage was observed and fewer lace bugs were present.

Insecticidal soap, neem oil and most synthetic systematic insecticides provide good control. Systemic insecticides like acephate and imidacloprid 17.8 SL are suitable for controlling this pest.

### References


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22. **ENTOMOLOGY**

**New Invasive Pest**

*Spodoptera frugiperda* and its Management

Sudhanshu Bala Nayak*, and Shefali²

1 Deptt. of Entomology, 2 Deptt. of Zoology and Aquaculture, CCS Haryana Agriculture University

The *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) commonly known as fall armyworm, occurrence reported in the maize fields of Karnataka, India. Severe damage was ranged from 9.0 to 62.5 percent in different districts of Karnataka like Chikkaballapur, Hassan, Shivamogga, Davanagere and Chitradurga during July-August 2018. It is a polyphagous pest that feeds on at least 100 plant species belonging to 27 families however poaceae plants like maize, sorghum, rice, wheat, sugarcane etc. are mostly preferred. All developmental stages of maize plant are attacked but severe damages occurred on young plants. The fall armyworm has a migratory behaviour with a high dispersal capacity that allows the pest to quickly spread along the range of its host plants. The life cycle varies according to the season is about 30 days during the summer, 60 days in the spring and autumn, and in 80-90 days during the winter. The fall armyworm eggs are usually laid in mass on the upper surface of the leaves and the number of eggs per mass can vary from 100 to 200, with up to 1,000 total eggs production per female. There are usually six larval instars in fall armyworm. The first and second instars feed on one side of the leaf skeletonizing it, whilst the final instars feed on most plant parts causing considerable damage. Duration of the larval stage tends to be about 14 days during the summer and about 30 days during cool weather. The last instar drops to the ground and pupate in the soil for about eight to nine days during the summer or for about 20–30 days during the winter.

**Nature of damage:**

After the eggs hatch the young larvae feed on the opened leaves by scraping and skeletonizing the upper epidermis leaving a silvery
transparent membrane. Maize plants damaged by the early instar larvae showed characteristic pin holes symptoms on the leaves. Grown up larvae were confined to the deep whorls and fed extensively on inner whorl. Such plants appeared to have been torn and start feeding between the leaves. Usually within a whorl, one or two larvae are present as a result a lot of faecal matter gets accumulated within the whorl leading to the characteristic symptom of damage. The older larvae feed on the developing primordial shoot, thus resulting in dead heart symptoms. Tassel feeding was also noticed in many fields. Larval feeding causes characteristic large feeding areas on the open leaves in the later stages. If the crop is affected in the early stage (upto 25 days of sowing) the mortality of the plants will be very high. High rainfall combined with overcast skies for more than a week is optimal for the increase in fall armyworm activity.

**Management:** Currently, integrated strategies are thought to be the best options to control fall armyworm.

**Cultural control:** The most important cultural practice to reduce damage is early planting (if possible of early-maturing varieties) in order to escape the peak of fall armyworm immigration. Mechanical control by manual picking of caterpillars in early stage of attack. Monitoring (weekly plant inspection for treatment decision making, good practices (early planting, use early maturing varieties, intercrop maize with legume, weeding, remove and destroy all crop residues, rotate maize with a non-host, ploughing/cultivating to expose larvae and pupae, handpicking egg masses and larvae, applying sand i.e. mixed with lime or ash, sawdust or soil in the whorl.

**Chemical control:** The method of chemical control using organophosphorus and pyrethroid insecticides like malathion, chlorpyrifos and lambda-cyhalothrin were found being effectivereported by most farmers in Kenya.

**Biological control:** The survey also revealed natural parasitism by egg parasitoids *viz.*, *Telenomusspp.* (Hymenoptera: Platygastridae) and *Trichogrammusspp.* (Hymenoptera: Trichogrammatidae), gregarious larval parasitoid *Glyptapanteles escreatonoti* (Viereck) (Hymenoptera: Braconidae) solitary larval parasitoid*CampoletischlorideaeUchida* (Hymenoptera: Ichneumonidae), and a solitary indeterminate larval-pupal (Hymenoptera: Ichneumonidae) parasitoid. *Spodopterafrugiperdais* the first host record for *Glyptapanteles escreatonoti* across the globe, being a well established parasitoid of various noctuids in India and Malaysia, was capable of parasitizing *S. frugiperda*. Besides these, other commonly found bioagents *viz.*, *Forficula* spp. (Dermaptera: Forficulidae) and entomopathogenic fungus *Nomuraearileyi* (Farl.) Samson was also evaluated against fall armyworm in large numbers.

**Some recommendations:**

1. Strengthen the capacities of national Crop Protection (PV) and extension services as well as farmers in order to accurately identify the species involved;
2. Implement a prospecting and trapping program to identify and determine affected areas;
3. Strengthen the control of plants and plant products on borders and points of entry.
4. Provide affected producers with effective equipment and means of treatment to identify reported and / or detected outbreaks and their control.
5. Establish a communication network and develop an information and sensitization program for the population, technicians and decision-makers by means of the press (audio-visual spot, press release etc.) and teaching materials (posters, leaflets etc.).

**References:**


23. AGRICULTURAL ENTOMOLOGY

Tomato leaf miner (Liriomyza trifolii):
An important pest of Tomato

*Supriya Okram, and Umesh Das

1 & 2 Ph.D. Scholar, Department of Agricultural Entomology, U.B.K.V., Pandibari, Coochbehar, 736165

Introduction

*Liriomyza trifolii* (Diptera: Agromyzidae) is also one of the important pest of tomato. Loss incurred to the tomato plant by leaf miner is insurmountable (Gerling, 1986). It was first described in the United States by Burgess in 1880. It is suspected to have been introduced into India in 1990-91 and damages various crops in Karnataka, Andhra Pradesh, Maharashtra, Gujarat and Delhi (Viraktamath, 1993). It is one of the most serious pests to both vegetables and ornamental plants throughout the world (Ganapathy et al., 2010). The most important crops attacked are beans, celery, chrysanthemum, cucumber, gerbera, gypsophila, lettuce, onion, potato and tomato (Spencer, 1989). *L. trifolii* is an invasive pest which was accidentally introduced into India from the American sub continent along with chrysanthemum cuttings. Leaf miner acquired key pest status on tomato from 1995 in India (Srinivasan et al., 1995).

Symptoms and nature of damage:

Feeding punctures and leaf mines were usually the first and most obvious sign of the presence of *Liriomyza*. Leaf miner feeding resulted in serpentine mines (slender, white, winding trails) and heavily mined leaflets had large whitish blotches and the feeding punctures appeared as white speckles between 0.13 to 0.15 mm in diameter. Oviposition punctures were usually smaller 0.05 mm and were more uniformly round. Leaves injured by leaf miner dropped prematurely, heavily infested plants may lose most of their leaves. If it occurred early in the fruiting period, defoliation can reduce yield and fruit size and exposed fruit to sunburn. Punctures caused by females during the feeding and oviposition processes can result in a stippled appearance on foliage, especially at the leaf tip and along the leaf margins (Parrella et al., 1985). However, the major form of damage was the mining of leaves by larvae, which resulted in destruction of the leaf mesophyll. The larval stages bored and feed within the leaves of the host plants, and at high fly densities this feeding can severely reduce yields (Spencer, 1989). Johnson et al. (1983) reported that besides the damage caused by the larvae, feeding punctures by adults caused loss of vigour and reduced the photosynthetic capacity and yield losses in general can be considerable.

Biology of Leaf Miner

Leaf miner had a relatively short life cycle and several generations may be produced during a year, with eggs being laid just beneath the surface of the leaves. Mating, egg-laying, larval emergence from leaves and adult emerges from pupae tends to occur mostly in the morning, depending on temperature.

The temperature threshold for development of the various stages is 6 to 10°C except that egg laying requires about 12°C. The rate of immature development of *Liriomyza trifolii* is dependent on temperature. At a uniform temperature of 28°C one generation cycle can be accomplished in 14-15 days, but at lower temperatures the time taken was progressively longer. According to Leibee (1984), *Liriomyza trifolii* required 21 to 28 days for completion of their life cycle in warm climates and produced several generations in the tropics. *Liriomyza trifolii* required 19 days from egg deposition to emergence of adults at constant temperature of 25°C (Leibee, 1984). Mikenberg (1988) reported that at 25°C the egg stage required 2.7 days for development and the following three active larval instars required 1.4, 1.4 and 1.8 days, respectively and spent 9.3 days in the puparium.

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24. GENETICS AND PLANT BREEDING

Elongated Uppermost Internode (eui) Gene for Panicle Exsertion in Rice (Oryza sativa L.)

V. Nirubana and K. Sangeetha

Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai –

Hybrid rice technology offers great potential to increase rice production and productivity on a sustainable basis. At present cytoplasmic male sterility (CMS) system is being used to develop hybrids in rice. Among various CMS sources available in rice, wild abortive (WA) type is the most widely exploited to develop hybrid cultivars. However, CMS lines with this cytoplasm have a problem of incomplete panicle exertion wherein 30 - 40% of the spikelets remain enclosed in flag leaf sheath (Gangashetti et al., 2004). Incomplete panicle exertion, known to be caused by reduced level of endogenous GA3 synthesis, is a major problem in hybrid rice seed production. This problem is usually overcome by application of GA3 (50-100 g/ha) which in turn increases the seed production cost and adversely affect the quality of hybrid seed through reduced dormancy and storage life (Honnaiah, 2003).

