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ZINC DEFICIENCY AND ITS CORRECTIVE MEASURE OF INDIAN RICE SOILS

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Introduction

Among the micronutrients, zinc (Zn) deficiency is considered as a major threat to the global and regional food security as it is the most deficient micronutrient in soils worldwide and more than 30% of soils have low Zn availability. Around the globe, it is estimated that 50% of agricultural soils devoted to cereal cultivation are potentially zinc deficient. Over two-thirds of the rice grown worldwide is produced on flooded paddy soils, which generally contain very low amounts of plant-available zinc. In high rice consuming areas, zinc deficiency caused yield reduction and Zn malnutrition in humans. Zn act as an essential component of many enzymes and controls several biochemical processes in the plants required for growth (IRRI, 2000). Compared with legumes, cereals are generally more prone to Zn deficiency leading to a substantial reduction in grain yield and nutritional quality Nonetheless, frequency of Zn deficiency is greater in rice than other crops. Total Zn contents in Indian soils ranged between 2 and 1,205 mg kg−1 compared to 10–300 mg kg−1 reported in soils of World. A significant correlation was reported between $CaCO_3$ and the Zn content of soils. Zinc availability is also dependent upon environmental conditions, plant species and their cultivars. Its deficiency is widely reported in flooded rice and in maize and wheat due to the slow release of Zn from soil organic matter complexes, as well as restricted root growth in the winter season leading to lower uptake of Zn by plants.

Role of zinc in plants

- Enzyme activation (carbonic anhydrase, alcohol dehydrogenase, Cu/Zn-superoxide dismutase and RNA polymerase)
- Auxin synthesis in plants is also controlled by Zn (its deficiency leads to leaf distortion and a shortening of Internodes)
- Photosynthesis, Protein synthesis, metabolism of carbohydrates, lipids, Auxins and nucleic acids, gene expression and regulation and reproductive development (pollen formation)

Reasons for zinc deficiency

High pH (close to seven or alkaline under anaerobic conditions). Solubility of Zn decreases by two orders of magnitude for each unit increase in pH. Zn is precipitated as sparingly soluble $Zn(OH)_2$ when pH increases in acid soil following flooding.

High calcareous soil: Adsorption or co-precipitation of zinc onto calcium carbonate particles in the presence of a large amount of free $CaCO_3$. HCO_3^- concentration because of reducing conditions in calcareous soils with high organic matter content or because of large concentrations of HCO_3^- in irrigation water.

Other Elements: Depressed Zn uptake because of an increase in Iron (Fe), Calcium (Ca), Magnesium (Mg), Copper (Cu), Manganese (Mn), and Phosphorus (P) after flooding.

Formation of Zn-phosphates following large applications of P fertilizer. High P content in irrigation water (only in areas with polluted water).

Formation of complexes between Zn and organic matter in soils with high pH and high organic matter content or because of large applications of organic manures and crop residues.

The poor availability of zinc caused by water logging can be due to a relatively high pH, zinc being present as the insoluble sulphide (ZnS) and elevated concentrations of ferrous, bicarbonate, and phosphate ions Excessive liming.

Zinc deficiency in paddy

- Symptoms appear between 2 to 4 weeks after transplanting in case of paddy
- Dusty brown spots on upper leaves of stunted plants
- Uneven plant growth and patches of poorly established hills in the field, but the crop may recover without intervention
- Burning appearance of plants
- Reduction in yields
- Tillering in paddy decreases and can stop completely and time to crop maturity increases under severe Zn deficiency
- Increase spikelet sterility in rice
- Chlorotic midribs, particularly near the leaf base of younger leaves
- Leaves lose turgidity and turn brown as brown blotches and streaks appear on lower leaves, enlarge, and coalesce
- White line sometimes appears along the leaf midrib

Zinc Deficiency in india

In India, zinc is now considered the fourth most important yield-limiting nutrient after, nitrogen, phosphorus and potassium, respectively. In all over India showed that 48.5% of the soils and 44% of the plant samples were potentially zinc-deficient and that this was the most common micronutrient problem affecting crop yields in India. Deficiency of zinc has increased in Southern States due to extensive use of NPK without micronutrients.

Periodic assessment of soil test data also suggests that zinc deficiency in soils of India is likely to increase from 49 to 63% by the year 2025 as most of the marginal soils brought under cultivation are showing zinc deficiency (Singh, 2006). Farming families consuming their zinc deficient crop produce leads to low zinc in their blood plasma compared to those which were fed on produce received from farms fertilized with zinc regularly. Zinc supplementation is therefore essential for maintaining high zinc content in soil, seed and blood plasma of human and animals (Singh et al., 2009).

State	1968-83	1983-89	1988-97	1997-2008
Punjab	53* (13341)	37 (6641)	27 (3142)	23 (3790)
Haryana	77 (14472)	52 (13350)	28 (7376)	19 (1702)
Uttar Pradesh	69 (6093)	62 (5570)	39 (20033)	36 (1259)

North India	66 (33906)	50 (25561	35 (30551)	24 (6751)
Bihar	54 (10779)	49 (6746)	66 (8435)	57 (721)
Madhya pradesh	63 (7643)	66 (8069)	38 (25224)	64 (1804)
Gujarat	26 (21994)	22 (18944)	18 (8158)	37 (943)
Central india	41 (40416)	38 (33759)	55 (41817)	55 (3468)
Andhra Pradesh	51 (4405)	52 (3304)	47 (3753)	45 (685)
Tamil Nadu	36 (7540)	48 (19433)	67 (25470)	74 (4581)
Sothern India	42 (11945)	49 (22737)	55 (6300)	70 (5266)

Singh *et al.* (2009)

Is Zinc fertilization really give profits?

Occurrence of Zn deficiency has been confirmed through the biological responses achieved in a large number of experiments on cultivator's fields conducted throughout India. A soil is classified as being 'responsive to Zn' only when it gave more than a 200 kg ha^{-1} increase in grain yield (Singh *et al*., 2003). Further increases in economic yield of <200, 200–500, 500–1,000 and >1,000 kg ha−1 representing <6%, 6–15%, 15–30% and >30% responses with a basal application of 5 kg Zn ha1 were considered as indicative of 'high', 'marginal', 'low' and 'very low' fertility status of the soils (Singh, 2001). Based on the above criteria, 37%, 37%, 19% and 7% of the 5,807 trials conducted on farmers fields showed high, marginal, low, very low fertility status of Indian soils, respectively. Therefore, Zn fertilisation proved a highly profitable option in 63% of cultivated soils in India.

Zinc sources

Highly soluble,

Zinc sulphate heptahydrate ($ZnSO_4.7H_2O$) (21–22% Zn),

Zn sulphate monohydrate ($ZnSO_4.H_2O$) (33% Zn),

Sparingly soluble,

Zn oxide (ZnO) (67–80% Zn),

Zn carbonate ($ZnCO_3$) (56% Zn),

Zn phosphate (Zn (PO_4)2 (50% Zn),

Zn frits (4–16%Zn),

Zn chelates,

Zn-EDTA (12–14% Zn)

Teprosyn-Zn slurry (55% Zn) are the important sources for ameliorating Zn deficiency.

- Zinc sulphate is the most common source of Zn in India due to its high water solubility, easy availability and relatively low price compared with other sources and it is being widely used to correct Zn deficiency in different crops and soils.
- Application of Zn-EDTA was found comparable to ZnSO4 in the calcareous soils of Pusa and Inceptisols of Hisar. It proved better than ZnSO4 in combating Zn

deficiency in rice on loamy sand soils of Punjab, but the higher cost of chelates made them less popular than ZnSO4.

- Blended sources of micro and macronutrients, like zincated urea, when added on a Zn equivalent basis to rice in calcareous soils produced comparable yields to those with $ZnSO_4$ and left significant residual effects to succeeding wheat crops compared with controls.

Zinc deficiency correction

- Generally, broadcast- plow down is the most effective method of application. Banding may be preferred in situations of shallow or minimum tillage.
- In season, zinc deficiency may be corrected by spraying the crop with a 0.5 percent zinc sulphate solution (1 percent for potatoes).
- Include a surfactant (wetting agent). Foliar applications are effective in greening foliage but are not as effective in producing yield response. Consider them as a salvage measure.
- Manure applications are quite effective in eliminating zinc deficiency problems when applied at the rate of 15 to 20 tons per acre.

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EPIPHYTIC MICROBES AND THEIR POTENTIALS

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Abstract

Plants harbours various life forms, in that particularly some beneficial microbes over their surface as beneficial epiphytes. Many epiphytes had been discovered for their potential use as plant growth promoting regulators, biocontrol agents and good metabolisers. Prominent epiphytes like some species of Saccharomyces, Ascomycetes, Basidiomycetes are common. Auxin and cytokinin synthesis by yeasts, Vitamin biosynthesis by *Methylobacterium*, killer toxins against phytopathogens produced by Wickerhamomyces were all some of the potentiality of plant epiphytic microbes. Their structure and living depends upon the prevailing environment factors.

Keywords: Biocontrol agents, Epiphytes, Microbiome, Plant growth promoters.

Introduction

Epiphytic microbes are those organisms that dwell on the surface of plant such as leaf, stem that is over the phyllosphere. These organisms don't harm plants just living in a nonparasitic relationship. They serve multiple functions in plants. Epiphytes involve in the metabolic pathway of plants making some alterations or through some induction. Commonly found epiphytes in plants are several species of yeasts, Ascomycetes, Basidiomycetes and some of Methylotrophs. Some yeasts species are known to induce auxin biosynthesis on external induction of IAA. *Methylobacterium oryzae* belonging to facultative methylotrophs possess certain genes that improves vitaminB_{12} biosynthesis, phosphate solubilisation, decreasing heavy metal toxicity, improving urea metabolism. Epiphytes are also prominent in the aquatic environment. Biofilms found in certain aquatic plants harbour several useful and potential epiphytes like some nitrifying bacteria such as *Nitrococcus, Nitrosomonas, Nitrospira*. Some other genes include *Proteobacteria, Chloroflexis, Acidobacteria* were also present. Epiphytes as a whole serve as a good mutualistic partner of plants.

Growth and Metabolism

Growth and metabolism are the basic constituents of any life form. The role of epiphytes here is very crucial. They are present both in terrestrial and aquatic plants. Several species of yeast like *Aureobasidium pullulans, Cryptococcus flavus*, some *Candida* species are known to promote or alter the auxin biosynthesis in plants by exogenous production of IAA. These fungi produce IAA through tryptophan dependent or independent way [1]. *Methylobacterium* species colonising around the stomata, trichomes produce their own auxin, cytokinin, ACC deaminase enzyme and stimulate plant growth. It possesses ACC deaminase enzyme through which it reduces the excess ethylene level. Vitamin B_{12} synthesis improves cobalt metabolism [2]. In the aquatic environment eutrophication or algal bloom is a major problem which pollutes the water leaving no sunlight or oxygen to pass through causing death of flora and fauna. Biofilm is good mitigation measure formed by the epiphytes on the aquatic flora containing denitrifying bacteria that denitrifies the nitrates back to air. *Nitrosomonas, Nitrococcus, Nitrospira* are found in free floating *Eichhornia crassipes* and *Trapa natans*. qPCR analysis shows the abundance of denitrifying genes like nitrite and nitrate reductase [3]. The leaf phyllosphere of *A.thaliana* contains prominent microbes like *Actinobacteria, Proteobacteria*, and *Bacteriodetes* have many potentials. The phyllosphere and rhizosphere microbial structure and diversity is influenced by several environmental factors like radiation, temperature, humidity [4]. *Herbaspirillum seropedicae* also promotes growth through biofilm formation on leaves with or without exopolysaccharide formation [5].

Disease resistance

Disease resistance is an important trait essential in plant that too by means of biological control will be more efficient and ensures biosafety. Fungal and bacterial epiphytes confer protection by producing some metabolites that are antagonistic against pathogens and also through certain mechanisms. *A.pullulans* is a biocontrol agent and has several biotechnological applications. *P.aphidis* secrete some extracellular metabolites that inhibits the fungal pathogens. *Methylobacterium oryzae* genome encodes bacteriocin and a precursor called 4-Hydroxy benzoate that acts as a precursor for activating antifungal proteins in *Nicotiana tabacum* [1]. The blue mould rot, a serious postharvest disease of apple caused by *Penicillium expansum* is biologically controlled by *Starmerella bacillaris* that grows on grapes. It is fructophilic, producing more glycerol hence also used in cider formation [6]. *Wickerhamomyces anomalus, Torulaspora delbrueckii* effectively controlled the green mould and blue mould caused by *Penicillium* species in lemon by producing low molecular weight killer toxins that has antagonistic activity. *W.anomalus* produces panomycocin that controls anthracnose rot caused by *Colletotrichum gloeosporoides*. *Leucosporidium scottii* produces volatile antifungal compounds against *Botrytis cinerea* of apple [7].

Conclusion

Microbial epiphytes are ubiquitous everywhere. For control of a disease use of chemical fungicide may be a solution but it can have adverse effect on the quality of the produce causing detrimental disease in both animals and humans. Phyllosphere microbes residing in the above surface of plant have best potential in increasing the metabolism, growth and disease resistance of plants. In the near future it is best that we go for testing the bio efficacy of all these epiphytes and commercially formulate them in such a way they could be used by the farmers to do farming in a chemical free and sustainable way.

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SUCKING PESTS OF MULBERRY AND THEIR MANAGEMENT STRATEGIES

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Mulberry is prone to attack by numerous pests which cause abrupt reduction in leaf yield quality. The insect pests infesting mulberry are divided into four types such as sucking pests, defoliators, stem borers and subterranean pests. Among these types, the damage caused by sucking pests cause significant loss to the mulberry leaves. They suck the plant sap and cause mainly the reduction in leaf quality. While sucking sap, some of them inject toxic material into the plant, which causes abnormality on the growing part like tukra, drying up of leaf margin, etc. The important sucking pests are mealy bugs, leaf hopper, scales, spiraling white fly and thrips.

1. Papaya mealybug - *Paracoccus marginatus*

Papaya mealybug is a new record, exotic in origin and seems to have been introduced into India. It is an invasive pest on wide variety of commercial crops causing serious economical damage characteristics and biology. In the year 2008, it was recorded on papaya from Coimbatore in Tamil Nadu for the first time.

Biology

Small to medium sized, yellow coloured insects with mealy or waxy coating having oval to elongate insects with terminal or waxy filaments. Eggs are yellow in colour and laid in sac (400 - 500 egg) which is three to four times more than the length of the body and covered with white wax. Egg period is 7-14 days. Nymphs are yellow with 4-5 instars and live for a month. First instar nymph is referred to as "Crawler". Upon hatching it moves out and selects tender portions and starts feeding. Female has four developmental stages, whereas, the male has six developmental stages. Females are wingless and adult male has a pair of membranous wings; but short lived; die after mating.