Hybrid rice breeders therefore, have been in constant search for a genetic alternative to GA3 application. Internode length of rice plant plays an important role in deciding the extent of panicle exertion (Wang et al, 2005). The first recessive rice internode elongation mutant was isolated from the Japanese rice cultivar Norin 8 by gamma ray treatment (Okuno and Kawai, 1978). Subsequently, Rutger and Carnahan (1981) identified a recessive gene causing elongation of the uppermost internode (EUI phenotype) in a japonica rice line 76:4512. Later the mutant rice line is characterized by a near doubling of uppermost internode thus enhancing panicle exertion and panicle length with almost no effect on other internode or plant characters.
Due to its ability to cause complete panicle exsertion the EUI phenotype in CMS line controlled by recessive genes prove a very useful trait in hybrid seed production and hence was called a fourth genetic element after the three genetic tools viz., male sterile (A), maintainer (B) and restorer (R) lines (Rutger and Carnahan, 1981).

During the past two decades hybrid rice breeders in China have therefore been instrumental in transferring eui gene into a number of female parents (cytoplasmic male sterile and thermosensitive genic male sterile lines) to improve the panicle exsertion. Further, CMS/TGMS lines incorporated with eui gene are likely to be available for commercial hybrid seed production in China. So far two eui loci controlling the elongated internode have been identified in rice. The gene conditioning the EUI phenotype in the mutant 76:4512 has been localized in chromosome 5 through trisomic analysis and named as ‘eui-1’ (Librojo and Khush, 1986). Subsequent studies on inheritance of internode elongation trait also confirmed it to be controlled by a single recessive gene (Gangashetti et al., 2004). Yang et al. (1999) identified another recessive gene (eui-2) in a gamma rays irradiated maintainer line, Xinquing ZhaoB which was mapped on chromosome 10 using SSR markers (Yang et al., 2000b; Yang et al., 2001). Gangashetti et al. (2004) identified a recessive gene controlling EUI in the rice breeding line IR91-1591-3 and later Gangashetti et al. (2006) tagged the gene by RAPD markers and mapped on chromosome 5 using a Sequence Tagged Site (STS) marker.

In view of the fact that the elongated uppermost internode gene is recessive in nature, hence its transfer is laborious and time consuming as one generation of selfing is required after every cycle of backcrossing. This problem could be overcome with the availability of molecular markers associated with this trait. PCR based markers such as simple sequence repeats (SSR), which exhibit co-dominant inheritance can be effectively used in marker based screening of eui gene and phenotype. A highly saturated SSR map of rice with over 18000 markers covering almost the entire rice genome is now available in public database (http://www.gramene.org/), which greatly facilitates easy identification of SSR markers closely linked to gene of interest to enable MAS.

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### 25. **SOIL SCIENCE**

**Use of Nanoporous-Zeolite in Farming**

Aakash Mishra¹, Pallavi Bhatt²* and Pawan Kumar Pant³

¹Assistant Professor, Department of Soil Science and Agriculture Chemistry, B.A.C.A., AAU, Anand, Gujarat, ²Research Scholar, Department of Soil Science, G.B.P.U.A. & T., Pantnagar, U.S. Nagar, Uttarakhand, ³Assistant Field Officer, Soil and Land Use Survey of India, Department of Agriculture Cooperation & Farmers Welfare, New Delhi

**Introduction**

Zeolite is a natural super porous mineral crystalline aluminosilicates with a general formula $\text{M}_x\text{D}_y[\text{Al}_{(x+2y)}^3\text{Si}_{x+y}^4\text{O}_{(3x+4y)}]\text{mH}_2\text{O}$, where $x$ is the number of monovalent cations, $y$ the number of bivalent cations, $n$ the cation valence and $m$ the number of water molecules in the formula. They are among the most common minerals in sedimentary rocks and are reported to be especially common in tuffaceous rocks. They are tectosilicates exhibiting an open, three-dimensional structure containing cations needed to balance the electrostatic charge of the framework of silica and alumina tetrahedral and containing water. Different combinations of $\text{SiO}_4^{4-}$ and $\text{Al(OH)}_6^{3-}$ tetrahedral lead to the formation of a three-dimensional framework with pores and voids of molecular dimension. Shape, dimensions and linkage of zeolite pores and voids are the key characteristics of zeolite materials. The pores and interconnected voids are occupied by cations and water molecules. The structure of each zeolite minerals is complex, but they all have large open ‘channels’ in the crystal structure that provide a large void space for the adsorption and exchange of cations.

Most of the initial research on the use of zeolites in agriculture took place in the 1960s in Japan. A brief review of the literature points out that Japanese farmers have used zeolite rocks over the years to control moisture content and increase pH of acidic volcanic soils. Ion-exchange properties of zeolites can be utilized in agriculture because of their large porosity and high cation-exchange capacity. They can be used both as carriers of nutrients and as a medium to free nutrients. Zeolite provides an ideal trap for positive cations like nitrogen rich ammonium and potassium which are then released that commensurate with crop nutrient requirement. With the current high price of nitrogenous fertilizers zeolites can be used to extend their efficiency and performance. Blending fertilizers with zeolites can produce the same yield from less fertilizer applied because of the reduction of volatilization and leaching losses. Zeolite can hold nutrients in the root zone which leads to more efficient use of N and K fertilizers. An added benefit of zeolite application is unlike other soil amendments. It does not break down
over time but remains in the soil to improve nutrient and water retention permanently. With subsequent application the zeolite will improve soil ability to retain nutrients and produce improved yields. The nutrient release from the zeolite is plant driven setting up a natural cycle of N, P and K release. The zeolite will recharge when an ammonium or potassium sources becomes available either naturally or applied. The zeolite prevents free nutrients from leaching has a strong affinity for ammonia (NH$_4^+$) and store it up instead of allowing it to volatilize. The ammonium ion (NH$_4^+$) is attracted to the negative charge of the crystal. The large honeycomb crystal structure provides a huge storage space. Plant nutrient cations e.g. potassium (K$^+$) and zinc (Zn$^{2+}$) are also stored in the zeolite crystal. Hence, zeolite helps in making all nutrients easily available to the plants.

**Classification of Zeolite**

Zeolites can be classified on the basis of their morphological characteristics, crystal structure, chemical composition, effective pore diameter and natural occurrence.

1. On the basis of silica: alumina ratio as follows:
   a) Low Si: Al ratio, between 1 and 1.5- zeolite A;
   b) Intermediate Si: Al ratio, between 2 and 5- zeolite Y;
   c) High Si: Al ratio from 10 to several thousand- erionite, mordenite.

2. Flanigen has classified zeolites based on pore diameter-
   a) Small-pores zeolites (8-rings) with free pore diameter 0.3-0.45 nm.
   b) Medium-pore zeolites (10 rings) with free pore diameter 0.45-0.60 nm.
   c) Large-pore zeolites (12 rings) with free pore diameter 0.6-0.8 nm.
   d) Extra large pore zeolites (14 rings) with free pore diameter 0.8-1.0 nm.

**Applications of Zeolite**

1. As an Input Use Efficiency
   a) **As a carrier of nutrients:** It is when mixed with nitrogen, phosphorus and potassium compounds, enhances the action of such compounds as slow release fertilizers, both in horticultural and extensive crops. The major use of zeolite is in nitrogen capture, storage and slow release.

   b) **Improving organic manure (farmyard manure/poultry) efficiency:** It was observed that zeolite mixed with manure increases the effectiveness of organic fertilizers on meadowland soils. The specific selectivity for ammonium (NH$_4^+$), can take up this specific cation from either farmyard manure, composts or ammonium-bearing fertilizers, thereby reducing loss of nitrogen to the environment. Most of manure-ammonia sequestered in the zeolite is unavailable to nitrifying bacteria because of the small (4-5 Å) pore size of the crystal lattice structure.

c) **Improving nitrogen use efficiency:** N liberation dynamics of the occluded form (in zeolites) is much slower than that of ionic form. The nitrogen molecules are retained by electrostatic attraction, and modifications of molecular angles, and single and double bonds occur in it. There are reports of urea-impregnated zeolite chips, which can be used as slow-release nitrogen fertilizers.

d) **Improving phosphorus use efficiency:** Ammonium-charged zeolites have shown their ability to increase the solubilization of phosphate minerals, leading to improved phosphorus uptake and yield of crops. Studies examined the solubility and cation-exchange in mixtures of rock phosphate and NH$_4^+$ and K-saturated clinoptilolite revealed that mixtures of zeolite and phosphate rock have the potential to provide slow-release fertilization of plants in synthetic soils by dissolution and ion-exchange reactions.