Damage symptoms

- Malformation of affected portion due to toxin injected during feeding.
- Apical portions are affected initially. Thereafter it spreads all over the plant affecting even woody regions.
- Yellowing of leaves
- Stunted growth of leaf and plant
- Sooty mould on leaves and plants due to honey dew secretions of the pest.
- Movement of ants in the vicinity which help in spread of the mealy bugs.

Management

- Inoculative release of the exotic parasitoid, **Acerophagus papaya** in the pest infested hotspot areas; releases may be repeated if necessary
- Removal of weeds in and around the garden.

- Removal of affected portions and burn them to avoid further spread.
- A lycaenid predator, *Spalgis epius* larva voraciously feeds on different stages of mealybug. This may be conserved or collected and released in place of need.

2. Pink mealybug - *Maconellicoccus hirsutus*

Biology

Males have a pair of wings and two long waxy tails. Females are pink in color with a white waxy covering and have no wings. Each female lays approximately 350-600 eggs in an ovisac covered with cotton like mealy substance. The eggs period is 6-9 days. Males have four nymphal instars while females have only three. Nymphal period lasts for 23-27 days. Lifecycle is completed in 30 days and has 10-12 generations in a year.

Damage symptoms

Malformation of the apical shoots, retarded growth, wrinkling and curling of the affected leaves, become dark green in colour. Leaves become pale yellow on severe infestation. Affected portions become brittle. Symptoms are collectively called as Tukra (Bushy top) disease. Nymphs and adults suck the cell sap from tender leaves and buds. Nutritive value of leaves, leaf yield and plant height are drastically reduced.

Management

- Spraying Fish Oil Rosin Soap (FORS) @ 40 g/l
- Cutting the affected shoots and burning
- Releasing *Cryptolaemus montrouzieri* @ 750 beetles/ha

3. Thrips - *Pseudodendrothrips mori*

Biology

The eggs are bean shaped and whitish in colour. Each female lays about 30-50 eggs on ventral surface of tender leaves which hatch in 6-8 days. The newly hatched nymph is initially colourless and transparent with a pair of dark red compound eyes and gradually changes to light creamy yellow. The pupa is yellow coloured, characterized by two pairs of short wing pads and pupation takes place in soil. Female is yellow in colour, while male is darker. Life cycle is completed in 20-22 days and has 15 generations in a year.

Damage symptoms

In early stage of infestation streaks are observed on leaves. In advanced stages, the leaves become yellowish brown on maturity. Injure the epidermal tissues of leaves and desap. Early maturity, depletion of moisture, reduction in crude protein and total sugars. Leaves become unfit to rear silkworm.

Management

- Release of *S. coccivora* @ 500 adults or *Chrysoperla* @ 1000 eggs / acre, a week after the insecticide spray.

- Mulberry field should be thoroughly cleaned after harvest by removing small side branches, dead leaves and weeds in order to eliminate any developmental stages of thrips on them.
- Providing frequent irrigation helps in increasing the pupal mortality in soil thereby reducing the thrips emergence.
- Water jetting or sprinkler irrigation is effective in reducing thrips population.

4. Leaf hopper - *Empoasca flavescens*

Biology

Adults are pale green or greenish yellow in color. Body is wedge-shaped with whitish markings on the head and thorax. The head is prolonged forward as a smooth, flat, triangular structure with a pair of antennae possessing sensoria. The thorax is simple and abdomen is tapering at the posterior end. The hind legs have two parallel rows of spines which extend all along the hind tibiae.

Damage symptoms

Hopper burn, triangular dark brown spot at the tip and margin of leaves. Drying starts from periphery to midrib of leaf. Finally leaves become cup shaped and wither. Adults and nymphs attack the mulberry leaves from lower side of the margin of the veins and deplete nutritive value of leaves. Also suck the sap from the tender stems of the twigs.

Management

- Spray neem oil (2%) or fish oil rosin soap (2%) with a safe period is 15 days.
- Set up light traps and yellow sticky traps to destroy adult population.
- Spray of a strong jet of water in the affected mulberry garden help to reduce the pest population.

5. Spiralling whitefly - *Aleurodicus disperses*

Biology

Each female lays about 40-70 pale yellow coloured eggs with a short pedicel on the underside of leaf. The eggs are laid along with deposit of waxy secretion in a characteristic spiraling pattern, hence the name 'spiralling whitefly'. Incubation period is 4-6 days. There are four nymphal stages. The first instar nymphs are mobile (crawlers) and suck the sap from the tender leaves. Subsequent instars are immobile which are found on the underside of older leaves. They produce whitish waxy filaments and copious quantities of honey dew. The final instar is the pupa from which adults emerge. The nymphal period exist for 14-20 days. The adult flies are 2 mm in length with white powdery wax material over the wings and whole body. Life cycle is completed in a month and has 10-12 generations per year.

Damage symptoms

Adults and nymphs congregate on the lower surface of leaves. Desap the leaves, resulting in yellowish speckling on leaves. Leaves crinkle and curl and sooty mould appears. Infestation spreads from the bottom leaves to the top. Eggs are laid on lower leaves with irregularly spiralling deposits of waxy white flocculence. Desapping of the leaves. Depletes nutritive value of leaves. Nymphs and adults cause damage

Management

- Removal of weeds
- Spraying Fish Oil Rosin Soap @ 40 g/l or Neem oil @ 20 ml/lit.
- Collection and destruction of leaves with egg masses, nymphs and adults.
- Setting up light traps and yellow sticky traps

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ANALYSIS OF VARIANCE (ANOVA) OF ALPHA LATTICE DESIGN USING R SOFTWARE AND PBTOOLS

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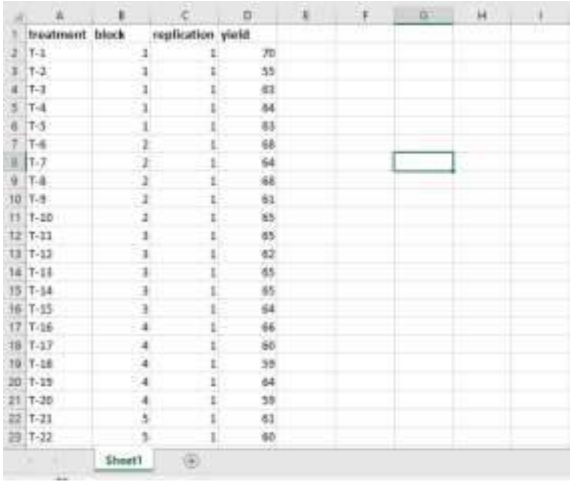
Introduction

The alpha lattice design is the one of the incomplete block design used among researchers to regulate the random variation in evaluation trails having large number of genotypes (Barreto *et al.*, 1996). It has been predominately used by plant breeders for the evaluation of various genotypes. It could even be useful where there is no factorial type relationship among treatments and the number of treatments are large and soil heterogeneity is very high in the experimental site. The complete block type of designs assumes that variation between units of a block is less than that between units of different blocks. In an alpha lattice design, the number of plots per block is smaller than the total number of treatments (e.g., genotypes). In the field, an incomplete block design is indistinguishable from a randomized complete block design. However, practical considerations dictate that all designs used for agricultural trials be resolvable. The alpha lattice design allows us in the adjustment of treatment means for block effects. This in turn brings benefit from the small incomplete blocks which help varietal comparisons under more homogenous conditions. The alpha lattice design also provides effective control within replicate variability.

R is a free, open source software program for statistical analysis, based on the S language available at https://mirror.niser.ac.in/cran/ . It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and Mac OS. For learning the usage of R, one can use some of the online websites such as http://www.statmethods.net/ or https://journal.r-project.org/ etc.,

Analysis of variance (ANOVA) using R

In the first step the data should be arranged as per the figure 1. After arranging the data save the file and open the R software, then import the data into the R. Then follow and use the R script given below.



	treatment	block	replication	yield
2	T-1	1	1	70
3	T-2	1	1	55
4	T-3	1	1	63
5	T-4	1	1	64
6	T-5	1	1	63
7	T-6	2	1	68
8	T-7	2	1	64
9	T-8	2	1	68
10	T-9	2	1	61
11	T-10	2	1	65
12	T-11	3	1	65
13	T-12	3	1	62
14	T-13	3	1	65
15	T-14	3	1	65
16	T-15	3	1	64
17	T-16	4	1	66
18	T-17	4	1	60
19	T-18	4	1	59
20	T-19	4	1	64
21	T-20	4	1	59
22	T-21	5	1	61
23	T-22	5	1	60

Sheet1

Figure 1: Arrangement of data in MS excel

library(agricolae)

PBIB.test(block,treatment,replication,yield,5,method = c("REML", "ML", "VC"), test = c("lsd","tukey"),alpha = 0.05,console = TRUE,group = TRUE)

Note: R is case sensitive; **5** is block size

Analysis of variance (ANOVA) using PBTools - Plant Breeding Tools

The PBTools software can be downloaded from the IRRI website (http://bbi.irri.org/products) at free of cost. After installing the software, for ANOVA of alpha lattice design follow the steps given below

1) Create the new project by clicking on the respective tab and import the ".csv" data file (data should be arranged as per figure 2)

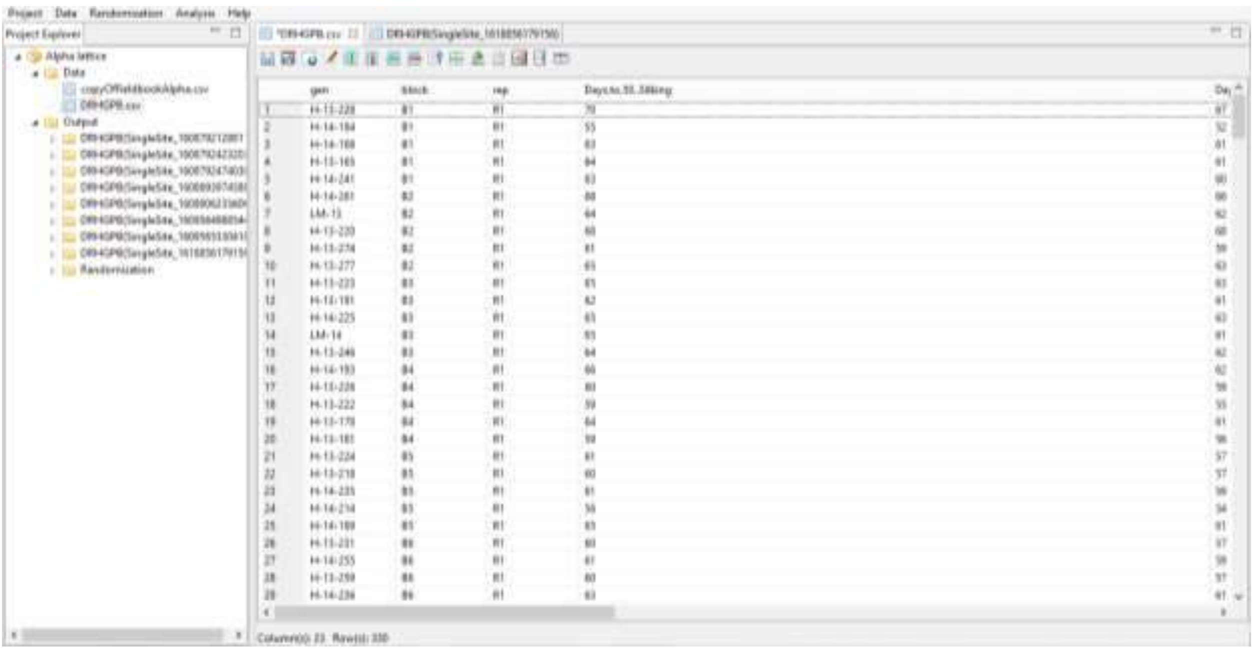


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Figure 2: Data arrangement for PBTools

2) Then open the project and the imported file, after opening the imported file click on the analysis tab.
3) Then click on single environment analysis, then a new window appears, the select "Alpha-Lattice" from the drop down menu.
4) In the response variable tab add the trait.
5) Then add genotype, block and replicate in the respective tabs (figure 3).

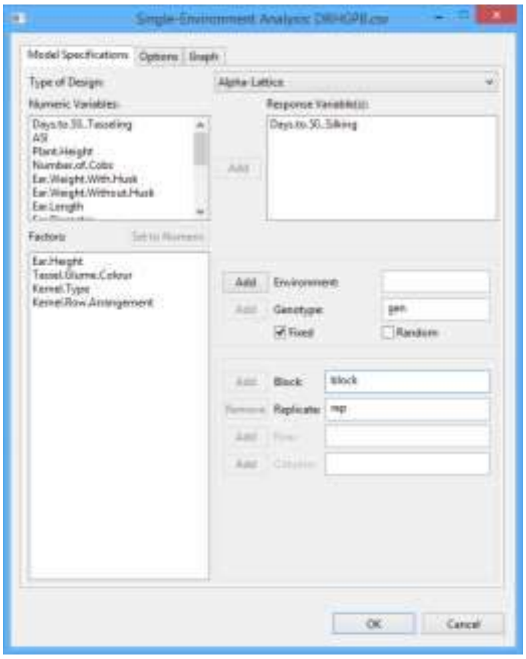

Figure 3. Model specifications for ANOVA

6) Make genotypes fixed or random (in my case fixed), then click on **ok**.
7) ANOVA will appear in the output tab of the software.