2. As an input in farming
   a) **As a fertilizer:** Zeolites in soils exchange sodium and potassium cations for NH$_4^+$. After the second and third year of zeolite action in the soil, the mineral is an effective nitrogenous fertilizer. A combination of zeolite and natural fertilizer was found to be
effective for improving crop growth. It increases ion-exchange sites in soils in addition to offering absorption sites for small molecules, due to their porous structure.

b) **In soil amelioration**
   i) **Improving Soil Physical Properties:** Zeolite may hold water more than half of their weight due to high porosity of the crystalline structure. Amendment of sand with zeolite increases available water to the plants by 50%.
   
   ii) **Buffering soil pH levels:** It is marginally alkaline in nature and its use with fertilizers may help buffer the soil pH levels, thereby reducing the need of lime application.
   
   iii) **Remediation of contaminated soil:** The application of zeolite to soil contaminated with heavy metals or radionuclides can be effective in lowering their input but extensive study is needed in future work.
   
   iv) **Removal of odour:** Natural zeolites have been used in partial liquidation of fast and liquid wastes from animal production in agriculture and can be utilized for removing unpleasant smell in stables.
   
   v) **As Soil amendment:** Zeolites consist of cage-like polyhedral units with a high cation-exchange capacity and internal pores in crystal lattices that result in high water adsorption and nutrient retention. It does not break down over time, but remains in soil to improve nutrient retention which significantly reduce water and fertilizer costs by retaining beneficial nutrients in the root zone. Zeolite amendments are an effective way to improve soil condition in an arid and semi-arid environment. It has been used on various crops, including vegetables and improves drainage and aeration, compaction resistance, reduces leaching of pesticides and fertilizers from the soil.

3. **In cleansing of wastewater**
   a) **Wastewater treatment:** It is used for removing ammonia from wastewater. Clinoptilolite is effective for selective removal of NH₄⁺ cations from wastewater. Zeolite also removes heavy metal from wastewater.

**Conclusion**
The use of nanoporous zeolite is taking interests in farming since few years back because of current public concern about the adverse effects of chemical fertilizers. The use of zeolites can be multi-dimensional viz. as a nutrient carrier, as a fertilizer, as a slow release compound, as an amendment material, improves many physical properties of soil, enhances the organic matter, nitrogen, phosphorus and potassium use efficiency. Hence, zeolite can be a good alternative to serve the multi-purposes at the same cost with achieving a good crop production on sustained basis.

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**26. GENETICS AND PLANT BREEDING SOIL SCIENCE**

**Do You Know Coeliac Disease?**

K. Sangeetha and V. Nirubana

*Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai.*

Recent research conducted in the USA, Europe and other countries suggests that the incidence of coeliac disease has at least quadrupled in the last 30 years. **Coeliac disease (CD) is caused by an inability to digest the gluten protein in wheat** and some other grains. The gluten is recognised by the immune system of the coeliac as being a foreign protein and their intestines suffer irreversible collateral damage as a result of an *autoimmune* reaction when
they consume gluten-containing foodstuffs.

Whilst 1% of the populations are recognised to have full-blown coeliac disease, many multiples of that figure may have some lesser degree of gluten intolerance that usually goes undiagnosed but that undermines their health. This can have serious consequences and one study found a four-fold higher risk of death amongst people with undiagnosed gluten intolerance.

Whilst screening procedures may have improved over the last 30 years, could there be another explanation for this massive rise in the incidence of coeliac disease?

Researchers at the Mayo clinic in the USA recently analysed blood samples from Air Force recruits that had been stored since the early 1950s for gluten antibodies. They assumed that about 1% of the sample would test positive mirroring the current rate of incidence of coeliac disease. However, they found that the numbers of positive results were far smaller than expected indicating that coeliac disease was rare 60 years ago. A Mayo clinic spokesperson attributed the increase in incidence of coeliac disease to “Something that has happened in a pervasive fashion from the environmental perspective”.

Coeliac disease and gluten intolerance

The first line of treatment for coeliac disease and gluten intolerance is to avoid gluten-containing grains for a lifetime. Coeliacs may also need to exercise caution when consuming non-gluten containing grains like millet and rice which can have been contaminated by being grown or processed near grains like wheat. For some gluten-intolerant people, supplementing digestive enzymes may help to break down gluten to below a safe threshold. (Sapone et al., 2012).

The hybridisation and genetic engineering of wheat has resulted in a staggering 500 fold increase in the gluten content of modern day wheats compared to the wheat our forefathers would have known and this may be one of the prime reasons behind the massive rise in incidence of gluten intolerance and coeliac disease in recent decades.

Coeliac disease and gluten intolerance are thought to be the most undiagnosed conditions in the world and symptoms include:

- Indigestion, heartburn and/or stomach aches
- Bloating and flatulence
- IBS-type symptoms with abdominal cramping and alternating diarrhoea and constipation
- Anaemia i.e: feeling tired and breathless
- Loss of appetite and/or weight loss
- Tingling and/or numbness in the hands and/or feet
- Loss of hair
- Muscle spasms
- Excessive production of mucus
- Swelling of the hands, feet, arms and/or legs
- Confusion, poor memory and cognitive impairment
- Fatigue,
- Depression or irritability
- Headaches,
- Muscle, joint or bone pain,
- Skin rashes
- Seizures and
- Osteoporosis

Whilst all these symptoms are attributable to gluten, wheat also contains a toxic and anti-nutritional compound known as wheat germ agglutinin (WGA). According to researchers at the University of Verona in Italy, WGA can cause the intestines to absorb substances from food which would not normally enter the blood stream leading to the development of allergies and dysfunctional immune responses (Toxicol Appl Pharmacol. 2009 Jun).

Prior to this time there was no evidence of degenerative diseases or tooth decay, but with
agriculture both men and women lost considerable height which has only now been recovered after 10,000 years. There is also evidence that there was a massive increase in infant mortality at this time. So it may be that wheat hybridised or not was never good news for human health.

More recent evidence supports the notion that modern ills including diabetes, obesity and heart disease have their origins in the refining of foods which has stripped out the nutrient content and created multiple mineral and vitamin deficiencies in the human population.

Other gluten containing grains include spelt, kamut, barley, rye and in lesser amounts, oats. Whilst spelt is genetically similar to wheat it has not been subject to the amount of hybridisation and genetic manipulation seen with wheat and its proteins are also easier to digest. Whilst not suitable for Coelias, some people may find they tolerate spelt products better than wheat and it also has higher protein content than wheat. (Rona et al., 2007; Pietzak, 2012).

Wheat is also a significant link between mercury toxicity largely acquired from dental amalgam fillings and the development of food intolerances, particularly to gluten- and casein-containing foodstuffs (Gibson and Shepherd, 2012). This is because mercury blocks the digestive enzymes involved. Possibly for this reason gluten intolerance appears to co-exist or play a causative role in conditions such as chronic fatigue, autism and attention deficit disorders.

Finally, if you do choose to include wheat in your diet, use certified organic flour or organic products to avoid some of the more dubious genetic manipulations of wheat.

References

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27. HORTICULTURE

Huanglongbing: A Destructive Challenging Disease in Citrus

Prashant Kalal¹, Sajana S.¹ and Parvathi Bennurmath²

Ph.D. Scholars, Indian Agricultural Research Institute, New Delhi outreach Ph.D. programme center IIHR, Bengaluru-560089

Huanglongbing (HLB) is one of the most devastating bacterial diseases in the citrus cultivating regions of the world except in Mediterranean regions and Australia/ New Zealand. Citrus greening was detected for the first time in the United States in 2005. Huanglongbing is a word derived from the Chinese language which is also popularly known as citrus greening, yellow shoot disease and yellow dragon disease in the many parts of the world. HLB is caused by mainly three species of gram-negative bacteria such as Candidatus liberibacter asiaticus (CLas), Candidatus Liberibacter americanus (CLam) and Candidatus Liberibacter africanus (CLaf). The bacteria CLas and CLam are mainly responsible to cause disease in the citrus orchards of Asian and American continents respectively, and these both species of a bacteria greatly transmitted through a vector called Asian citrus psyllid (Diaphorina citri). The third species CLaf is found to be most severe in the African continent and this pathogen has been spreading seriously through a vector named as African citrus psyllid
‘Trioza erytreae’. ‘Candidatus liberibacter’ spp is major phloem-limited, fastidious alpha-proteobacteria (McCollum and Baldwin, 2016). The term Candidatus itself indicates that this bacterium has not yet been possible to culture. The detection of the liberibacters is possible by adopting the PCR amplification of their 16S rRNA gene with specific primers.

**Disease distribution:** HLB is the most widely distributed disease in Asia, Africa and America, which are resulting in huge economic losses yield of about 30-100%. Most of all commercial citrus species and scion cultivars are susceptible to citrus greening irrespective of rootstocks (Rove, 2006). The sensitive genotype includes sweet orange cvs ‘Valencia’ and ‘Madam Vinous’, grapefruit cvs ‘Duncan’ and ‘Ruby’, tangelo cv ‘Minneola’ whereas the rootstock which displays more tolerance capacity to the disease such as Eureka lemon, Persian lime, Carrizo citrange, and Severinia buxifolia etc. (Folimonova et al., 2009).

**Host plants:** The numerous alternative host plants have been identified and which are found to be another reason for the dissemination of disease. The bacterium Candidatus liberibacter asiaticus has been surviving on Cleome rutidosperma, Pisonia aculeata, Trichostigma octandrum in Jamaica (Brown et al., 2011) and on Murraya paniculata in Florida (Damsteegt et al., 2010) and on Wampee tree (Clausena lansium) in the China (Deng et al., 2007). The other species of the bacteria have been surviving on tomato, pepper and potato.

**Characteristic symptoms of the disease**

**Leaves:**
- Small, erect, thickened leaves appeared like ‘rabbit ear’.
- Stunted, irregular chlorosis of leaves appears ‘blotchy’ mottling.
- Mottling and chlorosis of leaves which resemble Zn-deficiency.