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ROLE OF FLAVONOIDS IN NEMATODES

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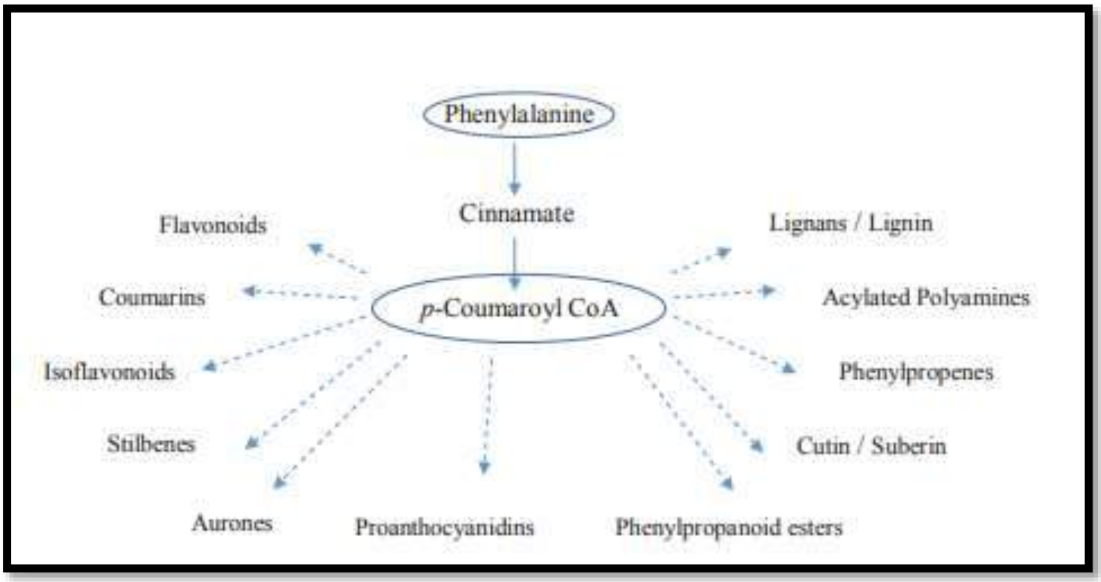
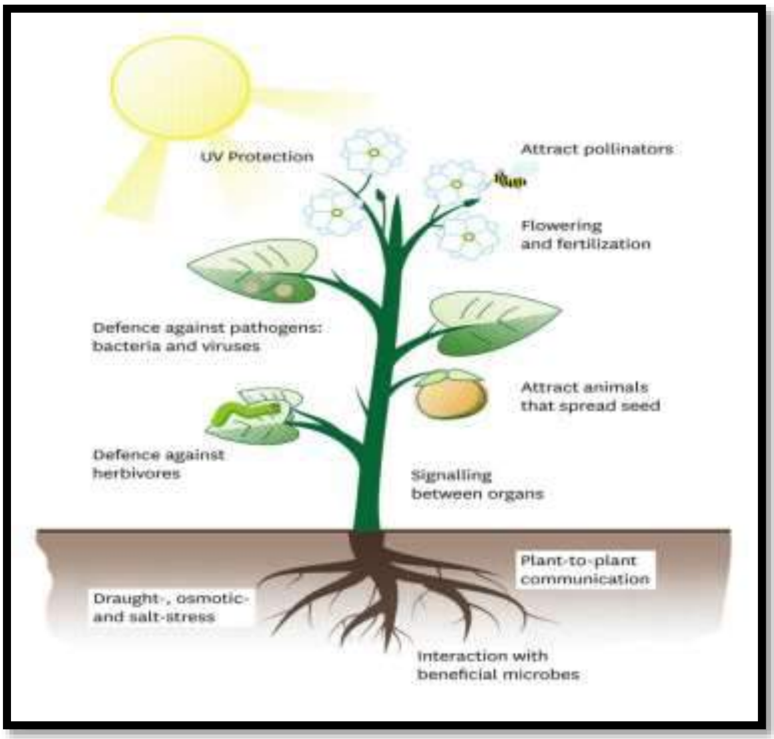
Flavonoids

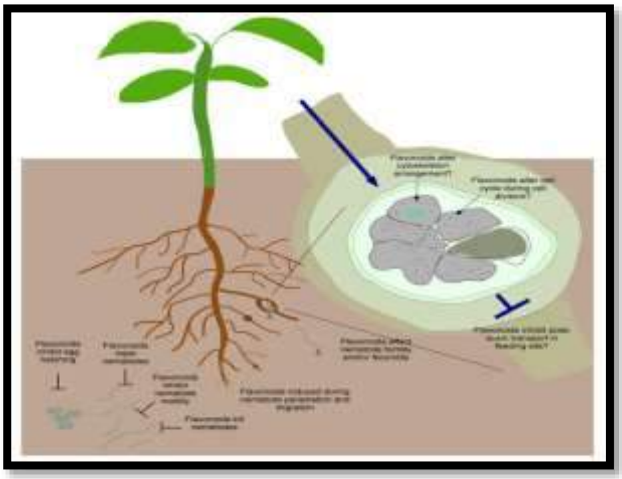
Flavonoids constitute a large class of secondary carbon-based metabolites present in all land plants. More than 10,000 different types of flavonoids have been described from a variety of plant species. It constitutes large class of secondary carbon-based metabolites and present in all plants. More than 10,000 different types of flavonoids had identified from a different plant species. Flavonoids are a class of phenylpropanoids derived from the shikimate and acetate pathways. There are several flavonoid subgroups - chalcones, flavones, flavonols, flavandiols, anthocyanins, condensed tannins, aurones, isoflavonoids, and pterocarpans. The functions of individual flavonoids are plant development via the control of auxin transport, flower pigmentation, as antioxidants (ROS scavengers), as defense compounds, chemoattractants, signals for plant–microbe interactions (notably nodulation), male fertility in some species and help in nutrient mining.





Role of flavonoids in nematode defenses

Flavonoids inhibits nematode egg hatching. It also induces quiescence by slowing down their movement, modify their migration towards the roots by repelling them and finally kills the nematodes. Flavonoids can affect adult stages of nematodes by altering their fertility and fecundity.

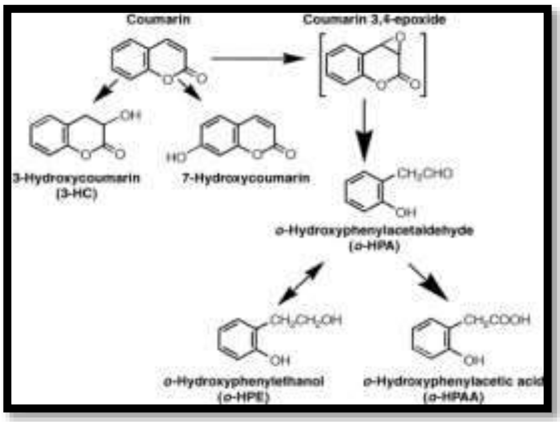


Examples

- ✓ Flavonols kaempferol, quercetin, and myricetin repelled and slowed *M. incognita* juveniles at micromolar concentrations.
- ✓ Kaempferol inhibited egg hatching of *Radopholus similis* .

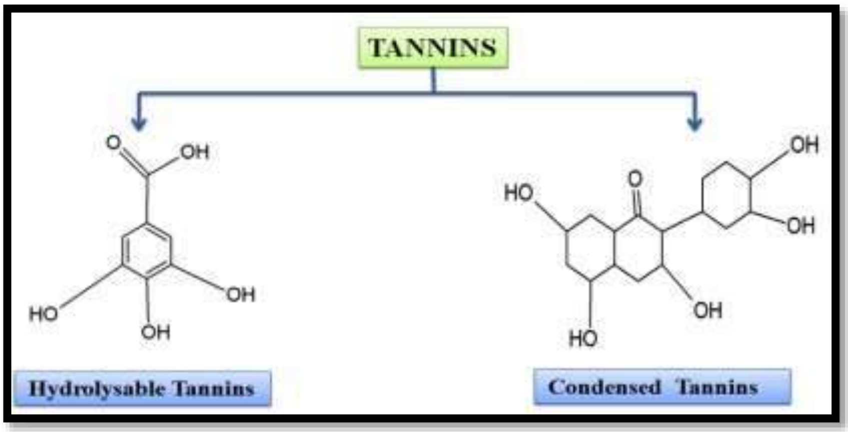
Coumarin

Coumarins are ubiquitously found in higher plants where they originate from the phenylpropanoid pathway. They are found in monocots and dicots plants. During plant-nematode interaction, coumarins (8-geranyloxypsoralen, imperatorin, and herclenin) causes lethal effect to Pine wood nematode, *Bursaphelenchus xylophilus* in white leaf hog weed, *Heracleum candicans* Coumarins from *Ficus carica* leaves (psoralen and bergapten) also exhibited a strong effect on *B. xylophilus* with a mortality rate of 91% within 72 h at 1.0 mg/mL. Furanocoumarin from parsley exhibits significant nematicidal activity against *M. incognita, M. hapla* and *M. arenaria.*



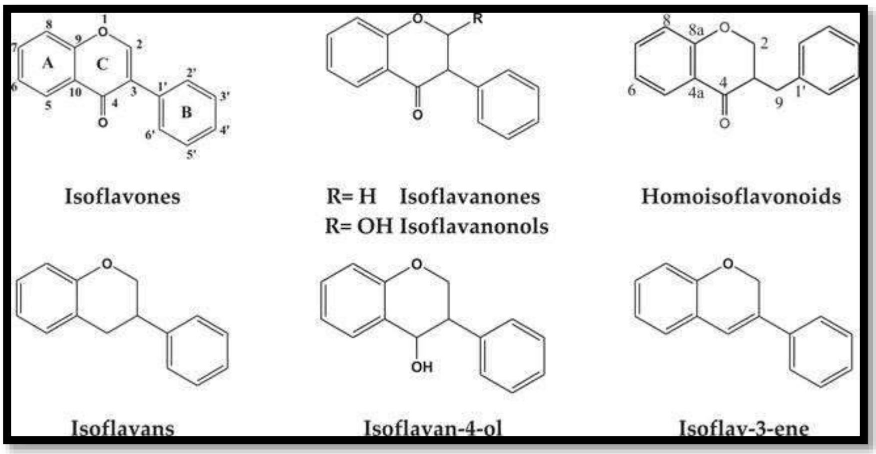
Tannin

Tannins are a group of condensable and hydrolysed polyphenolic compounds. Tannins from chestnut significantly reduced egg hatching of the root-knot nematode *M. javanica.* Low concentration of tannic acid (less than 40 mg/L) increased hatching of *H. glycines* eggs. Tannins in the extract of *Fumaria parviflora* have been shown to have strong nematicidal effects on J2 and eggs of *M. incognita.*



Isoflavonoids

Isoflavonoids plays an important role in plant-nematode interaction. Isoflavonoids are produced in infected roots of both *H. glycines*-resistant variety of hartwig and susceptible variety essex of soybean. Isoflavonoids are elicited in high amounts in *Medicago truncatula* in response to *M. javanica* infection. Isoflavonoid compound glyceolin was found to accumulate close to the nematode's head in a resistant cultivar but not in susceptible plants.



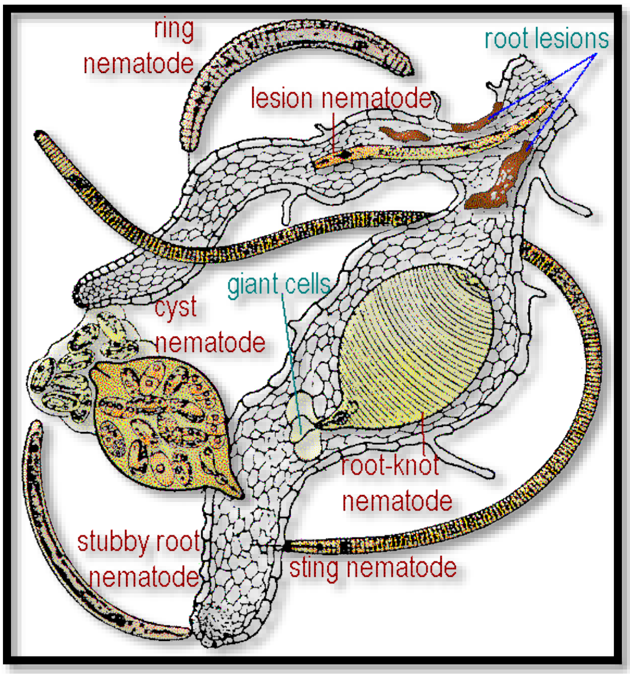
(Hamamouch and adil , 2019).

Role of flavonoids in formation of feeding site

Feeding sites are important for nematode survival. The endoparasitic nematodes like root knot nematode, cyst nematodes and some semi-endoparasitic nematodes. Feeding sites are giant cells, syncytium and nurse cells.

Flavonoids involved in the regulation of polar auxin transport to enhance auxin accumulation in nematode feeding sites. Some flavonoids inhibit cell-to-cell polar auxin transport and/or the inhibiting auxin efflux transporters, PIN (Pin-formed) and PGP (P-Glycoprotein). Flavonoids may also be involved in the cell cycle regulation of nematode feeding sites. Nematode feeding sites commonly contain enlarged nuclei with higher DNA content compared with other cells, a process achieved through endo-reduplication in the S-phase of mitosis during cell proliferation. It is presumed that endo-reduplication is a strategy used to increase DNA content and gene dosage, thereby increasing cell metabolism and growth in feeding sites.

Flavonoids such as quercetin, genistein, persicogenin, artemetin, luteolin, penduletin, and vitexicarpin inhibit cell cycle progression from G2 to mitosis and induce apoptosis . In addition, some flavonoids can control auxin content by regulating IAA (indole Acetic Acid) oxidase.



Chin *et al.,* (2018)

Conclusion

Several metabolic compounds were varied from resistant and susceptible hosts. Those compounds will give the resistance to the host from nematode attack and also enhances the establishment of nematode feeding site

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INTERCROPPING APPROACHES FOR INTEGRATED PEST MANAGEMENT

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Introduction

Intercropping, one of the cultural practices in Integrated Pest Management, which involves growing of two or more different crops in the same field. Growing of different crops in the same field provide co-existence of several organism and beneficial interaction between the organisms that can empower the agro-ecologically stable environment. Intercropping enhances the benefits of on farm diversity, increased productivity, resource distribution balance and weed and insect pest control and also maintains ecological balance.

Importance of Intercropping

- Intercropping give additional income to the farmers
- Intercropping with green manure crops is used as mulching, that provide more nutrients to the crops that in turn reduces the usage of fertilizer in the field.
- Intercropping with floral plants invites more natural enemies *i.e.*, parasitoids and predators.
- Intercropping provide ecological sustainability
- Intercropping suppress the pest population by delaying colonization of pests or by reducing the reproduction rate of insects
- Intercropping reduce the weed population and helps to conserve the properties of soil.
- Intercropping lowers the application of pesticides and improve the crop quality also.
- Intercropping protect the land from soil erosion and solarisation.
- The selected intercrop should not compete with the main crop.

Repellent intercropping

An intercrop which have repellency effect can also used for insect pest management. The repellent intercrop can masks or deters insect pest from the main crops. The chemical produced or the physical/morphological characters of the intercrop repels the insect pest.

An example of repellent intercrop is that when onion intercropped with carrot as main crop, repels carrotfly, *Psila rosae* and reduces the incidence in the main crop.

Trap intercropping

Trap intercropping is a practice of cultivating attractant crops close to the main crop. The intercrop is more attractive to the insect pest than the main crop, so that insect is easily drawn to the trap crop. An example of trap intercropping is cowpea intercropped with cotton to check the *Helicoverpa* sp. population.

Push – pull cropping

This is the combination of repellent and trap intercropping system. The trap crop will attract the insect, act as pull component and the repellent crop deter the insect, act as a push component. Example in maize ecosystem napier and sudan grass grown in border to attract the stemborer pest and intercropped with Molasses grass and silver leaf will repel the stemborer population.

Here, some successful examples of intercropping system, that can manage the major pest population of main crops are listed (Table.1)

Table 1. Successful examples of intercropping system

S.No.	Main crop	Intercrop	Pest controlled
1.	Apple	Buck wheat	Leaf roller pest, *Epiphyas postvittana*
2.	Bengal gram	Marigold	*Helicoverpa* sp.
3.	Brinjal	Coriander or Marigold	Leafhopper and Whitefly
4.	Cotton	Chick pea	*Helicoverpa* sp
5.	Ground nut	Sorghum, Bajra,Maize	Leafhopper, *Empoasca kerri*, Aphids, *Aphis craccivora* and Thrips, *Scirtothrips dorsalis*
		Cowpea	Leaf folder
6.	Maize	Beans and legumes	Leaf hoppers,Leaf beetle, Stalk borer
7.	Mustard	Cabbage	Cabbage head borer
8.	Oats	Carrots	Thrips
9.	Onions	Ragweed	Oriental fruit moth
10.	Pigeon pea	Sorghum	Leafhopper
11.	Potato	Marigold	Nematodes
12.	Radish	Cabbage	Flea beetle,Root maggot
13.	Rye	Soybean	Corn seedling maggot
14.	Soybean	Green beans	Mexican bean beetle
		Maize	*Helicoverpa* sp.
15.	Tomato	Cabbage	Diamond back moth
		Marigold	Tomato fruit borer and Root knot nematode
		Coriander	Whitefly, *Bemisia tabaci*

Conclusion

Selecting the right intercrop is very much important to determine which combination will suppress the pest population because not all the combinations of crops will reduce the pest population. Integration of intercropping as a component in integrated pest management strategy is a better approach to manage the pest population but its needs detail knowledge about the combination of plants, whether they will influence the behaviour of pests, beneficial organism and ecological sustainability.

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BEETLES AS EFFECTIVE DECOMPOSERS OF EXCREMENT

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Introduction

Excrement is a very special habitat for coprophagous species, and the spatial distribution of dung increases the tendency of these insects to concentrate in a limited space. The excrement of vertebrates generally is a rich source of nutrients, and insects play an important role in the rapid recycling processes of faeces. However, carnivorous excrement contains little material useable by insects because of their efficient digestive process. In contrast, the digestive system of herbivores is less efficient and the dung produced is quite similar to the original leaf material. More than half the food consumed by herbivorous animals is returned to the ground in the form of unassimilated material, *i.e.*, dung. Because it has abundant in organic matter and moist, herbivore dung is an ideal medium for establishment of a specific, rich entomofauna involved in the process of decomposition and elimination of faeces. Quantitatively, large herbivore dung pats are the most important resource for dung beetles in most regions, and this fauna is especially abundant in historic grazing areas.

The process of colonization of excrement typically consists of three waves of insects. The first wave of colonizers involves certain flies arriving within hours to lay eggs or larviposit on the dung before a crust is formed on the pat. The second wave is several families of beetles. Lastly, mites become abundant.

Beetles

Among beetles that use dung resources, the dung beetles belonging to the Scarabaeidae (Scarabaeinae,Geotrupinae and Aphodiinae) are the most important and numerous. Not all scarab larvae are strictly coprophagous, and some ingest soil organic matter or feed on roots of plants. However,many are coprophages, and often exceedingly abundant. Thousands of individuals from many species may be found colonizing single dung pats in temperate and tropical grazing ecosystems. Most Aphodiinae are saprophagous and within the Geotrupinae coprophagy is the rule for the Geotrupini. Only Scarabaeinae has coprophagy as a characteristic of most of its species. In this case, most of the nutrients eaten by the adults are derived from eating microbes or colloids suspended in dung. The larvae feed on the dung supplied by their parents in a nest chamber.

Various other groups of beetles visit dung but they are primarily predators. Coleoptera of the families Hydrophilidae, Staphylinidae and Histeridae are associated with carrion as predators of larvae of flies and dung-beetles. However, the two former families also include coprophagous species. In the temperate region, the hydrophilids *Cercyon* and

Sphaeridium (Coleoptera: Hydrophilidae) are coprophagous, arriving within the early hours after deposition of dung.

The Dung beetles

The behavior of dung beetles (Coleoptera:Scarabaeidae) is specialized and diversified inresponse to exploitation of excrement by adults and larvae. The Scarabaeidae consist of approximately 7,000 species (5,000 Scarabaeinae, 1,900 Aphodiinae and 150 Geotrupinae). Many species of Scarabaeinae and Geotrupinae have developed special feeding and breeding strategies that allow them to remove dung rapidly the soil surfaces by digging burrows below the dung pad to store fragments of dung in tunnels. They also may form dung into balls and roll them away from the pad for burial far from the food source. The importance of these habits is the protection of food for adult or larvae, avoiding competitors, predators and unfavorable climatic conditions. Only Aphodiidae do not make a nest. Aphodiidae eat directly into the dung and many species deposit theirs eggs directly in dung pads without nest chamber or in the surrounding soil. Geotrupinae and many tribes of Scarabaeinae are tunnelers. These species dig a tunnel below the dung pat and accumulate dung in the bottom of the burrow; this food can be used either for adult or for larval feeding. Finally, some species of Scarabaeinae are rollers, making a ball of dung that is rolled away from the pat for a variable distance before burying.

One of the most important aspects of the biology of Scarabaeinae and Geotrupini is the interesting behavior. Geotrupini nests are the most primitive and consist of simple burrows filled with“sausages” of dung, usually containing one egg each.

The reproductive biology of Scarabaeinae has several distinct patterns, which have been reviewed and compiled in comprehensive and wonderful books by Halffter and Matthews (1966) and Halffter and Edmonds (1982). The process of nesting involves the creation of a place in the soil where a supply of dung is accumulated for development of larvae.

Scarabaeinae nesting frequently involves bisexual cooperation of a pair of beetles, for either shortor long periods of time, and parental care sometimes exists. The adults make brood balls in the protected nest, each of which contains the amount of food required for larvae to enable them to complete larval development. Nesting behavior is considered as an adaptation to isolate immature larvae from each other and from adults, increasing the survival of offspring. Obviously this is a process that requires the investment of considerable time and energy on the part of the parents. Nesting derives from feeding behavior and basically corresponds to food relocation: tunnelling and ball rolling.

The tunnelling scarabs take food from the dung pat and bring it into a previously excavated gallery. Various types of nesting have been described for tunnellers, and it is sometimes difficult to ascribe a particular type of nesting to a species.

The most primitive and simplest nest behaviour is observed in some genera of Dichotomini,Oniticellini, Onitini, and also Onthophagini. A female digs a simple burrow, fills it with food, forms a brood mass and provides a single egg. In this case, there is no bisexual cooperation or maternal care, and the species involved show relatively high fecundity.

Other groups of dung beetles make nests containing several or many brood masses such as those observed in some species of Dichotomini, Onitini,Onthophagini and Oniticellini. The brood masses are constructed in series, in the same tunnel or separated in individual side branches. In this type of nesting, bisexual cooperation may exist, but the role of the male is restricted to introducing food into the tunnel. These species have relatively high fecundity, and there is no maternal care.

Coprini and several Dichotomini, Onitini and Oniticellini species construct nests that contain several spherical brood masses arranged in a single or branched tunnel with or without separation.

Some scarabs produce a nest containing only a few brood balls in a chamber, and physically separated from other chambers. This nesting behaviour is present in species with low fecundity: Phanaeni (without maternal care), several Dichotomini (with or without maternal care), and several Coprini (with maternal care).

Finally, the species of *Oniticellus* (Oniticellini) show endocoprid nesting behavior: digging burrows and making brood chambers in the dung pat, where nesting takes place. The species of this genus present moderate to extensive maternal care.

Rollers

The roller habit of food relocation is only present in some tribes of Scarabaeinae: Scarabaeini, Chantonini, Gymnopleurini and Sisyphini. Species of these groups make a brood ball that is rolled away from the pat. The weight of the ball can be up to more than fifty times the weight of the beetle. The process is initiated by one partner and the ball acts as a sexual display to the other sex. The brood ball also may be rolled by two partners, but sometimes the female is transported on the ball. Combat is common between members of the same species when rolling balls. Generally, sexual cooperation finishes when copulation takes place in the burrow, after which the male leaves the female. Females prepare four to five pyriform brood balls and lay eggs in a narrow cavity at the upper end of each pair. The female may abandon the nest after oviposition, such as in Scarabaeini, Canthonini,Gymnopleurini and Sisyphini, or they can remain in the nest until the offspring emerge, as has been described for the African genus *Kheper*.

Finally, there are some species of dung beetles that demonstrate special feeding and nesting biology. They are species using part of the food resources accumulated by other dung beetle species in burrows or a breeding chamber. These species are called kleptoparasites, and examples are found in Aphodiidae and Scarabaeidae. These species live as parasites in the nest prepared by either roller or tunneller dung beetles.

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PROSPECTS OF ORGANIC FARMING IN INDIA

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Organic farming is gaining momentum across the world. Awareness of human health and environmental issues in agriculture has demanded production of safe and environmentally friendly food as an attractive source of farm income generation. While there are trends of rising consumer demand for organic food in India among the wealthiest consumers, sustainability in production of crops has become the prime concern in agriculture development. Even though organic food production has several advantages and growing demand, there are many constraints for its adoption in a country like India. India has potential for organic production and agriculture is the main sector of the economy. The growing and large population limits organic farming, as some say it cannot provide enough food to meet this demand. Use of organic farming in India is therefore a topic of debate.

Definition

According to Codex Alimenarius "organic agriculture is a holistic production management system which promotes and enhances agro ecosystem health, including biodiversity, biological cycles and soil biological activity". The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people (Scialabba and Hattam, 2002). There are many other definitions for organic farming (Lieberhardt, 1989; Lampkin *et al.,* 1999). For a farmer to certify a product an organic he/ she should not use any synthetic input including genetically modified crops. Both organic farming and conservation agriculture are different forms of sustainable agriculture which aim to meet the future food demand without degrading the natural resources. The difference between these two is organic farming restricts the usage of some commercial inputs and use of genetically engineered crops whereas CA does not have such restrictions.

Principles of sustainable farming

- To maintain the long-term productivity of soils.
- To produce foodstuffs of high nutritional quality and sufficient quantity.
- To increase the efficiency of fossil fuel use and research alternative sources of energy.
- To give livestock conditions of life that conforms to their physiological need.
- To make it possible for agricultural producers to earn a living through their work and develop their potentialities as human beings.
- To reduce and minimize environmental degradation by controlling soil erosion and desertification.

Ecological profit of organic agriculture

The impact of organic agriculture on natural resources favors interactions within the agro eco system that is vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient cycling, predation, pollination, habitat and biodiversity conservation and clean water (IFOAM, 1998). Organic farming systems have reportedly better performance in all the environmental impact indicators (floral diversity, faunal diversity, habitat diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residues, GHG emissions, nutrient use, water use and energy use) than conventional systems. There is also a higher consumer health cost with conventional agriculture, particularly in the use of pesticides (Conway and Pretty, 1991).

Safety and quality of organically produced food

There is a growing demand for organic foods driven primarily by the consumer's perceptions of the quality and safety of these foods and to the positive environmental impact of organic agriculture practices (Pell, 1997). There have been many claims that eating organic foods increases exposure to microbial contaminants (Avery, 1998). But studies investigating these claims have no evidence to support them (Pell, 1997; Jones, 1999). Organic foods must meet the same quality and safety standards applied to conventional foods. These include the CODEX General Principles of Food Hygiene and Food Safety Programmes based on the Hazard Analysis and Critical Control Point (HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product). Analysis of pesticide residues in produce in the US and Europe has shown organic products have significantly lower pesticide residues than conventional products (Rutenberg, 2000; Woese et al., 1997; Benbrook and Baker, 2001). Some studies have shown increases in vitamin C, minerals and proteins (Lampkin, 1990), sweeter and less tart apples (Reganold et al., 2001) in organic products than conventional one.

Organic crops had significantly higher levels of all nutrients analyzed compared with conventional produce including vitamin C (27% more), magnesium (29% more), iron (21% more) and phosphorous (14% more) (Worthington, 2001). Generally, organic crops are not protected by pesticides and research has shown that organically produced fruit contain higher levels of phenolic compounds than conventionally grown fruit and contain 10% to 50% more antioxidants than conventional crops (Brandt and Molgaard 2001). Scope of organic farming in India Green revolution and monoculture The need for organic farming in India arises from the unsustainability of agriculture production and the damage caused to ecology through conventional farming practices. It is true that the green revolution saved India from starvation. But the negative consequences include the use of plant protection chemicals like fungicides, insecticides, and herbicides farmers used to protect crops from pest and disease problems.

Scientific surveys and sampling indicate that pesticides sprayed on crops leave harmful residues that are transferred to human and other living bodies through grains, vegetables, fruits and grasses, causing a number of diseases, ailments and harmful effects on our health (Bhattacharyya, 2004). It is not also the amount of pesticides but also the time of application and LD 50 value (LD50 is the amount of a material, given all at once, which causes the death of 50% of a group of test animals) is also important. The other issue is the practice of monoculture (growing the same crop year after year) that can lead to build up of pest outbreaks. But monocropping may be the only option, for example deep water rice in flooded areas. Except for this practice croprotation is recommended. It is also better to rotate a leguminous crop with a non leguminous one. This has the advantage of shifting the pest and disease problem, and the different root architecture in both will help in bringing nutrients deep in the soil to the upper layer (in most of the cases). Another issue is the manufacture of fertilizers and a pesticide, two major inputs, which need energy from fossil fuels to produce, as well as their association with environmental and health issues. Increasing population Increasing global population and decrease in the availability of non renewable resources such as energy, land, and water, creates a real challenge for farmers in the coming years. We are in need of a production system that can meet the growing food demands without degrading the natural resources needed for food production. A sustainable way of crop production is the only way to achieve this target.

Indigenous Traditional knowledge of organic farming

India has a long history of traditional agriculture. It was initiated thousands of years ago when farmers started cultivation using only natural resources. Every farmer used this convention until the introduction of fertilizers and pesticides in the 20th century. This is said to be the traditional agriculture of a country. There is a brief mention of several organic inputs in India's ancient literatures like Rigveda, Ramayana, Mahabharata, Kautilya, etc. India is endowed with various types of naturally available organic forms of nutrients in different parts of the country and they can be used for organic cultivation of crops. There is diversity in environments- climates with respect to rainfall, flat and hill areas, deserts, areas with strong traditional farming systems involving crops, trees and animals, many innovative farmers, vast rainfed lands (approximately 60% of the agriculture land), and areas that use very few chemical inputs. In fact, the rainfed, tribal, north east and hilly regions of the country where negligible chemicals are used have practiced subsistence, organic agriculture for a long period (Bhattacharyya, 2004).

Present status organic farming in India

India of Progress in Organic farming India is bestowed with lot of potential to produce all varieties of organic products due to its various agro climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. According to the "Agricultural and Processed Food Products Export Development Authority" (APEDA) India ranks 10th among the top ten countries in terms of cultivable land under organic certification. The certified area includes 15% cultivable area with 0.72 million Hectare and rest 85% (3.99 million Hectare) is forest and wild area for collection of minor forest produces. The total area under organic certification is 4.72 million Hectare (2013-14).

Table 1: Data for Organic Products (2013-2014)

Total production	1.24 MMT
Total quantity exported	194088 MT

Value of total export	403 Million USD
Total area under certified organic cultivation	4.72 Million hectares
Increase in Export Value over previous year	7.73 approx.

Organic products are exported to US, European Union, Canada, Switzerland, Australia, New Zealand, South East Asian countries, Middle East, South Africa etc. Soybean (70%) lead among the products exported followed by Cereals & Millets other than Basmati (6%), processed food products (5%), Basmati Rice (4%), Sugar (3%), Tea (2%), Pulses and Lentils (1%), dry fruits (1%), Spices (1%) and others.