**Fruits**
- The infected fruits are smaller, yield less juice and lower sugar content.
- The fruits remain green in color.
- A decline in the quality of fruits and finally fruit drop.

**Stem**
- Stunted stem with limited phloem function.
- In the initial years of infection, the tree yields heavily and later yield would reduce gradually.

**Root**
- 30-37% reduced fibrous root mass density in the Valencia orange trees.
- Loss of fibrous root function and results in poor absorption of nutrients.

**Major causes for the infection**
- Fluctuation of soil moisture level
- Hormonal imbalance
- Improper culture practices

![Fig. 1: An Infected citrus tree with characteristic irregular necrotic leaves and green fruits.](image1)

![Fig. 2: Asian citrus psyllid (Diaphorina citri) feeding on citrus plants.](image2)

**Systems for the detection of pathogen**
- Based on the symptomatology
- Biological indexing
- Adoption of Indicator plants (Sweet orange cv ‘Pineapple’, Kinnow mandarin, Citron and Sweet lime)
- Electron microscopy
• Traditional PCR, Real-Time PCR and direct sensitive PCR
• Ultrasensitive detection system
• Loop-mediated isothermal amplification (LAMP)

Management of disease
• Clean cultivation and adopting the sanitary practices.
• Removing the infected trees and burn it at one corner of the orchard.
• Implementing the integrated weed, water, insect pest and disease management.
• Use of tolerant cultivars and rootstocks
• Biocontrol: Application of solitary parasitoid Tamaraxia radiata for controlling the vector Asian citrus psyllid. Thermotherapy graft infected seedling at 48-50°C under greenhouse condition.
• Application of micronutrients ZnSO4 and FeSO4.
• Chemotherapy of HLB affected trees with Tetracycline @500 ppm.
• The 3 to 4 time’s applications of Agrimycin 100g + 500g copper oxychloride in 500 liters of water per hectare.
• Spraying Bacteriomycin @25g/ha.
• Use of transformed resistant rootstocks by stacking desired resistant genes.

Conclusion
Control of HLB is more difficult if the pathogen inoculum and vector population would have well-established in the field. The several disease management strategies have been developed, but these are not much more effective for the eradication of a disease. Since the bacterium is not possible to culture and also maintenance. Therefore the only option is to implement the integrated disease management by using tolerant rootstocks, cultivars with biocontrol and chemical strategies.

Future consideration
The control of HLB in the field condition is urgently needed but it would be difficult to achieve because there are no reliable control measures. Due to the lack of reliable disease resistance source, the adoption of prophylactic measures such as phytosanitary practices is necessary for obtaining a healthy crop. An adoption of novel genetic engineering techniques for developing the transformed resistant rootstocks and varieties. The development of efficient and cost-effective control strategies will be needed.

References
Introduction
Zero-tillage, synonymous to no-tillage or conservation agriculture is worldwide accepted and adopted on 115 m. ha of cultivated land. South America ranks first in acreage accounting to 49.5 m. ha with nearly 70 percent of land go under no-tillage cultivation. Zero tillage technology was first reported in USA in 1930’s and from there spread to many countries of Europe, Australia, Canada, Asia and Africa.

Benefits of Zero tillage:
No-till farming addresses many global challenges of climate change, soil degradation and food security. Benefits derived are therefore to be taken seriously by practicing farmers, researchers and development professional. AAPRESID, 2008 reported benefits of no-tillage systems are follows.

- 96% less erosion
- 66% reduction in fuel consumption
- Reduced CO2 emissions
- Enhanced water quality
- Higher biological activity
- Increased soil fertility
- Enhanced production stability and yields
- Incorporation of new areas into production
- Lower production costs

Myths on Zero tillage concept:
Adoption rates of zero tillage are small, mainly arising from lack of clarity with regard to the concept of Zero tillage, as many consider it to be a technology of placing seed in untilled soil and other aspects of its continuity, crop residue management are not much given emphasis. As a consequence, possibilities of realizing full benefits from no-tillage are meager. In real terms zero-tillage is considered 50 percent of Conservation agriculture which mainly focuses on three major principles (FAO, 2009) as given below.

1. Continuous minimum mechanical soil
2. Permanent organic soil cover.
3. Diversified crop rotations.

The widely accepted definition of Philips and Young (1978) on no-tillage reflects all the components that qualify for conservation agriculture.

“No- tillage is defined as system of planting (seeding) crops into untilled soil by opening a narrow slot, trench or band only of sufficient width and depth to obtain proper seed coverage. No other soil tillage is done.”

Practicing no-tillage technology strictly means, the soil need be permanently covered with crop residues of previous crop or management with green manure cover crops and subsequently ensuring crop rotations.

Adoption of Zero tillage technology in India:
The adoption of zero-tillage practices by farmers has occurred mainly in rice-wheat double cropping systems primarily to avoid late planting of wheat.

For cultivation of rice in next season farmers carry out tillage operations such as ploughing and puddling of soil. This makes no-tillage wheat a temporary practice rather a continuous one. The area under such temporary no-tillage practice accounts to 5 m. ha., unfortunately has been counted out from inclusion under no-tillage practice. There are very few farmers practicing zero tillage technology in its true sense.

Maize crop has been cultivated in Andhra Pradesh since 1999. Since then acreage over a decade period from 1999 to 2009 had increased from 3.60 lakh acres to 5.30 lakh acres in kharif, 0.92 lakh acres to 3.58 lakh acres in Rabi. The productivity of the crop varied between 2205 kgs per ha to 4581 kgs per ha depending on the availability of moisture and favorable conditions during kharif. In Rabi crop, maize crop cultivated under irrigated conditions produced yield ranging between 2996 kgs per ha to 4930 kgs per ha.
Farmers Perceptions on Various Factors of Production.

“Is it possible to cultivate a crop without ploughing and opening up of soil?” This was the first reaction of farmers on hearing about the zero till technology. It was obvious that the whole village was unaware of such technology making demonstration itself very novel in nature. Farmers were skeptical of results till the end of demonstration.

Tillage cost: Farmers assessed savings on cost of tillage operations in comparison to conventional practice, as rice fallows possess hard sub surface soil on account of flooding of previous season crop. Minimum of 6 ploughings required to break hard clods amounting to cost escalation to the tune of Rs 6000 per acre in conventional tillage. This was found to have reduced in zero till crop. In this technology the field usually not ploughed and soil is opened up for sowing with seed drill and fertilizer is placed in adjacent slot made with same seed drill. A seed drill specially designed for the purpose actually facilitated in sowing which to a large extent constituted the success factor of technology adoption.

Labour use: Only family labour was utilized throughout all farm operations and incurred less of labour cost compared to conventional tillage method. But farmer reported high family labour that has been utilized for continuous monitoring of crop as night watchman, irrespective of ZT or CT maize, against wild boar causing severe damage particularly after sowing and cob development stages. 60 percent of duration of crop consumed family labour only to guard at nights to prevent from wild boars attack.

Weed Management: As major thrust in Zero tillage is weed management its control, therefore, consumed high proportion of weedicides. 15 percent of cost of inputs was incurred on weedicides mainly to control weeds and prevent rice stubbles emergence. Zenteir and Campbell (1998) reported, zero tillage found successful only when weedicides prices are low in order to improve use efficiency. However, in spite of high Nett returns from ZT, environment concerns need to be given top priority as chances of contamination of ground water from atrazine sprays cause severe environmental hazards and therefore a well planned integrated weed control measures to be adopted.

Nutrient management: Many micronutrient deficiencies were identified by farmers during crop growth stage and had to be corrected by series of foliar sprays with N, K and Zn. Corrective measures incurred 35 percent of total cost on inputs. Nitrogen in the form of urea was applied more in ZT crop. This was is in agreement with Grover and Sharma, 2011, who reported higher urea application in zero tilled wheat crop.

In zero tillage technology, fertilizer application is challenging and therefore to derive complete benefit of Zero tillage with Maize crop, a high nutrient feeder, there is need to improve input use efficiency by adoption of soil test based fertilizer application, timely foliar sprays with micronutrients and proper placement of fertilizers.

Nett returns: Zero tillage rabi maize resulted in 60 percent higher Nett returns when compared to Conventional tillage grown rabi maize. Studies reported variability in Nett returns from high to low depending to cost of inputs and variations in crop yields (Khakbazan and Hamilton, 2012)

Yields: Farmers did not find any significant change in yield levels under two technologies of ZT and CT technologies. Yield increase is subjective in nature as farmers with 1-2 quintal gain is not big deal from farmers point of view. This technology has not demonstrated much yield increase but gains in Nett returns by reduction of tillage cost to the tune of Rs 6000 form attractive proposition to adopt this technology in future.

Fodder security: It has provided ‘fodder security’ to many livestock holding farmers that supplied adequate dry fodder for animals in summer.

Local factors influence economic performance of zero tillage maize as farmers adopt technologies from profitability point of view in terms of Net returns and labour use, in contrast to conservationist view who look at sustainability of natural resources. However, considering the resource conservation and increasing cost of cultivation Zero tillage has been considered as a promising technology to conserve resources of soil, water and crop residues. In addition to, the benefits derived from saving of tillage time and cost, availability
of seed drill for sowing and fertilizer placement are important factors essential for up scaling of zero technology.

References:

29. HORTICULTURE

Vetiver (Vetiveria Zizanioides Linn.): An Aromatic Grass Use for Flood and Stream Bank Erosion Control
Souvick Banik* and C. S. Karthik**

*PG and **Ph.D. Research Scholar, Bidhan Chandra Krishi Vishvavidyalaya, West Bengal

Vetiver (Vetiveria zizanioides Linn.) is a tall, fast growing perennial grass native to India which is now extensively used for erosion and flood control in over 70 countries worldwide. It is generally distributed widely in tropical Asia, Africa and Australia. It is an obligate cross-pollinated crop. Vetiver grass is a C4 perennial grass that fits well in ecosystem service model contributing to local and national economies for its multifarious environmental applications, and offers sustainable opportunities for carbon sequestration. Vetiver grass has been used for degraded land reclamation, erosion control and slope stabilization for centuries and its popularity has increased remarkably in the last decades in many parts of the world and also India. India produces the best quality vetiver oil in the world and has the potential to export.

SYSTEMATICS

Kingdom: ........................................................ Plantae
Clade: ............................................................ Angiosperms
Clade: ............................................................ Monocots
Clade: ............................................................ Commelinids
Order: ............................................................ Poales
Family: .......................................................... Poaceae
Genus: ............................................................. Chrysopogon
Species: .......................................................... C. zizanioides

Vetiver is a Tough Plant against the Soil erosion:
It have the ability to resist a deep drought for up to eighteen months, Vetiver is just as flexible when it is submerged and can remain under water for up to three months without damage. The plants grow readily to approximately 60cm wide and up to a maximum of 180cm tall, never exceeding these dimensions. Once they reach maturity at around three years old they can be grazed right to the ground and will spring happily away again. Stock generally does not prefer it to grass, although some cows love it, but they will readily eat it when more appealing feed isn’t available. It does them no harm and provides feed in drought conditions.

Vetiver – Fungicide and Pesticide
Vetiver is a well-known flea repellent in some countries and is used as a fungicide as well as a pesticide. Grown near other crops, it protects them from fungal and pest attack.

Vetiver System use as flood and stream Bank Erosion
The Vetiver System is a developing technology. The Vetiver System (VS) is a system of soil and water conservation whose main component is the use of the vetiver plant in hedgerows. The Vetiver System is used in more than 100 countries for soil and water conservation, infrastructure stabilization, pollution control, waste water treatment, mitigation and rehabilitation, sediment control, prevention of storm damage and other environmental
protection applications (through bioengineering and phytoremediation). When Vetiver is planted as a hedgerow across a slope, it forms a dense vegetative barrier that slows and spreads rainfall runoff. Combined with a deep and strong root system, a wide range of pH tolerance (from about pH 3 to pH 11), a high tolerance to most heavy metals, an ability to remove from soil and water large quantities of nitrates, phosphates and farm chemicals, the vetiver plant can be used for soil and water conservation, engineered construction site stabilization, pollution control (constructed wetlands), and other uses where soil and water come together. A good hedge reduces rainfall runoff by as much as 70% and sediment by as much as 90%. A hedgerow stays where it is planted and the sediment that is spread out behind the hedgerow gradually accumulates to form a long-lasting terrace. It is a low-cost, labour-intensive technology claimed to have a high benefit/cost ratio. When used for civil works protection, its cost is claimed to be about 1/20 of traditional engineered systems and designs.

Vetiver: Use as Perfume Ingredient and handicrafts

It is also a well-known ingredient in perfume manufacture and as well as handicraft manufacturing.

Reference


30. POST HARVEST TECHNOLOGY

Salicylic Acid: Role in Delaying Fruit Ripening

Netravati

Assistant Professor (PHT), Dept. of Post Harvest Technology, College of Horticulture, UHS campus, Bagalkot (Karnataka)

Introduction

Salicylic acid (SA), chemically known as 2-hydroxy benzoic acid (ortho-hydroxy benzoic acid) is one of a diverse group of phenolic compounds, consisting of an aromatic ring bearing a hydroxyl group or its functional derivative, which is synthesized by plants. Salicylic acid is present in plants as a free phenolic acid and as conjugate form, which may be generated by glucosylation, methylation or hydroxylation of the aromatic ring. The best known natural salicylic acid derivative is salicilin (β-glucoside salicylic alcohol), occurring in white willow (Salix alba) and other willow species including S. pupurea, S. daphnoides and S. fragilis (Lee et al., 1995).

Salicylic acid is usually found in the plants at basal amounts ranging between 1 and 50 µM, and its concentration increases when the cells, organs or plants are under stress conditions (Vlot et al., 2009). Recently Blazics et al. (2010) showed that Filipendula ulmaria is a rich
source of salicylic acid, which is present in its herb and flowers at an amount of about 1.4 mg.g\(^{-1}\) dry mass.

**Biosynthesis, mode of action and general functions of salicylic acid**

Mode of the biosynthesis and action of salicylic acid on the induction of biotic and abiotic stress tolerance is presented in Fig. 1.

SA is known to perform many roles in the plant systems such as:

- Triggers plant defense responses: against pathogens in the form of Local Acquired Resistance (LAR) and Systemic Acquired Resistance (SAR).
- Mitigates abiotic stresses: such as drought, chilling, heavy metal toxicity, heat, osmotic stress, etc.
- Photosynthetic rate: it prevents the auxin oxidation since, elevated auxin level increases photosynthetic rate and reductase activity.
- Reduces oxidative stress: When plants are exposed to various environmental stresses they produce range of reactive oxygen species (ROS) in large quantities sufficient to disrupt cellular and metabolic functions of plant. To prevent oxidative injury by the toxic ROS, the activity of antioxidant enzymes superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR), peroxidase (POX), and catalase (CAT) is increased by salicylic acid.

![Fig.1 Model of the biosynthesis and mode of action of salicylic acid on the induction of biotic and abiotic stress tolerance (Hayat et al., 2010)](image)

**3. Mechanism of action of SA in delaying ripening**

SA decreases ethylene production and inhibits cell wall and membrane degrading enzymes such as pectinase, pectinethylase, etc leading to decreased fruit ripening rate and thereby delaying senescence.

Salicylates reduce the lipoxygenase activity and retard the lipid peroxidation. ACO, an ethylene inhibitor, blocks the conversion of ACC to ethylene by decreasing the ACS and ACO production and activity hindering the ethylene biosynthesis. SA decreases the respiration rate, where there is breakdown of complex molecules into simpler one’s resulting in weight loss. Effect of SA in decreasing the respiration rate is mainly due to its negative effect on ACS, ACO, PG, PME, cellulase and antioxidant enzymes leading to decrease in ethylene production and action. It inhibits cell wall and membrane degrading enzymes such as PG, LOX, cellulase and PME leading to decrease in the fruit softening rate (Fig. 2).
31. HORTICULTURE

Cocoa: Nursery Establishment and its Maintenance

*C. S. Karthikand Souvick Banik

*Ph.D. and PG Scholar, Bidhan Chandra Krishi Viswavidyalaya, West Bengal

The cocoa tree (*Theobroma cacao* L.), of the *Malvaceae* family, is a tropical plant cultivated for its beans, from which cocoa powder and butter are extracted. Still called “food of the gods”, is an important plantation crop grown as a mixed crop in arecanut, coconut, oil palm gardens and partially cleared forests. Commercial cultivation of Cocoa in India was started during 1960's and its mainly grown in Kerala, Karnataka, Andhra and Tamil Nadu states. Cocoa production is also a source of foreign exchange for producing countries. In 2012, worldwide production of cocoa reached 4 million tonnes. Its global trading generates a sum of $ 105 billion US. The production and management of seedlings in the nursery decide the performance of cocoa in the field and ultimately the end product. This manual envisages the scientific nursery techniques to be followed for cocoa planting material production.

**Nursery establishment:** The nursery is set up 5 - 8 months before the plantation. It is usually located near an inexhaustible water source to facilitate watering. It must be as near as possible to the future plantation, to the village or to humus-bearing soil. It is also advisable to build it on well-drained land that is at or only slightly sloping. Low-lying areas
should be avoided. If necessary (e.g. if located on a steep slope), drainage ditches can be dug in the direction of the steepest slope. The shade house should be made from wood or bamboo to a height of 2.5 m. It is covered with evenly distributed palm leaves or straw, allowing 50% of the light to pass through. It is also necessary to have a cover on those sides exposed to sunlight. Prepare the soil to be used to fill the sacks in which the beans will grow (humus-bearing, sandy-clay) by choosing surface soil, preferably under forest cover, while avoiding areas containing old cocoa trees or non-decomposed manure. If the soil is very heavy, mix 1 barrow-load of sand with 3 barrow-loads of black soil. Sift well. Fill plastic sacks (polyethylene) with humus-bearing sand-clay soil. The bags should measure 15 x 25 x 10 cm and the lower half should be perforated beforehand. Place the filled sacks onto the boards (10 sacks wide and 50 sacks long), which will be separated by 60 cm rows and 1 m from the sides of the nursery to allow easy access. Keep the sacks upright using bamboo supports attached horizontally to small vertical stakes. Build a fence around the shade house to protect the young plants from rodents. For a one hectare plantation, allow 80 - 100 m² for the nursery (2,000 plants), i.e. 60 or 70 ripe pods.