Constraints in organic farming

Lack of knowledge: Most Indian farmers lack organic crop management knowledge. Many farmers in the country know little about organic farming and its advantages compared to conventional farming methods (Singh et al., 2001). Knowledge about the availability and usefulness of an integrated organic approach to enrich the soil is also vital to increase productivity. Farmers lack the knowledge of recent technologies in compost making. Largely small farmers lack knowledge in proper certification requirements.

Inadequate infrastructure: In spite of the adoption of the NPOP (National programme on Organic Production) during 2000, state governments in India are yet to formulate policies and a credible mechanism to implement them (Narayanan, 2005). There are only four agencies for accreditation and their expertise is limited to fruits and vegetables, tea, coffee and spices. The certifying agencies are inadequate, the recognized green markets are non-existent, the trade channels are yet to be formed and the infrastructure facilities for verification leading to certification of the farms are inadequate (Narayanan, 2005). Farmers adopting organic production methods in India have difficulties to get certification (Certification is the assurance given to the consumer for its safety and quality). Often high amounts of money are involved in the process of certification which depends on the size of the farm, the cost of inspection, reorganization and paperwork done for accreditation which becomes expensive for small farmers. The high cost of certification hinders exports to international markets where higher profits could be obtained but not without being certified. On the other hand farmers have difficulties complying with the standards of certified organic production, especially when these require high initial costs of investment. In India there is no need of certification or labelling for the domestic market. But in the future this may be required. In the absence of regulation, there are many fakes stacked up with authentic ones. Some years back there was also a case of producing GM cotton in the name of organic cotton by the farmers in some districts of Andhra Pradesh. All this happened because of the lack of proper certification.

Higher cost of production: The small and marginal farmers in India have been practicing organic farming in the form of the traditional farming system. They use local or own renewable farm resources and carry on their agricultural practices (Katyal, 2000). Often the larger farms need to get organic inputs from the market. The costs of the organic inputs are higher than those of industrially produced chemical fertilizers and pesticides including other inputs used in the conventional farming system (Kler et al., 2001). Organic inputs are bulkier than synthetic inputs in terms of nutrient content and so cost more labour to transport and spread on the fields. There is also a government subsidy on synthetic fertilizer making them cheaper per unit of nutrient. The groundnut cake, neem seed cake, vermi-compost, silt, cow dung, other manures, etc. applied as organic manure are increasingly more costly making them unaffordable to the small cultivators if they do not have sufficient of their own manure. The organic sources listed above also have other competing uses like cattle feed, fuel etc. which also hinders availability. Absence of appropriate agriculture policy Appropriate agriculture policy in India is vital for national food security including policies related to supply of inputs, promotion of organic farming for export and domestic markets, product and input supplies (FAO, 2003). These are serious issues and a solution for them along with a national consensus is essential for future growth. Formulation of an appropriate policy for organic agriculture that takes concern of these complexities is essential to promote organic agriculture in a big way in India.

Low yields: In many cases farmers experience some loss in yield when switching away from synthetic inputs or conversion of their farming method from conventional to organic. Restoration of full biological activity in terms of growth of beneficial insect populations, nitrogen fixating bacteria and other soil microbes, pest suppression and improved nutrient recycling will take time before these transition yield declines can be reversed (Hanson et al., 1997). It may also take years to make organic production profitable on the farm (Peters, 1994; Liebhardt et al., 1989). Small and marginal farmers cannot take the risk of low yields for the initial 2-3 years when converting to organic farming. There is a need for schemes to compensate them during this transition period if small farmers are to be encouraged to grow organic food. The price premiums on organic products will not be much help, as they will disappear once significant quantities of organic farm products are made available (Narayanan, 2005).

Poor marketing facilities: There is a lack of a marketing and distribution network for organic produce. Often the retailers are not interested in buying organic produce from farmers because of the higher cost and less demand by Indian consumers. This is because the majorities of the people are poor and cannot afford to buy organic products because of its higher price. Lack of cold storage facilities is the other factor which is very important for perishable products like fruits and vegetables. Organic products like fruits and vegetables are more likely to find an organic market than other staple food crops like cereals. India should concentrate on good marketing channels for fruits and vegetables.

Recommendation

To meet the human needs for food in a more efficient and ecologically friendly way it is important to combine both organic and inorganic approaches of crop production. To ensure food and nutritional security, rather than promoting organic farming universally, it would be desirable to carefully delineate areas for organic farming. At this point of time it is important to have a sustainable method of farming to meet the future food demand and at the same time be safe to the environment.To have a sustainable approach that meets food security needs it is better to have an integrated approach; a combination of both organic and inorganic farming.

- Formation of organic agriculture societies through registration.
- Small farmers with potential areas for organic production can increase through group farming system to better avail markets for organic products.
- High value crops like, spices, medicinal plants, fruits and vegetables should be produce.
- Increasing awareness for adopting organic crop production is needed.
- Knowledge in proper certification procedures is important for the future of organic food production.
- The certification process will be made easy so that small farmer can take advantage of it.
- Developed organized marketing system for organic products in rural areas.
- Motivation/ training of farmers for adopting improved organic crop production technologies.
- Provision of consultancy services to the organic agricultural producers.
- Intensification of transfer of technology and extension activities related to profits of organic farming in the rural area.
- Organic agricultural policies that combine increased income generation and improved domestic food production from organic farming are needed.
- Crop and area specific package of practices for organic cultivation should be developed and after thorough on farm validation, recommended for adoption. Such proven packages and practices need to be documented in regional languages. Participatory approaches where farmers can interact and learn in farmer school approaches need to be developed.

Conclusion

India is bestowed with a lot of potential to produce all varieties of organic products due to its various agro climatic regions and traditional knowledge. The export market potential is also increasing. But there are many constraints for organic production in a country like India. Depending upon organic farming to meet food security needs will not be sufficient to meet the food needs of more than 1 billion people. Overcoming constraints and identifying the prime areas and potential hotspots to produce organic products will help India emerge as a good exporter of organic products and increase farm net revenues. To combine a sustainable production system to meet food security needs of India with a healthy environment an integrated approach that combines organic and inorganic methods of crop production is recommended.

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THE WONDERFUL LYCOPENE

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Discovered by Millardet in 1876 from Tomato, the red coloured pigment has been named as lycopene by Schunck, a carotenoid hydrocarbon. The lycopene found in the food matrix are commonly reported to be present in papaya, pink grapefruit, pink guaya, red carrots and watermelon in addition to tomato. However, lycopene is not present in strawberries and cherries. Highly accepted by food industry as food additive and for health benefits the demand of lycopene is increasing manifold as it acts as red colorant and as well as antioxidant agent. Keeping in view the increasing world consumption of lycopene the alternative sources for its production are warranted in order to take out the best from the application of Lycopene.

1. How Lycopene gets into Human body?

Lycopene, like other carotenoids, is a tetrapene (a class of natural products consisting of compounds with a formulae $(C_5H_8)_n$) which is symmetrical in nature and is insoluble in water. The red colour of lycopene is due to its eleven double conjugated double bonds (Fig.1) and owing to its colour it is useful as food colouring.

The bioavailability of lycopene to humans largely depends on the isomeric shape and the *cis* form is more absorbable than *trans* one. The heating of lycopene enriched products changes the *trans* isomer of lycopene to *cis* form and even the sun dried and olive fried turns *cis* form of lycopene into *trans* isomer so that the absorption rate increases manifolds in the human digestive tract. The absorption of the lycopene is more in small intestine than larger one in the human digestive system. Lycopene follows the same absorption process as dietary fat as being the fat soluble compound. The lycopene once in duodenum part of small intestine separated from the food matrix and gets dissolved in the lipid phase which prior to absorption via passive or diffusion process from lipid droplets

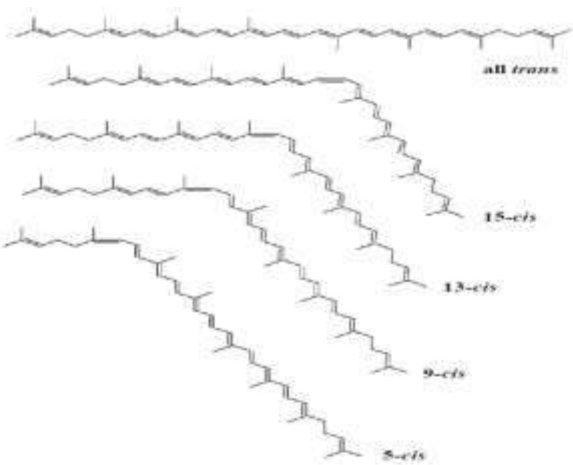

Fig 1: Outline structurer of Lycopene (Source: Agarwal and Roa 1998)

The lycopene is parcelled into triacylglycerol-rich chylomicrons and secreted into lymph transport system, and lastly transferred to the liver, however the presence of lycopene in other tissues has also been reported and lycopene concentration was the highest in human testes, followed by adrenal gland > prostate > breast > pancreas > skin > colon > ovary > lung > stomach > kidney > fat tissue > cervix within the concentration range of 0.2–21.4 n mol/g tissue

2. Lycopene in service to human race

Although not considered as the essential nutrient but the dietary intake of lycopene is recommended because of the reason that it protects lipids, proteins and DNA from oxidative damage, stimulate the modulation of cell growth and also help in increasing immune system and reduce inflammation.

Molecular formula	$C_{40}H_{56}$
Molecular weight	536.85 Da
Melting point	172–175 °C
Crystal form	Long red needles separate from a mixture of carbon disulfide and ethanol
Powder form	Dark reddish-brown
Solubility	Soluble in chloroform, hexane, benzene, carbon disulfide, acetone, petroleum ether and oil; Insoluble in water, ethanol and methanol
Stability	Sensitive to light, oxygen, high temperature, acids, catalyst and metal ions

Table 1: Physical properties of Lycopene (Source: Shi et *al* 2002 In Functional Foods-Biochemical and Processing Aspects: CRC Press: USA, 2002; pp. 135–168)

i. As Antioxidant

Lycopene being prone to oxidation is one of the best antioxidant based on electron transfer reaction. In electron transfer reaction the carotenoids like lycopene generate the radicals, anion radical or alkyl radical, but the Nitrogen dioxide radical and oxidant chloromethylperoxyl may convert lycopene to radical cations as well. Since lycopene lies in close vicinity to the surface membrane thus it is expected that the lycopene be a poor antioxidant due to its limited interaction with the aqueous phase radicals in the lipid bilayer as compared to more polar carotenoids. However, the role of lycopene as a lipid phase antioxidant have its own importance and combinations of other antioxidants with lycopene lycopene has exhibited higher scavenging activity in scavenging of reactive species and also gave a better inhibiting effect towards certain chemicals to reduce their activity which erstwhile are considered not for health system and thus have wide potential for human health and also help in the development of nutritional products which has been in favour for their health benefits. Lycopene as the first defence system of cells is important in inhibiting lipid radicals at membranes.

ii. Effect of Lycopene toward Diseases

Lycopene has been shown to have the protective effects on oxidative stress, cardiovascular disease, hypertension, atherosclerosis, cancers, diabetes and others. Reports have been put forth regarding lycopene-rich diet and lycopene supplementation provided protective effects against DNA damage in both normal and cancerous human cells. Study has shown a high plasma level of lycopene was associated with a decreased risk of Cardiovascular diseases particularly in women. The circulating plasma lycopene is believed to atherosclerosis in smokers, reduced the formation of atherosclerotic plaques significantly in the aorta and improved lipid profiles in high-fat diet. Lycopene is reported to reduce the risk of cancer incidences worldwide and has also shown chemopreventive effects of in liver and ovary cells. The other beneficial health related actions of lycopene in improving the impairment of other diseases are indicated in table 2

Lycopene doses	Method	Impairment	Improvement
0.2 mg/kg b.w. daily	*In vivo*–rats	Cataract	Significant delayed in the onset and progression of galactose cataract and reduced the incidence of selenite cataract.
2.5, 5 and 10 mg/kg b.w. daily	*In vivo*–rats	Cognitive function	Significant improved in memory.
60 mg/kg b.w. daily	*In vivo*–hyperlipemia rabbits	Lipid peroxidation injury	Significant reduced in the levels of serum TG and MDA, increase serum SOD activity, increase serum NO.
0.1, 0.5, 1, 2 g/kg b.w. daily	*In vivo*– mouse ear oedema model	Swelling	Decreased swelling of the croton oil-induced ear.
0, 5 and 10 µg/mL carried by liposomes	*In vitro*–Calu-3 cells	Inflammation of cells infected by rhinovirus or exposed to lipopolysaccharide	Reduced the release of interleukin-6 and interferon-gamma induced protein-10.
8 or 16 mg/kg/day by i.p. injection	*In vivo*–murine model of asthma	Ovalbumin-induced inflammation	Significant inhibition of the infiltration of inflammatory immunocytes into the bronchoalveolar lavage.
2 mg twice daily	*In vivo*–primigravida women	Pre-eclampsia and intrauterine growth retardation	Significant reduced in pre-eclamsia incidence and intrauterine growth retardation in the lycopene group compare to placebo group.
9 mg/kg b.w. twice a day for 2 weeks	*In vivo*–rats	Chronic bacterial prostatitis	Significant decreased in bacterial growth and improvement of prostatic inflammation.
0.025–2 mg per 20 mg b.w.	*In vivo*–white heterozygote mouse	X-ray radiation lesions	Moderate curative effect on the radiation lesions and increased survival rate

Table: 2: Action of lycopene in improving the impairment of other diseases
(Source: Kong et al., Molecules 2010, 15, 959-987; doi:10.3390/molecules15020959)

3. Market trend of Lycopene

Due to increasing number of benefits offered by lycopene in preventive healthcare, dietary, food products, personal care, cosmetics and pharmaceuticals, and its rising applications in various industries across the globe are driving the lycopene market and the lycopene market is estimated to be valued at USD 126 million in 2020 and is expected to grow USD 161 million by 2025. Besides the increasing demand and usage of lycopene is exposing its widespread properties, thus, empowering manufacturers to bring more innovation to the products to increase the market share. With the result the Asia Pacific region is projected to be the fastest-growing market although the European region dominated the market in 2019. There are different factors which are driving the Asia Pacific market growth. The Lycopene-Rich By-Products from Food Processing is also providing a helping hand to cope the market of the lycopene and providing a healthy competition in the market.

4. Future Strategy

With the advent of target delivery carriers the application of several of novel lycopene delivery carriers are on the rise including nanoemulsions, nanostructured liposomes, and polymer nanoparticles for various diseases prevention like cancer with future needed development. In addition, the synergistic mechanism between lycopene and other nutrients or drugs and novel delivery systems of lycopene are now deeply investigated to improve its clinical application in various diseases intervention in the future and are the need of an hour.

Note: The contents of this article have majorly reproduced from the documentary literature available in the references as mentioned in this article.

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IRIDESCENCE IN INSECTS

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Introduction

Goniochromism ascribes several creatures from sparkling terrestrial beetle *Charidotella sexpunctata* to marine *sapphrinid copepods* in the Blue Planet. Iridescence provides the ability to produce short reflecting wavelengths ranging from blue to green, enabling the job ease. Iridescence is the property of changing surface colour with viewing angle and one of the quintessential phenomena in animal kingdom evolution, predominantly in Insects. For the survival of the fittest, these six-legged engineers retain the crown of puzzling physics phenomena over the last million years, and these miniatures perfected to harvest a wide variety of hues independent of illumination intensity, leveraging broad techniques such as reflection, interference, diffraction, dispersion, refraction, etc., by exploiting its structural and pigmentary integument for aposematic display and attract a mate in the ambient spectral environment. Besides opalescence, some butterflies are believed to generate a neural image, based on the relative percentage of polarization reflectance and ultraviolet pattern from their environment for location and acquisition of food resources, appropriate oviposition sites and conspecific as well as interspecific communication (Weiss and Papaj, 2003). Earlier scientists claimed that iridescence attracts the potential sex and warns predators by Mullerian and Batesian mimicry. Nevertheless, a counterintuitive hypothesis was proposed as they also act as camouflage (Kjernsmo *et al*., 2018) this notion was emphasized by the experiment's findings at the University of Bristol School of Biological Science. Due to the pigments and nanomorphology of integumentary tissues, the iridescence mechanism is broadly categorized.

Pigmentary Colours

The chemical compounds coin the pigmentary colours, which are accentuated in many species and materials. Blue pigments were hardly present in animal taxa except for some molluscs, crustaceans, and arachnids. These principle compounds scatter the unabsorbed light from its surface and comparatively less effective than structural phenomena due to their diffuse scattering. In comparison, the colour remains non-iridescence, however promoting heterotherm insects and ideal camouflage. Owing to the cumulative geometric effect of scales, selective absorption or selective reflection of light by a pigment creates matte colours distinct from the vivid metallic appearance of *Lycaena phlaeas*. The shorter wavelengths were scattered, whereas the longest being transmitted and eventually absorbed by the deep layers in the case of *Lycaenidae,* contrary to *Pierida* (Berthier, 2017). Papilionid butterfly wing scales harbour a distinctive class of pigments, the papiliochromes, which act as a spectral filter (Wilts *et al*., 2015). The chemical structures of these pigments are often vulnerable to environmental pressures. *Polyommatus icarus* butterflies ventral wing experiences colour alteration relative to its frosty environment (Kertész *et al*., 2017). Some insects are also described for fluorescence and bioluminescence, as in *Sternotomis virescens* and Firefly respectively.

Structural Colors

The chitin molecule in the integument consists of long-chain N-acetylglucosamine monomers forming microfibrils coated with a proteinic matrix, resulting in layers parallel to the epicuticle (Berthier, 2017). This framework, including helicoid structures and photonic crystals, appears to form complex configurations. The dazzling structural colours are designed by the interaction of light on the boundary between the media of differing refractive index, made up of a stunning plethora of nanoarchitecture arrangement, reflecting and refracting light directionally by interference or diffraction. Diffraction is the product of periodicity gratings and the incident wavelength. Sometimes the lateral flanges in scales function as thin-film stacks to produce iridescence. Also, structural colours rely on the thickness, orientation and optical index of single or multilayer scales. *Lycaena phlaeas* scales – cover and ground scales differ in length with the same thickness. Incidence of absolutely unpolarised light on the anisotropic mesoscale structure on or above the Brewster angel results in reflection of completely polarised light whereas polarised incident light tends to transmit or reflect based on the arrangements, facilitating in conspecific and interspecific communication. Also, the higher refractive index (RI) of structure positively correlated to higher wavelength reflection. The surface becomes transparent when the index of two mediums is merely equal, which can be accomplished either by optical impedance matching or direct matching. Some Insects have localized nanostructure and a relatively thin film of chitin layer to mould the transparency-Dragonflies and cicadas (Schroeder *et al*., 2018). Generally, quite similar properties were observed between the iridescent scale and thin-film colour. Spectacular outcomes always proceed from a subtle mix between the two phenomena, the two reinforcing each other (annihilating or combining). Eg. Upper lamella hides the iridescence of lower lamella when the incidence approaches grazing angle in *Lycaena icarus*. *Morpho godarti* structural scales hardly contain any pigment and when an index match is achieved, they turn transparent, revealing ventral side patterns (Berthier, 2017).

Conclusion

The iridescent and non-iridescent structural colours are fundamentally formed from the coherent scattering but vary significantly in their nanostructural origin (Prem, 2006) and intensively effective than pigmentary colours under varying circumstances. Gleaming insects surfaces are often seen as synonymous with elegance, which potentially teaches the researchers and engineers over time for numerous innovations. Still, the roots and evolution of these nanostructural integuments of their progress remain anonymous. Apart from lighter, more robust and flexible properties of insect covering, Insect taxonomy is a fortune to grip the source of crucial iridescence to helps in attracting partners, camouflage, thermoregulation by absorption or heat dispersion (e.g. *Koscuiscola*), gender superiority as in *Phanaeus vindex* horned dung beetles to highlight the size of the iridescent horn and prothoracic shield, water repellent and ward off predators. These motifs are evolutionarily correlated with their surroundings, making insects omnipresent in our diversified ecosystem.

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IMMUNE PRIMING IN INSECTS – A SECRET WEAPON OF THE INSECT WORLD

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Introduction

Immune priming is the prior exposure of sub – lethal dose of a pathogen / Anti – microbial agents / thermal stress / trans generational immune memory which leads to increased immunity and production of Anti – microbial peptides. Immune priming in insects has the advantage of giving protection from a subsequent potentially lethal infection. Immune priming can be recognized by an increase in the density of circulating hemocytes and abundance of AMPs in the insect hemolymph. The increased hemocyte density arises from the activation of sessile hemocytes which are normally attached to the inner surface of the cuticle rather than de novo synthesis and an increased density of circulating hemocytes has been correlated with protection from infection. There are three types of immune priming

- Exposure to Anti – microbial agents
- Thermal / Physical stress
- Trans – generational Immune priming

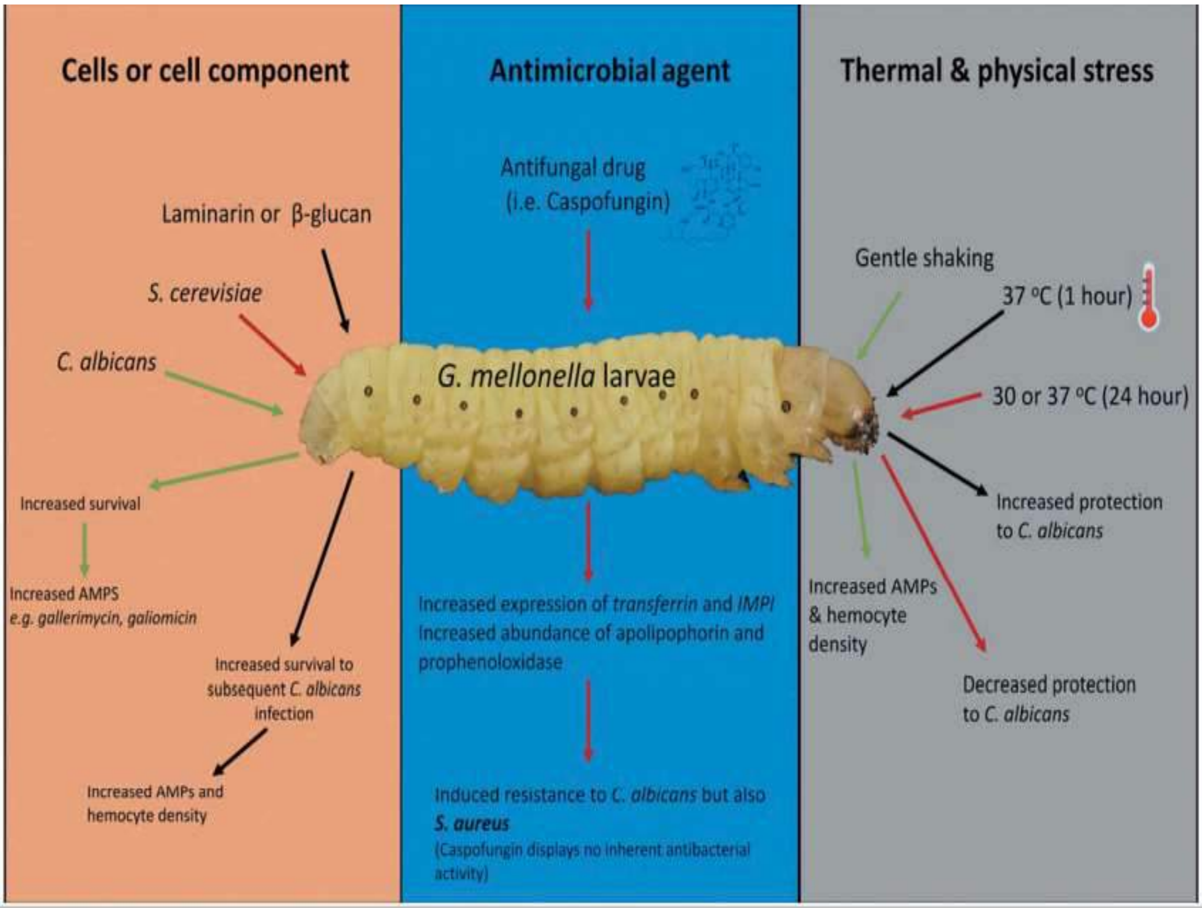
Immune priming through introduction of anti – microbial agents

Larva of *Galleria mellonella* is highly susceptible to infection by *Candida albicans*. Introduction of Capsofungin into the hemocoel of *G. mellonella* larvae can trigger an increased immune response and resistance to infection by *C. albicans*. Enhanced larval survival was seen in *G. mellonella* larvae administered with caspofungin. The increased resistance was mediated by an elevated hemocyte density and expression of genes coding for transferrin, apolipophorin and prophenoloxidase due to the administration of caspofungin. Administration of caspofungin also resulted in increased resistance to *Staphylococcus aureus* infection even though caspofungin has no inherent antibacterial activity. This indicated that immune priming resulted in generalized immune response against both fungal and bacterial infections.

Immune priming by subjecting to thermal and physical stress

Physical factors such as incubation temperature or agitation can also induce immune priming. Gentle shaking *G. mellonella* larvae in cupped hands for a short period of time resulted in disruption of integrity of the gut epithelium allowing bacteria to enter the hemocoel. The entry of bacteria led to increase in the expression of AMPs in the haemocoel of *G. mellonella.*

Alterations in incubation temperature can induce immune priming. Incubation of larvae at 37 ° C for 1 hour leads to increased protection against subsequent infection by *C. albicans*.



Trans – generational immune priming in insects

A form of immunological memory in insects has been identified and is known as Transgenerational Immune Priming (TgIP). TgIP involves the passing of a protective effect from the parent insect to its offspring. The *Paenisbacillus* fungal infection is lethal to the honeybee, *Apis melliferia*. When queen bees were infected with heat killed *Paenisbacillus* larvae, the offspring showed a 26 % reduction in larval mortality when compared to the progeny of untreated queens. The offspring of immune primed honeybees contained a threefold increase in the level of differentiated hemocytes which are involved in the production of AMPs. Thus immune priming proved to be effective until the succeeding generation.

Conclusion

Compounds with no inherent antimicrobial activity (glucan, LPS) can trigger immune priming and render an insect resistant to a pathogen. This can be used as an adaptive advantage in the management of diseases in productive insects and prove to a milestone in innovation science. Also, immune priming is possible only in few insects. Research has to be done to carry out immune priming especially in productive insects.

"Save productive insects from pathogens through immune priming"

Silkworm

Honey bees

Lac insect

Reference

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BIOLOGICAL CONTROL AS A TOOL OF PLANT DISEASE MANAGEMENT IN ORGANIC FARMING

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Introduction

Organic agriculture has increased in importance worldwide over the past 20 years, with growth rates of more than 10% per year in many countries. By 2014, approximately 2 million certified organic producers farmed more than 43 million hectares of certified organic agricultural land. Organic crop production is partially characterized by the absence of synthetic pesticides and fertilizers, but practices that promote ecosystem health are even more important. The emphasis is mainly on the application of naturally occurring antimicrobial organic substances also application of antagonistic microorganism as tools for sustainable productivity and management of pests, diseases, and weeds.

What is Biological control

Biological control is a mechanism in which the natural enemies to diminish the number of destructive organism, which could be in any form, small bacterium to large animals. This mechanism includes the use of predators, competitors, pathogens and compounds of biological origin.
According to Garret (1965), "Biological control of plant disease may be precisely defined as any condition or practice whereby survival or activity of a pathogen is reduced through the agency of any living organism (except man himself) with the result that there is reduction in incidence of the disease caused by the pathogen."

Why Biological control

Biological control is eco-friendly, and the diversified microbial world provides endless resources for biologically active molecules which can stably inhabit the environment as non dominant species but maintain their effectiveness in suppression of plant pathogens.

Advantages of biological control

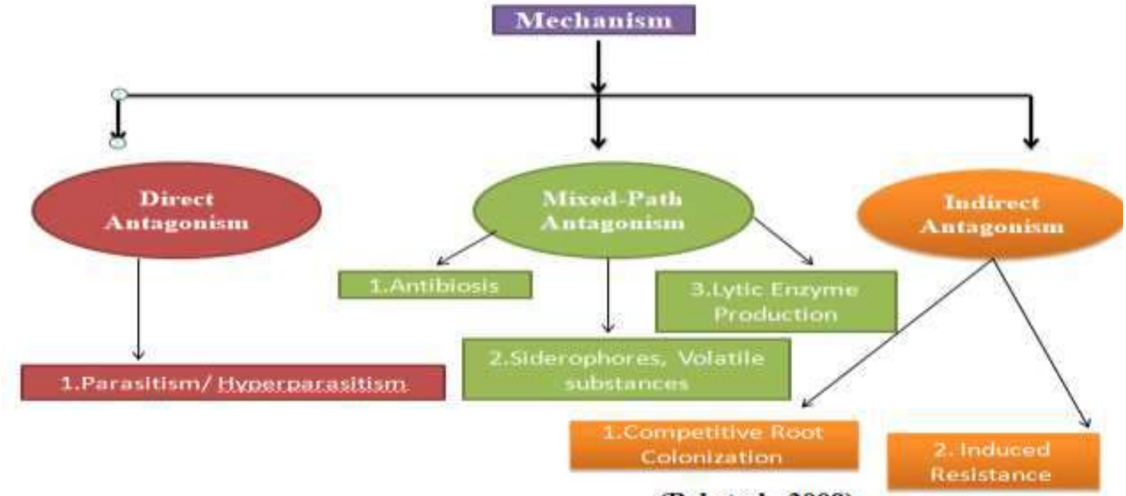
- It is comparatively easier to manufacture biocontrol agents.
- It can eliminate the specific pathogens effectively from the site of infection and can be used in combination with biofertilizers.
- Biocontrol agents are very effective for a large number of soil-borne pathogens.
- Biocontrol agents do not cause any toxicity to the plants.
- Biocontrol agents avoid problems of resistance.
- Biological control is self-regulating and helps to preserve the ecosystem.