Seedlings: To obtain good productivity, use seeds from the most productive trees or pods of improved varieties supplied by research centres. Remove healthy pods (those displaying no signs of rot, insect damage or spots, etc.) from the productive trees shortly before their optimum point of maturity (colouring over three-quarters of the pod). After harvesting or receiving the chosen pods, open them carefully without damaging the beans. Dispose of the 3 sterile beans at the base of the pod. Clean the extracted beans thoroughly in water then scrub them with ne sand or sawdust to remove the mucilage (whitish pulp). Rinse them again in water, removing any beans that are at, too small, sprouting or that float in the water. Beans must be sown within three days of being harvested as the seed loses its ability to germinate if it stays out of the pod too long. The day before sowing, water the bags filled with soil. Sow one bean at the centre of each bag, with the fatter end of the seed pointing down or at, so that the root is upright. Push the seed to a depth of 1 cm. Cover it with soil and press it lightly with the fingers, then water abundantly. Germination will begin around the fifth day and the plants will remain in the nursery for 6 - 8 months.

Maintenance: Water the nursery every day (early morning or evening) for the first 15 days after sowing, then every other day – but not excessively – to ensure that the bags of soil remain moist. Weed the bags and the rows between the boards to eliminate plants that will compete for water and nutrition. Replace missing plants 2 weeks after sowing by repeating the bean selection process. It is possible to repeat the operation 2 - 3 times. If necessary, begin fungicide treatment with a "mixture of Metalaxyl and copper (e.g.: Ridomil Gold Plus 66 WP at a ratio of one bag per 15 litre spray of water)" when the plants have 2 - 4 leaves, then apply every 21 days. Protect the plants against insects by spraying insecticide once a month (e.g.: Deltamethrine [75 ml of Decis 12.5 EC for 15 litres of water] alternating with Imidaclopride/Lambdacyhalothrine [50 ml of Parastar, Plantima 30 SC, Con dor 200 SL, Con dor 200 OD, Miprid 200 SL, Contras 200 SL, Tropicao 200 SL, aonet plus 200 SL, Thiofor-extra 200 SL for 15 l of water]). Regularly group plants of the same size together on the same board. Gradually reduce the amount of shade one month before the transplantation to allow the plants to get used to brighter sunlight. Kept in good conditions, plants aged 5 - 6 months should measure at least 50 cm when they are planted.

Reference
Introduction

Banana is one of the most important fruit crops of India. In banana there are more than 15 insect pests which cause damage at different growing stages. Among them banana pseudostem weevil, *Odoiporus longicollis* (Oliver) is considered as major pest causing considerable damage. The banana pseudostem weevil is a monophagous pest. This pest alone causes 10-90 per cent reduction in yield of banana. The pest is distributed throughout banana growing states of India viz., North Eastern hills region, West Bengal, Assam, Tamil Nadu, Kerala, Andhra Pradesh, Karnataka and Gujarat. Banana cultivars such as Poovan, Karpuravalli, Nendran, Red vanana, etc. are found to be highly susceptible to this pest.

Identification of different stages of Banana Psudostem weevil

- **Egg:** Eggs are laid at random on cut ends of pseudostem, yellowish-white, cylindrical in shape.
- **Grub:** Grubs are apodous, creamy white with dark brown head.
- **Pupa:** Pupa is pale yellow colour, fibrous cocoon formed inside the tunneling on the periphery.
- **Adult:** Adults are robust, reddish brown and black.

Life Cycle of Banana Psudostem weevil:-

The female weevil bites a small hole in the corn, lays a single egg and continues this activity on other plants throughout the year. A female can lay 10-50 eggs during its life of months. The larvae emerge from the eggs in about a week and bore into the corm, where they feed making tunnel. When full grown in 2-6 weeks the larvae pupate in the same tunnel. The pupal stage last about week. The adult on emergence remain in soil for some time, feeding on the underground parts of the plant. Later they visited growing point of oviposition.

Nature of Damage Banana Psudostem weevil

Initially the young grubs burrow extensive tunnels in the leaf-sheaths. Tunnels are roughly circular and can reach up to about 8 mm in diameter. The important symptoms of infestation are small pin head size holes on the lower leaf sheath, gummy exudation, yellowing and withering of leaves, and decaying of peduncles resulting in the immature fruit ripening. The ascending flower bud and the peduncle inside the pseudostem can be eaten and damaged, resulting in non-emergence of the flower bud. Infested plants have dull yellow green and floppy foliage. Heavily infested plants produce small bunches, and are easily blown down by the wind.

IPM Practices of Banana Psudostem weevil

- The planting material should be trimmed to reduce the number of eggs and grubs.
- Weed free cultivation helps in reducing the spread of infestation.
- Removal & destruction of older and dried leaves.
- After harvest remove the pseudo stem and treat it with insecticide viz., carbaryl (2 g/l) to kill the egg laying weevils.
- Prune the side suckers every month.
- Do not dump infested materials into
manure pit.  
- Disc-on-stump traps and old pseudostems can be used for trapping weevils.  
- Disc-on-stump traps consist of corn slices placed on top of harvested plants cut at the rhizome. Old pseudostems can be cut into lengths of 20 to 60 cm and split each length, and placed on the ground near the corn bases with the cut surface downwards.  
- Adult weevils are attracted to the cut stems or corns for shelter, to feed and to lay eggs. When the eggs hatch the life cycle cannot continue as the cut pieces dry out and the grubs die from desiccation.

- Soil incorporate at the time of planting carbofuran 3G @ 33 g/sucker  
- Use the entomopathogenic nematodes, Steinema and Heterorhabditis spp. that attack on both stages adults and larvae of this pest can achieved effective management of this pest.  
- Use the entomopathogenic fungi Beauveriabassiana and Metarhiziumanisopliae.  
- Spray 315ml ofPhosphamidon, 100 or 625 ml of Dimethoate 30 ECin 625 lit of water per hectare around the base of the plants or clumps.

## 33. GENETICS AND PLANT BREEDING

### Molecular Pharming: Farming Pharmaceuticals in Living Systems

Bhavyasree R K  
*Centre for Plant Breeding & Genetics, TNAU, Coimbatore - 641003 Tamil Nadu, India*

#### The concept

The molecular pharming is a biotechnological method which includes the modification of plants or animals (agricultural products) to produce proteins and chemicals for pharmaceutical purposes. The production of pharmaceutical materials is so expensive so that many developing countries cannot afford most of them. So reducing the cost of production of the drugs will be very useful in the medical sector of these countries. Molecular pharming can be an efficient method to overcome this problem. Plants provide a cost efficient way to produce the valuable proteins as these plants will be modified genetically in such a way to produce the essential chemicals or proteins. Plants are advantageous over various aspects like economics, safety etc.

#### History

The first plant derived protein (also called recombinant plant derived protein (PDP)) was human growth hormones in 1986 in tobacco and sunflower. Later, the first plant derived antibody was produced in tobacco in 1989. The most popular one was the recombinant serum albumin, which was produced from transgenic tobacco and potato in 1990. In 1992, the trials of these crops began in United States and United States Department of Agriculture has approved the cultivation of the pharma crops in every states. Later industrially important enzymes like amylase and protein polymer like elastin were produced in tobacco plants. The commercial production of avidin in maize was started in 1997.

In early 2000s, the concept of pharming was proved by the production of several PDPs like antibodies, hormones, blood products, enzymes, human vaccines and animal vaccines. By 2003 several such products were developed by several biotech companies and were successfully used for the cure of human diseases like cystic fibrosis. Recombinant gastric lipases, corn- produced aprotonin, trypsin, beta-glucoronidase and avidin are the examples for these PDPs. But planting the recombinant plants in open field was a controversial issue which was solved by growing the small plants in bioreactors or in green house conditions.

#### How it is done???

1. The DNA segment which contain the genetic information to produce a specific product is identified and inserted in to the plant which is known as genetic transformation
2. This genetic information is read and processed by the plant protein making machinery and the product of interest will be produced along with the other proteins in the plant. Here the plant itself will act as a bioreactor.

3. The pharmaceutically active substance produced is extracted from the plant through industrial processing.

4. The extracted substance will be transformed in a consumable forms like the pills.

The advantages of utilizing transgenic plants as bioreactors:

The advantages of plants in comparison with other expression systems such as bacteria, virus, yeast and animals are as follows:

- The protein or the product will be free from the human pathogens and toxins as the plant cannot be a host for those pathogens.
- We can get multi chain protein by crossing with several plants.
- Reducing the costs of production as the inputs of plant to produce these bioactive substances are carbon dioxide, solar energy, and inorganic materials.
- If they are producing in dry textures like grains, it can reduce the post production costs like storage and transportation of the recombinant protein.
- If the plant part producing the protein are edible, then it will reduce the efforts of purification.

Industrial products through biopharming:

Several companies are producing the biomolecules through the biopharming techniques in a commercial scale. The Sigma is producing Avidin which is traditionally isolated from chicken egg whites and important in the diagnostic field by growing transgenic corn. The company also produce β-glucoronidase used as a visual tracer in biological experiments and trypsin which is having several pharmaceutical applications through pharmanig in transgenic corn. Also the companies like ProdiGene, Meristem Therapeutics, Ventria, Planet Biotechnology are using biopharming in a commercial scale production of proteins like lysozyme, lipase, collagen, edible vaccines etc.