Disadvantages of biological control

- Biocontrol agents work slowly.

- No Broad spectrum activity.
- The antagonists and shelf life of biocontrol agents are short. For example, the shelf life of *Pseudomonas fluorescens* is 3 months and of *Trichoderma viri*de is 4 months only.
- Skilled persons are also required for multiplying and supplying the biocontrol agents without contamination

Mechanisms of Biological Control



(Pal et al., 2009)

Hyper parasitism

Hyperparasites are the agents that are parasites of harmful plant pathogens. They reduces the disease producing capacity of the pathogens by involving direct physical contact with the pathogen and causes hyphal lysis. Sclerotia or may parasite growing hyphae by coiling around them. The mycoparasites penetrates resting structure. A classic example is the Hypovirus, a hyperparasitic virus on *Cryphonectria parasitica*, a fungus causing chestnut blight.

Antibiosis

Antibiosis came from the term Antibiotics which refers to organic substances produced by microorganisms that affect the metabolic activity of other microbes and growth. Many organisms especially soil fungi and actinomycetes produce antibiotic substances. The result of antibiosis is often death of microbial cells by endolysis and breakdown of the cell cytoplasm. *Agrobacterium radiobacter* K-84, produced commercially as Agricon 84, was first recognized as a valuable control agent of crown gall since 1973.

Siderophores

Siderophores are ligands with low molecular weight having high affinity to sequester iron from the micro-environment. It has the ability to sequester ferric ion and competitively acquire iron from iron-limiting environment thereby preventing growth of other microorganisms. Two major classes of siderophores, classified on the basis of their functional group, are catechols and hydroxamate. A mix of carboxylate-hydroxamate group of siderophores is also reported. Numerous strains of *Streptomyces spp*. have been reported as siderophore producers, namely, *S. pilosus* . *Pseudomonas fluorescence* produces Ferribactin, pyoverdine, pseudobactin which have high affinity towards ferric ion.

Volatile substances

Apart from the production of antibiotics, some biocontrol agents are also known to produce volatile compounds as tools for pathogen inhibition. Common volatile compounds are hydrocyanic acid (HCN), certain acids, alcohols, ketones, aldehydes and sulphides. HCN production is reported to play a role in disease suppression, for instance. HCN production by strains of *P. fluorescens* that helped in the suppression of black root rot of tobacco.

Lytic Enzyme

Many microorganisms secrete and excrete lytic enzymes that can hydrolyse a wide range of polymeric compounds, including hemicellulose, cellulose, chitin, DNA and proteins. *Serraia marcescens ,Streptomyces scabies* was found to be inhibitory against *Sclerotium rolfsii, Fusarium spp.*

Competitive Root Colonization

From the microbial perspective, living plant surfaces and soils are often nutrient restricted environments. Nutrient limitation is an important mode of action of some biological control agents. Carbon plays an important role for competition of root colonization for nutrients such as *Trichoderma spp*. Carbon competition between pathogenic and non-pathogenic strains of *F. oxysporum* is one of the main mechanisms in the suppression of *Fusarium* wilt. Ability of bio control agents to colonize specific substrates or sites provides protection to infection site from pathogen attack.

Plant Growth Promotion Through SAR and ISR

Chemical stimuli are produced by some biocontrol agents, i.e. non-pathogenic plant growth-promoting rhizobacteria (PGPR) and fungi (PGPF), or by soil- and plant associated microbes. Such stimuli can either induce a sustained change in the plants which increase the capacity of tolerance to infection by pathogens or induce the local and/or systemic host defences of the whole plant against broad-spectrum pathogens. This phenomenon is known as induced resistance. Two types of induced resistance are distinguished in plants, systemic acquired resistance (SAR) and induced systemic resistance (ISR). The first of the two pathways is mediated by salicylic acid (SA) which is frequently produced after pathogen infection and induces the expression of pathogenesis-related (PR) proteins that include a variety of enzymes. The second method is mainly Jasmonic acid (JA) and/or ethylene mediated following the applications of some nonpathogenic rhizobacteria.

Table 1

Mechanism	Biocontrol agent	Target pathogen
1.Hyperparasitism	*Phlebiopsis gigantea*	*Heterobasidion annosum*
	Ampelomyces quisqualis	*Powdery mildew fungi*
	Trichoderma	*Rhizoctonia, Sclerotium*
2. Siderophore	*Pseudomonas fluorescence 3551*	*Pythium ultimum*
	Pseudomonas putida WCS 358	*Fusarium oxysporum f. sp. raphani*
3.Volatile substances	*Pseudomonas putida N1R*	*P. ultimum*
4.Competitive Root Colonization	*E. herbicola*	*Erwinia amylovora*
	Pseudomonas spp	*Botrytis cineria*
	Trichoderma spp	*Rhizoctonia solani*

Table 2

Mechanism	Antibiotic	Biocontrol agent	Target pathogen
5. Antibiosis	**Agrocin 84**	*Agrobacterium radiobacter*	*Agrobacterium tumefaciens*
	Gliotoxin	*Trichoderma virens*	*Rhizoctonia solani*
6.Lytic enzyme	**Chitinases**	*Arthrobacter sp*	*Fusarium sp.*
	Glucanases	*Streptomyces sp.*	*Phytophthora fragariae*

Conclusion and Future Prospects

The last century witnessed the rise of chemical pesticides and fertilizers, but only recently the hazardous effects of the injudicious use of these toxic pesticides and fertilizers have been observed. Thus it almost became a necessity to explore either the stress-tolerant stains of biocontrol agents or to produce them through biotechnological interventions. Sequencing of both agriculturally important and harmful genes of Biocontrol agents is advocated for strain improvement. The Biocontrol agent plant molecular interaction should be provoked, which will lead to functional understanding of underlying molecular mechanisms of biocontrol. Currently, biggest hindrance in commercialization of BCAs is their poor shelf life. Thus, it would be of utmost importance to develop formulations with improved shelf life.

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SILK AND ITS USE

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Abstract

Silk is a natural, environmentally-friendly fibre with a remarkable range of properties, making it ideal for use in apparel and many other applications. Silk constitutes about 3% of the world textile trade. More than 30 countries produce silk, and India's share in global raw silk production is nearly 17.5% behind China (79.10%). Silk–one of Nature's most intriguing materials in terms of its strength, toughness, and biological role–in its various forms, from protein molecules to webs and cocoons.

Key words: Silk, Types, Properties and Uses

Introduction

Silk is a natural protein fiber, some forms of which can be woven into textiles. The protein fiber of silk is composed mainly of fibroin and is produced by certain insect larvae to form cocoons. The best-known silk is obtained from the cocoons of the larvae of the mulberry silkworm *Bombyx mori* reared in captivity (sericulture). The shimmering appearance of silk is due to the triangular prism-like structure of the silk fibre, which allows silk cloth to refract incoming light at different angles, thus producing different colors.

Types of silk

Mulberry silk

Bulk of the commercial silk produced in the world comes from this variety and often generally refers to mulberry silk. Mulberry silk comes from the silkworm, **Bombyx mori** L which solely feeds on the leaves of mulberry plant. These silkworms are completely domesticated and reared indoors. Mulberry silk contributes to around 90 percent of the world silk production.

Tasar silk

The tasar silkworms belong to the genus *Antheraea* and they are all wild silkworms. There are many varieties such as the Chinese tasar silkworm *Antherae pernyi* which produces the largest quantity of non-mulberry silk in the world, the Indian tasar silkworm *Antheraea mylitte* next in importance, and the Japanese tasar silkworm *Antheraea yamamai* which is peculiar to Japan and produces green silk thread. The Chinese and Japanese tasar worms feed on oak leaves and other allied species. The Indian tasar worms feeds on leaves of Terminalia and several other minor host plants. The worms are either uni- or bivoltine and their cocoons like the mulberry silkworm cocoons can be reeled into raw silk.

Eri silk

These belong to either of two species namely **Samia ricini** and **Philosamia ricini** (also called as castor silkworm) is a domesticated one reared on castor leaves to produce a white or brick-red silk popularly known as Ahimsa silk. Since the filament of the cocoons spun by these worms is neither continuous nor uniform in thickness, the cocoons cannot be reeled and, therefore, the moths are allowed to emerge and the pierced cocoons are used for spinning to produce the Eri silk yarn.

Muga silk

The muga silkworms (*Antheraea assamensis*) also belong to the same genus as tasar worms, but produce an unusual golden-yellow silk thread which is very attractive and strong. These are found only in the state of Assam, India and feed on *Persea bombycina* and *Litsaea monopetala* leaves. The quantity of muga silk produced is quite small and is mostly used for the making of traditional dresses in the State of Assam (India) itself.

Anaphe silk

This silk of southern and central Africa is produced by silkworms of the genus Anaphe: *A. moloneyi* Druce, *A. panda* Boisduval, *A. reticulate* Walker, *A. ambrizia* Butler, *A. carteri* Walsingham, *A. venata* Butler and *A. infracta* Walsingham. They spin cocoons in communes, all enclosed by a thin layer of silk. The tribal people collect them from the forest and spin the fluff into a raw silk that is soft and fairly lustrous. The silk obtained from *A. infracta* is known locally as "book", and those from *A. moleneyi* as "Trisnian-tsamia" and "koko" (Tt). The fabric is elastic and stronger than that of mulberry silk. Anaphe silk is used, for example, in velvet and plush.

Fagara silk

Fagara silk is obtained from the giant silk moth *Attacus atlas* L. and a few other related species or races inhabiting the Indo-Australian bio-geographic region, China and Sudan. They spin light-brown cocoons nearly 6 cm long with peduncles of varying lengths (2-10 cm).

Coan silk

The larvae of *Pachypasa atus* D., from the Mediterranean bio-geographic region (southern Italy, Greece, Romania, Turkey, etc.), feed primarily on trees such as pine, ash cypress, juniper and oak. They spin white cocoons measuring about 8.9 cm x 7.6 cm. In ancient times, this silk was used to make the crimson-dyed apparel worn by the dignitaries of Rome; however, commercial production came to an end long ago because of the limited output and the emergence of superior varieties of silk.

Mussel silk

Mussel silk is obtained from a bivalve, *Pinna squamosa*, found in the shallow waters along the Italina and Dalmatian shores of the Adriatic. The strong brown filament, or byssus, is secreted by the mussel to anchor it to a rock or other surface. The byssus is combed and then spun into a silk popularly known as "fish wool". Its production is largely confined to Taranto, Italy.

Spider silk

Spider silk – another non-insect variety – is soft and fine, but also strong and elastic. The commercial production of this silk comes from certain Madagascan species, including **Nephila madagascarensis, Miranda aurentia** and **Epeira.** As the spinning tubes (spinne-rules) are in the fourth and fifth abdominal segments, about a dozen individuals are confined by their abdominal part to a frame from which the accumulated fibre is reeled out four or five times a month. Because of the high cost of production, spider silk is not used in the textile industry; however, durability and resistance to extreme temperature and humidity make it indispensable for cross hairs in optical instruments.


Mulberry silk


Tasar silk


Eri silk


Fagara silk

Types of silk


Muga silk


Coan silk


Mussel silk


Anaphe silk

Properties of the silk

Silk contains 70-75% fibroin and 25-30% sericin protein. The biochemical composition of fibroin can be represented by the formula $C_{15}H_{23}N_5O_6$. It has the characteristic appearance of pure silk with pearly lustre. It is insoluble in water, ether or alcohol, but dissolves in concentrated alkaline solutions, mineral acids, and glacial acetic acid and in ammoniacal solution of oxides of copper. Sericin, a gummy covering of the fiber is a gelatinous body which dissolves readily in warm soapy solutions and in hot water, which on cooling forms a jelly with even as little as 1% of the substance. It is precipitated as a white powder from hot solutions by alcohol. Its chemical formula is $C_{15}H_{25}N_5O_8$. It can be dyed before or after it has been woven into a cloth. The weight in gram of 900m long silk filaments is called a **denier** which represents size of silk filament.

Silk has following peculiar properties

- Natural colour of Mulberry silk is white, yellow or yellowish green; that of Tasar brown; Muga is light brown or golden and Eri is brick red or creamy white or light brown.
- Silk has all desirable qualities of textile fibres, viz. strength, elasticity, softness, coolness, and affinity to dyes. The silk fibre is exceptionally strong having a breaking strength of 65,000-lbs/sq. inch.
- Silk fibre can elongate 20% of original length before breaking.
- Density is 1.3-1.37g/cm^3.
- Natural silk is hygroscopic and gains moisture up to 11%.
- Silk is poor conductor of heat and electricity. However, under friction, it produces static electricity. Silk is sensitive to light and UV- rays.
- Silk fibre can be heated to higher temperature without damage. It becomes pale yellow at 110° C in 15 minutes and disintegrates at 165° C.
- On burning it produces a deadly hydrocyanic gas.

Uses of silk

Man adores the natural fabrics from time immemorial. Silk had a prestigious place in the culture and commerce of India in the Pre-Vedic age. Silk term speaks about mulberry silk only. It is soft smooth, lustrous and holds a prestigious place among textile fibres and known as '*Queen of Textiles*'. Bulk of silk fibres produced is utilized in preparing silk clothes. Uses of pure silk are decreasing gradually due to its high cost value and costly maintenance. Production of synthetic fibres has posed a serious threat to the silk industry. Clothes in which Silk fibres are combined with other natural and synthetic fibres are in great demand not only in India but also in foreign countries. Seeing this demand many textile industries are manufacturing clothes like Teri-silk, cotsilk etc. Besides silk being used as garments it is also used in other industries and for military purposes.

- It is used in the manufacture of fishing fibres, cartridge bags, insulation coils for telephones and wireless receivers, filter clothes for flour mills, and in medical dressings and suture materials.
- Spun silk is used for dress materials and the coarse variety for making scarves, chaddar, shawls and quilts.
- Garments in various weaves like plain, crepe, georgette and velvet.
- Knitted goods such as vests, gloves, socks, stockings.
- Silk is dyed and printed to prepare ornamented fabrics for saries, ghagras, lehengas and dupattas.
- Jackets, shawls and wrappers.
- Caps, handkerchiefs, scarves, dhotis, turbans.

- Quilts, bedcovers, cushions, table-cloths and curtains generally from Eri-silk or spun silk.
- Parachutes and parachute cords.
- Sieve for flour mills.
- Artillery gunpowder.

Conclusion

Silks arguably are the quite remarkable materials in nature. As evolved, they are exemplary models of material efficiency and function, with lightweight mechanically robust systems that exist in virtually any environment on the planet. With the advances in silk in high technology applications and the growing insight into the origins of the unique properties, silk serves as a nucleus of inquiry into the future.

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PLANT GROWTH REGULATORS IN VEGETBLE CROPS

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Introduction

Plant growth substances or plant growth regulators are the chemical compounds that are organic, regulating or modifing the physiological process in some appreciable measure in the plant when used in certain concentrations. They are easily absorbed and can move rapidly through the tissues when applied to different parts of plant. These compounds are specific in action and the response of plants to application depends up on their concentration (Meena, 2015).

Some of the specific characteristics to call them as hormones

1. They must be organic substances
2. They are endogenously produced in the plants
3. Generally translocate to the site of synthesis to the site of action
4. At low concentrations it must regulate plant physiological processes
5. They are ubiquitous

Classification of plant growth regulators

They are broadly classified into —

A. Endogenous plant growth regulators

Hormones	Other substances
• Auxins	• Phenolics
• Gibberellins	• Phytoalexins
• Cytokinins	• Phytotoxins
• Abscissic acid	• Tricontanol
• Ethylene	• G-substances
• Brassinosteroids	• Allelo chemicals
	• Poly amines

Auxins: Stimulates cell elongation and often used to stimulate the initiation of adventitious roots cuttings. Eg: NAA, IBA, 2,4-D, 2,4,5-T etc.

Gibberilins: Stimulate the cell elongation and aids in seed germination. Eg: GA_3.

Cytokinins: Stimulates cell division, it is important in shoot initiation and branching of plants. Eg: Zeatin, BA-6, Isophentyl adenine etc.

Abscissic acid: In general, it inhibits the action of growth promoters. It is considered as a hormone, synthesized in large concentrations during moisture stress, high temperature, saline conditions etc.

Ethylene: At a physiological temperature, ethylene in its pure form is a gas. It is an ageing hormone frequently used for stimulating ripening of fruits and to promote senescence. Eg: Ethephon.

Brassinosteroids: They are considered as a hormone because of its hormonal characteristics that was recognized during 1997.

B. Synthetic plant growth regulators: NAA, CCC, Paclobutrazol, SADH, Mapiquat chloride.

Methods of application

- Lanolin paste
- Immersion into concentrated or dilute solutions
- Spraying technique
- Dust method
- Aerosal and vapour method
- Soil application

Growth regulators and the chemicals in vegetable production

In vegetable crops, the PGR and the chemicals are known to be effective for seed germination, growth, tuberization, flowering, fruit and seed development, fruit ripening and yield etc (Prajapati *et al.*, 2015).

Seed germination: The seed treatment before sowing with the growth regulators reported to improve the seed emergence.

Brinjal - GA at 40mg/1 and NAA at 25m for 24 hours improved germination.

Okra - GA at 10mg/litre or NAA 100ntg/1 soaking 24 hours enhances seed germination.

Seed dormancy: Major problem in potato, where the freshly harvested tubers fails to sprout before termination of the resting period. Growth regulators and the chemicals that are reported to break the resting period are Thiourea, GA, etc.

Seedling treatment: Seedling root dip at transplanting is found effective for reducing the transplanting shock and also improves seedling growth. NAA or IBA at 1mg/1 for 6 hours in case onion seedlings are been used.

Flowering: Production of the flowering in the plants that fails to flower has also been reported with the use of several plant growth regulators. GA application at 50mg in young leaves at the non-flowering varieties of potato, when the floral buds has just formed, results in the flower induction.

Sex expression: Growth regulators treatments changes the expression in pepper, okra and cucurbits. In cucurbits, the exogenous gibberellins application induces male flower production. NAA at the concentration of 25-100ml is found to be effective in increasing the female flowers in bottle gourd, muskmelon, cucumber, bitter gourd, watermelon and ridge gourd. Spraying IBA at 25-100mg/1enhances the number of female flowers in squash melon, muskmelon, bottle gourd and watermelon. Silver nitrate application induces the male flowers for producing gynoecious lines in cucumber.

Gametocides: Some of the PGR induces gametocidal action for producing sterility that are used for producing F_1 hybrid seeds. Maleic Hydrazide at 100-500mg/l is used in tomato, peppers and okra.

Hybrid seed production: PGR helps in hybrid seed production. GA_3 induces staminate flowers in the gynoecious lines. Silver nitrate at the rate of 500mg induces male flowers in cucumber gynoecious lines. In muskmelon, the silver thiosulphate at 400mg induces the male flowers in gynoecious lines.

Fruit set: Poor fruit set is a major problem that are observed in brinjal, tomato and chillies, that are frequently caused due to the adverse weather conditions during the time of flowering, PGR have reported to enhance the fruit set under both normal and adverse weather conditions. GA_3 at 10mg/1 or 2,4-D at 5mg/1 or NAA 10mg/l during flowering time aids fruit set

Fruit ripening: Ethephon an ethylene releasing compound has been reported to enhance ripening in pepper and tomato. Field application of the ethephon at the rate of 1000mg/l at turning stage induces early ripening of fruits thus increasing early fruit yield by 30 to 35%. Post haverst dip treatment with ethephon at rate of 500-2000mg/1 induces ripening in mature green tomatoes.

Fruit yield: Application of chemicals and growth regulators increases fruit yield. In muskmelon, foliar sprays of NAA at 25mg/1, bottle gourd - TIBA at 50mg/l, pumpkin ridge gourd and squash 250mg/1 of ethephon, potato soaking of seed tubers at 500mg./1 of CCC are known to increases the fruit yield.

Sprouting, storage and shelf life: Postharvest treatment of potato tubers with MENA as vapours or dust and CIPC at 5000mg/l as dip treatment is most effective for reducing losses from sprouting and rotting under ordinary storage. Field application of 2, 4, 5-T at 75mg/1, 1-7 days before the harvest were also effective.

Disease resistance: Foliar sprays of CCC at 50mg/1 or 2,4-D at 50mg/1 reported to reduce the nematode severity in tomato whereas, the foliar spray of CCC at 200mg/1 to nursery reduces their severity to leaf curl virus.

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NUTRIENT DEFICIENCIES IN VEGETBLE CROPS

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Introduction

Nutrition to the vegetable crops can be provided through organic matter or by chemical fertilizers. For the vegetable production both organic and inorganic manure are in use but inorganic *i.e.,* the chemical fertilizers are preferable over the organic manures since, the chemical fertilizers provides the nutrient(s) very rapidly. The nutrients required by the plants in larger quantities are reffered to major or macro nutrients. These are nine in number *viz.,* nitrogen, phosphorous, potassium, magnesium, sulphur, calcium, carbon, hydrogen and oxygen. The nutrients that are required by the plants in smaller quantities are also known as the minor or trace elements *viz.,* manganese, zinc, iron, boron, copper, molybdenum and chlorine. If these nutrients are supplied at lesser quantities, the plants exhibit deficiency symptoms (Alloway, 2008).

Deficiency symptoms of nutrients

Nitrogen

The primary symptoms of nitrogen deficiency in vegetable crops are very slow rate of growth followed by a change in the colour of leaves from green to pale yellow. A similar change in colour may also occur in the stem. The yellowing usually starts from the younger leaves at the top and later on all the leaves are affected and ultimately the entire plant may turn brown in severe cases. Nitrogen deficiency also hastens maturity, causes the shriveling of grains. In solanaceous crops, N-deficient plants have lower levels of endogenous auxins and a reduced gibberellin activity (Chatterjee and Dube, 2004).

Phosphorus

The symptoms of phosphorus deficiency are lesser characteristics than those of nitrogen deficiency and they cannot always be recognized by simple visual observation. Vegetable crops deficient in phosphorus bare stunted in their growth, having leaves darker green than the normal and there is often a tendency to develop purple or reddish anthocyanin pigmentation. These symptoms may be accompanied by dead areas on the leaves and petioles causing the abscission of leaves and delaying the maturity of the crops.

Potassium

Potassium deficiency causes yellowing of leaves which ultimately develop areas of dead tissues at the tip and around the margin of the leaf. In soils with low potash content, symptoms usually do not appear until fruiting. Bronzing along the margin of leaves is a very common symptom of potash deficiency in most vegetable crops. The older leaves show the symptoms of deficiency first.

Calcium

The lack of calcium causes a rapid and quite spectacular disintegration of the terminal growing root and shoots. The young leaves may be severely destroyed with the margins curled backward or forward, showing brown scorching or marginal bands chlorotic; low Ca level in the soil cause blossom end rot in tomato, melon and gourd.

Magnesium

Symptoms of magnesium deficiency are most marked on the foliage and always develops initially on the older leaves. Generally, there is loss of green colour between veins followed by yellowing or chlorosis of leaves and death of certain portions or of the entire leave premature defoliation usually occurs.

Sulphur

Sulphur deficiency causes yellowing of younger leaves and in severe deficiency causes even the older leaves may turn pale green, unlike nitrogen, sulphur does not translocate easily from older to younger leaves. The roots and stems become abnormally long and develops woodiness.

Boron

Boron deficiency is exhibited by internal tissues becoming brown in colour, prolonged deficiency may cause death of growing point. Brown heart or browning disorder in cauliflower is very common, cracking in stem of celery and carachip of beetroot are also due to boron deficiency. Vegetables susceptible to boron deficiency are cauliflower, celery, beetroot, turnip, cabbage, radish, spinach, tomato, onion and potato.

Zinc

Zinc deficiency results in shortened internodes and chlorotic areas of older leaves or may appear in younger plants also. Leaves become mottled. Beans and lima beans are quite susceptible and tomato and onion are somewhat sensitive to zinc deficiency.

Manganese

The most common symptom of manganese deficiency is the chlorosis of leaves followed by necrosis. Manganese deficiency first appears on the young leaves of inter-veinal areas. Manganese is available in acidic soil. Spraying of manganese sulphate with 0.1 to 0.2 per cent may produce beneficial results.

Iron

Iron deficiency causes inter-veinal chlorosis or complete yellowing/whitening of youngest leaves first and the veins remain green. Iron deficiency commonly occurs in calcaeous soils since the iron availability is greatly reduced due to the formation of insoluble complexes with carbonate, hydroxide or phosphate.

Molybdenum

Molybdenum deficiency occurs in vegetable crops when grown in very acidic soils or on very well drained alkaline soils. Its deficiency causes stunted growth, lamina of leaf is reduced. Molybdenum deficiency symptoms are likely to occur when leaf molybdenum concentration is less than 0.2ppm on dry weight basis. Molybdenum deficiency symptoms have been observed on tomato, cauliflower, spinach, Chinese cabbage.

Copper

Copper deficiency exhibits in plants as wilting of young leaves, chlorosis and necrosis. Affected plants do not maintain firmness. In peas and beans leaves become grayish green. Yield of tomato and lettuce is decreased.

Chlorine

Deficiency symptoms of chlorine are wilting, chlorosis, necrosis and an unusual bronze discolouration noticed on tomato plants.

Sodium

It is not essential micronutrient but crops like beet, celery, radish and turnip benefit greatly by the application of soluble sodium salts.

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IMPACT OF COVID-19 ON ENVIRONMENT

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Introduction

The Covid-19 slammed with the truth that we are not conquerors but guests of this eternal nature and our ungratefulness has been punished by nature's fury. We have failed to understand that eco-friendliness and sustainability are not mere business gimmicks to sell the products but an indispensable duty as an inhabitant of this magnanimous ecosystem. A lesson imparted by Covid-19 is,

"There is no use for a mansion with astounding assets if one does not have an immune environment to breathe in."

THE RADICAL TRANSFORMATION

Air quality index

If humans had followed the protocols for an uncontaminated environment unitedly it would have been a simple task. But the same is carried out by a microparticle by dividing and shutting us within the doors of our so-called materialistic shelter. Yes, the curfew and minimalistic operation for industries has drastically improved the air quality index due to reduced transportation, industrial emissions, anthropogenic activities, and greenhouse gas emissions. More than 40% decrease in PM_{25} and 47 % decrease in PM_{10} was observed in North Indian cities. More than 35% decrease in NO_2 in metropolitan cities which shows that

"COVID 19 is indeed nature's restoration mode to purify its polluted lungs."

Snow albedo

Cleaner air prevents dust and soot accumulation on snow and increases snow albedo. It causes the melting of snow at a slower rate. As the melting of glaciers is the dreadful impact of global warming and this steady reversion is a great change observed during global pandemic curfews than in the last two decades.

Reversed supply chain

There is a difference between the number of cars hitting the grocery shops versus a grocery vehicle visiting every house. The drastic reduction in transportation, traffic and increased home deliveries and online transactions substantially reduces energy in the form of fuel consumption which leads to **reduced carbon footprint** and elates the environment's health.

Wildlife flourishment

Due to reduced fishing activities and escaping the injuries due to fishing nets, boats, and propellers, **the Olive Ridley Sea Turtles** show a mass increase in nesting on the seashore after a gap of seven years along the **coast of Odisha.** There was an increase in the number of **flamingoes** congregating in **Mumbai.**

"The bustling market, the loud crowd, the ceaseless commotion was replaced with chirping birds, squeaking squirrels, and unusual wild visitors glorifying the urban landscapes."

THE FLIP SIDE

Wildlife conservation

Though the reports say there is an increase in the number and presence of animals wandering in the urban environment, on the flip side this opportunity is used for misdeeds. There is a devastating hike in **illegal fishing rates, wildlife hunting, unlicensed logging** due to economic crisis and unmonitored national parks, land and marine conservation zones.

Hazardous biomedical wastes

The masks, tissues, cotton swabs, used PPEs, gloves, shoes, headcovers, spills were aggregated in tonnes in the past year after COVID-19. The usual motto of **Reduce-Recycle-Reuse** cannot apply to this situation. We ought to **Segregate-and-Incinerate** as the biomedical wastes are mixed with common wastes and it is very hectic to manage those wastes due to non- segregation.

Solid waste management

Though the online shopping trend reduces carbon footprint emissions, the dumping of shipping materials lead to an increase in solid municipal wastes. Though there were fluttering images that the Ganga River has rejuvenated itself due to industrial shutdown, the actual truth is that still it is being polluted by domestic sewage from the nearby households.

Less is more

The enormous dumping of disinfectants may cause ecological imbalance as it may harm beneficial organisms and increase the risk of new resistant species.

HARMONY IS PEACE

Life is all about proper balance. Though there are soaring levels of air and water quality, flora, and fauna flourishment owing to the pandemic, the economic crisis may lead to dangerous levels of exploitation if the prevailing situation continues. As humans play a major role in the food chain, improper balance in their existence may lead to devastating effects.

Epiphany of nature

The coronavirus spread suppresses our impulse for connection, seeing our friends, getting together in groups, and restrain us from the warmth of touch of our beloved ones just to make us realize the pain of nature when it abandoned from its beautiful creations via deforestation, poaching, pollution, and human perils.

"Earth provides enough to satisfy everyman's need but not every man's greed"

- Mahatma Gandhi

Conclusion

The blissful changes in the environment would not last if humans revert to their pre-pandemic behavior. Humans are blessed with six senses to be a savior of fellow inhabitants and not to jeopardize the ecosystem.

"Live, let live"

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