Risks and Concerns:

- This can cause to the contamination of the environment through the pollen grains which cause the flow of the gene from genetically modified plants. Also there is a risk of the adverse effect of these proteins in the non-target, useful organisms like butterflies and honeybees.
- There can also the chance of contamination of food supply through accidental or intentional gene transfer.
- Health safety concerns are also there due to these proteins may cause side effect or allergy in those people who consume the plants. It can also cause non-target organ responses.

Safeguards for 'molecular farming':

The risks can be overcome by using several strategies with the careful maintenance of the transgenic plants. If there is some differences between the normal and genetically modified crops like easily observable color differences can help to distinguish the same. The new technologies like terminator technology can be used to avoid transfer through seed and the transfer through pollen can be avoided by using male sterility. Also the system of pharmanig should be transparent so that the public awareness will be there to avoid the ill effects in the society. The proper rules and procedures should be there for the whole processes.

Reference:


Whey Protein’s Benefits to Health: A Review

Jaspreet Kaur
Ph.D. Research Scholar, Department of Food Science and Nutrition, College of Community and Applied Science, MPUAT, Udaipur, Rajasthan 313001

Introduction
Drinking milk is a practice that dates back to the domestication of animals in prehistoric times, and has taken advantage of the extensive nutritional value of that natural product. In recent years, milk constituents have become recognized as functional foods, suggesting their use has a direct and measurable effect on health outcomes (Gill et al., 2000). Milk is made of two proteins, casein and whey. Whey protein can be separated from the casein in milk or formed as a by-product of cheese making. Whey protein is considered a complete protein as it contains all 9 essential amino acids. It is low in lactose content.

Protein is an essential part of the diet and necessary in the process of protein synthesis in the human body. For those who are endeavouring to build a large amount of muscle mass through weight lifting, protein consumption can be a key concern. There are several ways to get protein, and each has its own benefit.

History
At the beginning of the 20th century, although some rules and limitations were set for reaching to this nutrient, at the same time many investigations were carried out to identify this protein. At the beginning of the 21st century investigations on whey protein biologic value showed the high biological and nutritional value for this protein (Jooyandeh, 2009).

Composition
Whey protein, 20% of total milk protein, consists of several different proteins, including β-lactoglobulin (β-LG), α-lactalbumin (α-LA), the heavy-and light-chain immunoglobulins (Igs), bovine serum albumin (BSA), lactoferrin (LF), lactoperoxidase, and glycomacropeptide (GMP) (De Wit, 1998).

Health Benefits
1. Diabetes Type 2: Karamanlis (2007) found that the consumption of whey protein can reduce blood sugar after a meal, which could have a protective effect against type 2 diabetes. Pal & Ellis, (2010) conducted a clinical study and found that supplementing the diets of overweight and obese individuals with whey protein for 12 weeks improved fasting lipids and insulin levels, as opposed to casein and glucose supplementation.
2. Cancer: Whey protein concentrates have been researched extensively in the prevention and treatment of cancer. Glutathione stimulation is thought to be the primary immune-modulating mechanism. In a review of whey protein concentrates in the treatment of cancer, Bounous (2000) discusses the antitumor and anticarcinogenic potential. The amino acid precursors to glutathione available in whey might: (1) increase glutathione concentration in relevant tissues, (2) stimulate immunity, and (3) detoxify potential carcinogens (Bounous., 2000).
3. Cancer patients are undergoing chemotherapy or radiation may have difficulty in meeting their nutritional requirements and this is because of lack of appetite. So, this may lead to muscle loss, weight loss and protein calorie malnutrition. Here, the use of whey protein provides excellent protein choice for the cancer patients (Yamul & Lupano, 2003). In addition to these, it helps them very easy to digest.
4. Cardiovascular Health: Heart disease is considered as one of the most leading disease which causes death for both men and women. It is essential to maintain health and nutrition diet and also regular exercise to maintain the healthy
cardiovascular system (Walzem et al., 2002). Kawase et al., (2000) study was conducted on a group of 20 healthy adult males to investigate whether a fermented milk supplement with an added whey protein concentrate would affect serum lipids and blood pressure.

5. **Weight Management**: Diet plays a key role in any weight management program and adding whey protein often helps make a positive difference. Diet plays a key role in any weight management program and adding whey protein often helps make a positive difference.

6. It has potential as an added component in dietary plans and in functional foods aimed at control of appetite and body weight and in the management of the metabolic consequences of excess body fat. It has potential as physiologically functional food component for persons with obesity and its co-morbidities (hypertension, type II diabetes, hyper-and dislipidemia) (Luhovyy, 2007).

7. **Bone Health**: Milk contains several components effective for bone health. Milk basic protein promotes bone formation and suppresses bone resorption in healthy adult men. Milk basic protein is in the whey protein fraction. 300 mg of milk basic protein increases serum osteocalcin concentrations. Milk basic protein promotes bone formation and suppresses bone resorption (Toba et al., 2001). The milk basic protein of whey is the active protein that activates osteoblast. The active component in the whey protein plays an important role in bone formation by activating osteoblasts (Takada Y. & Kumegawa, 1996).

8. **Enhancing Body Composition**: Elite athletes are looking for nutritional supplements that will maximize performance. The demand for BCAAs increases with exercise, making whey protein an ideal source of Branch Chain Amino Acid (BCAAs) to enhance protein synthesis and muscle growth during the recovery period. Whey protein is particularly effective at stimulating muscle protein synthesis rates because the Amino Acid (AA) profile in whey protein is almost identical to that of skeletal muscle and the high levels of EAAs in whey protein are effective at stimulating protein synthesis in adult muscle (Volpi et al., 2003)

**Reference**


https://doi.org/10.1093/ajcn/78.2.250


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35. SOIL SCIENCE

Effect of Soil Physical, Chemical Properties in Soil Quality

Tupaki Lokya

Ph. D Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, OUAT, Bhubaneswar

Soil quality: The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.

Physical properties: Soil structure, Depth of soil Infiltration, bulk density, Water holding capacity Indicator Relationship to Soil Health Retention and transport of water and nutrients Habitat for microbes Estimate of crop productivity potential Compaction, low pan, water movement Porosity Workability

Chemical properties: Chemical properties of pH, Electrical conductivity, Extractable N-P-K Biological and chemical activity thresholds Plant and microbial activity thresholds Plant available nutrients and potential for N and P loss.

Role of Physical, Chemical Properties in Soil Quality

Texture: Soil having different textural groups, on basis of the proportion of different sized particles. Soil texture directly influences soil-water relation, aeration and root penetration. It also effect on the nutritional status of soil. Soil texture can be expressed significantly by its electrical conductivity.

Moisture: Moisture is a most important physical property of soil. The absorption of nutrients is depends on the moisture of the soil. The water content of soil is also much related to its texture and structure.

Soil Temperature: Temperature of the soil is an important property because it influences the chemical, physical and biological processes associated with plant growth. Soil temperature fluctuates with season, time of day, and local climatic conditions. The major source of heat is sun and heat generated by the chemical and biological activity of the soil.

pH: pH is a most important physical properties of soil. It having great effects on solute concentration and absorption in soil. Soil pH is an important consideration for farmers and gardeners for several reason, including the fact that many plants and soil life forms prefer either alkaline or acidic condition. If the pH is less than 6 then it is said to be a acidic soil, the pH range from6-8.5 it’s a normal soil and greater than 8.5 then it is said to be alkaline soil.

Electrical Conductivity: Electrical conductivity is a very quick, simple and inexpensive method to check health of soils. It is a measure of ions present in solution. The electrical conductivity of a soil solution increases with the increased concentration of ions. Electrical conductivity varies with depth and its range of variation was less in upland profile, probably occurred due to slope of land surface, high permeability and high rainfall, responsible to leach out alkli and alkaline bases.

Nitrogen: Nitrogen is a most important fertilizer element. Plants respond quickly to application of nitrogen salts. This element encourages above ground vegetation growth and gives a deep green colour to the leaves. Plants root take up nitrogen in the form of NO3 and NH4. It is the most important major nutrient required by plant for proper growth and development and it is a part of all living cells is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. Nitrogen cycle plays an important role in soil system and is influenced by biological processes.

Phosphorus: Phosphorus is a part of every living cell in plant. It is one of the most important micronutrient essential for plant
growth. Phosphorus is most often limiting nutrients remains present in plant nuclei and act as an energy storage. It helps in transfer of energy. Phosphorus is an essential element because of the large amount of phosphorus required by plants growth.

Potassium: Potassium is not an integral part of any major plant component but it plays a key role in a vast array of physiological process vital to plant growth from protein synthesis to maintenance of plant water balance. It is involved in many plant metabolism reactions, ranging from lignin and cellulose used for formation of cellular structural components, to regulation of photosynthesis and production of plant sugars that are used for various plant metabolic need

Soil Organic Matter: Soil organic matter is an important property of soil. If the soil is poor in organic matter then it enhances the process of soil erosion. If the soil organic matter is present in soil then this soil is usefull for the agricultural practices. Organic matter may be added in the soil in the form of animal manures, compost, etc.

MANAGING FOR SOIL QUALITY

Each combination of soil type and land use calls for a different set of practices to enhance soil quality. Yet, several principles apply in most situations.

1. Add organic matter: Regular additions of organic matter are linked to many aspects of soil quality. Organic matter may come from crop residues at the surface, roots of cover crops, animal manure, green manure, compost, and other sources. Organic matter, and the organisms that eat it, can improve water holding capacity, nutrient availability, and can help protect against erosion.

2. Avoid excessive tillage: Tillage has positive effects, but it also triggers excessive organic matter degradation, disrupts soil structure, and can cause compaction.

3. Carefully manage fertilizer and pesticide use: Fertilizer can increase plant growth and the amount of organic matter returned to the soil. They can harm non-target organisms and pollute water and air if they are mismanaged. Manure and other organic matter also can become pollutants when misapplied or overapplied.

4. Increase ground cover: Bare soil is susceptible to wind and water erosion, and to drying and crusting. Ground cover protects soil, provides habitats for larger soil organisms, such as insects and earthworms, and can improve water availability. Cover crops, perennials, and surface residue increase the amount of time that the soil surface is covered each year.

5. Increase plant diversity: Each crop contributes a unique root structure and type of residue to the soil. A diversity of soil organisms can help control pest populations, and a diversity of cultural practices can reduce weed and disease pressures.

Conclusion

Conventional agriculture has been largely dependent on intensive chemical inputs which plays an important role in improving food productivity to meet human demands. Small crop also affected due to large use of fertilizers and pesticides. So it becomes essential to analysis of soil parameter. Above information help to farmers for use integrated nutrient management practice to maintain optimum concentration of all the essential nutrients for plants.

Reference


Introduction
Multi-storey cropping is practiced for growing two or more crops in the inter spaces during main crop growing season and which include both inter and mixed cropping. As population has increased, increasing the need for agricultural production, the use of multicropping systems is more prevalent. Though the history of multiple cropping is old, the concept has received very little attention from agricultural scientists, and what limited interest exists has come about very recently.

The practice of multi storied cropping system is highly successful in plantation crops especially in Coconut, Areca nut, Coffee and Cashew for enhancing sustainable productivity and realizing higher income per unit area. The basic principles of multi-storey cropping system include (i) Opportunities for crop diversification on scientific, ecological & economic principles; (ii) Maximize system productivity; (iii) Utilization of resources with higher efficiency; (iv) Intensive input use and (v) Sustainability of farm resources & environment on long term perspective. This system mainly comprises an over story of trees or shrubs with an understory of economic or forage crops. Tree-to-tree distance would be wide enough to let sufficient light through to understory crops.

Many crops like paddy, sorghum, cowpea, groundnut, vegetables, yams, pineapple, banana, etc. were grown by the farmers as intercrops in coconut/arecanut gardens. Crops like dioscorea, elephant foot yam, taros were grown in pits or trenches, while pineapple and banana, ginger, turmeric, arrowroot, chilies, etc. were planted in raised beds of convenient size and were recommended for the particular locality. Various species in mixed cropping should be selected according to the age of the palm, shade tolerance and amount of light penetration to the ground level. It is practiced mainly through use of interspaces for growing other crops of shorter duration, which effectively utilized the soil moisture at different depths of soil and intercept solar energy at different height. The main advantage of multiple cropping isvability to provide substantial increase of diversified crops and income per unit area through better utilization of resources like land, space, light and nutrients. Ex. Mango+guava+cowpea, Areca nut+betal vine+papaya+pigeon pea+pineapple+ginger

CRITERIA FOR SELECTING MAIN CROP:
1. Xeric characters such as deep tap root system, high bound water in tissues, sunken stomata, waxy coating, thick cuticle and pubescence.
2. Ability to complete maximum vegetative and reproductive phase during the period of moisture availability.
3. Root system and root growth should be able to exploit deeper soil layers than those tapped by the under and ground storey crops.
4. Branching habit that allows light penetration to the under storey crops.
5. Species should be strong coppicer and should respond to pruning.
6. Leaf fall during the growth period of the ground crops and the rate of litter fall and decomposition should have positive effect on soil fertility.
7. Resistant to pest and diseases.

IMPORTANT CONSIDERATIONS FOR RIGHT CROP COMBINATIONS:
- Produce
- Growth pattern
- Inputs
- Rooting pattern
- Improve of soil fertility
- Covering of the soil

Advantages.
- Multiple cropping gives additional yield and income/unit area than sole cropping.
It acts as an insurance against failure of crops in abnormal year.
Inter-crops maintain the soil fertility as the nutrient uptake is made from both layers of soil.
Reduction in soil runoff and controls weeds.
Inter-crops provide shade and support to the other crop.
Inter cropping system utilizes resources efficiently and their productivity is increased.
Intercropping with cash crops is highly profitable.
It helps to avoid inter-crop competition and thus a higher number of crop plants are grown per unit area.

Disadvantages
Yield decreases as the crops differ in their competitive abilities.
Management of intercrops having different cultural practices seems to be difficult task.
Improved implements cannot be used efficiently.
Higher amount of fertilizer or irrigation water cannot be utilized properly as the component crops vary in their response of these resources.
Harvesting is difficult.

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Related Links.
https://www.tnauagriportal.in./publication

37. HORTICULTURE

Vertical Garden: The Living Walls
Gawade Nagesh Vithu
Ph.D. Scholar, Department of Horticulture, Junagadh Agricultural University, Junagadh

What is vertical garden?
Vertically growing of plants interior or exterior of a house supported on wall or any other material is vertical garden Or The activity of making plants grow up a wall or out of a wall, often because there is not much space available on the ground.

Concept
A huge variety of different designs and concepts are available. The design of vertical garden depends on the available material, space and local preferences as well as on the creativity and imagination of the users. Crops that can be grown comprise food crops (vegetables, fruits, herbs) and non-food crops (e.g. ornamental plants, medical plants). Vertical Gardens utilize soil, compost, vermicomposting, acrylic material as well as aquaponic and aeroponic solutions as growing media thereby maximizing the use of the resources while compromising the degradation of nutrients by using various planting medium.

Types of green walls
1. Wall-climbing Green wall: The wall-climbing type is the very common and traditional green walls method. Although it is a time-consuming process, climbing
plants can cover the walls of building naturally. Sometimes they are grown upwards with the help of a trellis or other supporting systems.

2. Hanging-down Green Wall: The hanging-down type is also another popular approach for green walls. It can easily form a complete vertical green belt on a multi-storey building through planting at every storey.

3. Module Green Wall: The module type is the latest concept compared to the previous two types. It requires more complicated design and planning considerations before a vertical system can come to place. It is also probably the most expensive green walls method.

Elements of a living wall:

1. Orientation: As with any planting design, orientation and climate determine the choice of appropriate plant species for the living wall. Plants grown at the top of a wall will have different light, air movement and moisture conditions than those located near the bottom or lower parts of the wall. It is important to understand these microclimatic conditions as well as the amount of light required for plant survival, especially in indoor conditions which may require supplementary light.

2. Plant Selection: Several plants that have thrived in living walls for the past few years include epiphytes, lithophytes, bromeliads, ferns, succulents, climbers and grasses. Native plants as well as ornamental species have also been successfully used. The plant choices are influenced as much by local microclimatic conditions and orientation as by the availability of local plant stock. Selected plants must be evergreen, with good canopy, suitable to locality and selected plant must be long lasting.

3. Irrigation: As living walls are basically hydroponic systems where water and nutrients are fed to the wall via some means of mechanical irrigation, it is important to establish control and timing of the watering system. Most probably drip irrigation system is used as it saves the water and also ensures proper irrigation.

4. Maintenance: Designing a building with an early understanding of living walls can greatly reduce maintenance costs. Designing the living wall as a pivoting or removable screen can reduce the use of lift equipment to maintain living walls that are placed high on a building. The usual requirements of pruning, feeding and watering still apply though in a different way. Establishing a well-understood maintenance regime with facilities management personnel, especially at the specification stage, will greatly improve the likelihood of survival of the wall.

Growing media & feeding

Soil is often avoided in vertical garden set-ups due to its weight, especially when wet. It tends to compact over time when put inside a container. This hinders water absorption and drainage, and reduces the amount of space for roots to grow as well as oxygen intake. Coarse and more lightweight materials like pumice (a porous volcanic rock) and coarsely chopped coconut husk are commonly used as growth media alternatives. The large particle size of these media provides spaces that permit healthy root growth and allow for drainage and aeration. Each of these media type has its own advantages and limitations. Some are better at holding water and nutrient, others offer better stability (duration that it retains its integrity). These media may be used alone or combined in various proportions to cater to individual plant needs and growing conditions. For the non-soil media, they usually do not contain nutrients on their own and do not hold certain plant nutrients as well as soil does. To ensure that plants thrive, you should dissolve water-soluble fertiliser, to feed your plants at the same time as you water them.

Advantages of living walls

Reduces urban heat island effect and smog. Cleans outside air of pollutants and dust and offsets the carbon footprint of people and fuel emissions. Cleans interior air space by removing VOCs and other harmful toxins like benzene and formaldehyde. Acts as a sound proofing barrier. Soil and plants are a natural filter that can clean the water that flows through the wall. Insulates and cools the building envelope, as well as protecting it from the elements. Creates habitats for birds and beneficial insects, increasing biodiversity. Can be used for growing food in
urban settings, creating sustainable and local control of food sources. Increases real estate value. Increases foot traffic in retail spaces. Speeds recovery time for patients through biophilia. Helps children to focus better in school. Reduces absenteeism in the work place and boosts employee morale.

Disadvantages
Sometimes the roots grow deep inside the wall and damage it, but there is a solution to this: the use of a waterproofing system, of very light plants and of automated watering. It may emit bad odour. It can be mosquitos hiding places.

References

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