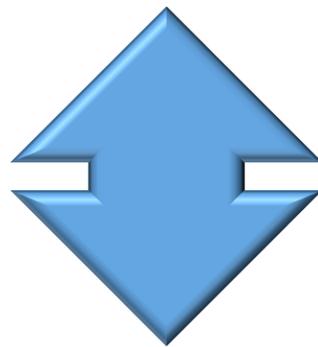


*PPE-322(Insect Pests of Vegetable, Ornamental and
Spice Crops)=(2+1)*



9. Insect Pests of Vegetable, Ornamental and Spice Crops (HPI 203) 3 (2+1)

Economic importance of insects in vegetable, ornamental and spice crops - ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect-pests of vegetable, ornamental and spice crops, their host range, bioecology, injury and integrated management. Insect-pests of processed vegetables and ornamental crops, their host range, bio-ecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical: Study of symptoms, damage, collection, identification, preservation, assessment of damage/population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

| | |
|-----------------------|--|
| course Title: | Insect pests of vegetable, ornamental and spice crops |
| Course number: | PPE 322 |
| Credit hours: | 3 (2+1) |

Theory:

Economic importance of insects in vegetable, ornamental and spice crops. Ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, biocology, injury, integrated management of important insect pests affecting vegetable, ornamental and spice crops. Important storage insect pests of vegetable, ornamental and spice crops, their host range, biocology, injury and integrated management. Insect pests of processed vegetables and ornamental crops, their host range, biocology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical:

Study of symptoms, damage, collection, identification, preservation, assessment of damage/ population of important insect pests affecting vegetable, ornamental and spice crops in field and during storage.

Lecture - 1 Economic Importance of Insects

Lecture - 1

Learning Objectives: All insects are not harmful, those harmful are not harmful unless their population density crosses certain limit (ETL). (Economic importance of insects lies more in their harmful effects than beneficial effects. Higher the status of an insect as pest, more important that insect is. Hence, the main objective of this lecture will be to teach the students regarding their beneficial and harmful effects.

Importance of Insects

Some facts about insects:

- Insects are the most prevalent features of our environment.
- Everybody has to deal with insects. Some find them fascinating while others may see them as a hindrance
- It is the abundance (large number) of these insects which make them important and attract our attention
- The abundance of insects depend upon their inherited traits and environmental factors. Since both these factors are dynamic, insect number is also dynamic

Beneficial effects:

- Industrial importance
- Pollination
- Entomophagous insects
- Nutrient cycling
- Human food
- Aesthetic value
- Study tools
- Insect collection can be adopted as a hobby
- Scavengers

Insects of industrial importance:

- Honeybees: Honey, beeswax, bee venom, royal jelly, propolis and pollination
- Silk worm: Silk

- Lac insect: Shellac

Pollination: Transfer of pollens from anthers to stigma

- Self pollination
- Cross pollination

Reasons for cross pollination:

- Male and female parts at different flowers at same plant or different plants
- Maturity of male and female parts do not coincide
- Structure of flower

Insect Pollinators:

- Honey bees (75-80%), butterflies, flies, beetles, thrips, etc.

Entomophagous insects:

- Predators:
- Parasitoids:

Predators:

- Coccinellids (Coleoptera): e.g. *Coccinella septempunctata*, *Hippodamia variegata*, *cheilomenes sexmacula*, etc.
- Syrphids (Diptera): e.g. *Episyrphus balteatus*, *Metasyrphus corrollae*, *Scaeva pyrastris*, *Ischiodon scutularis*, *Metasyrphus confertor*, etc.
- Chrysopids (Neuroptera): e.g. *Chrysoperla zastrowi sillemi*, *Mallada sp*
- Predatory bugs (Heteroptera): e.g. *Anthocoris minki*, *Orius spp*, *Blaptostethes pallescens*
- Preying mantids (Dictyoptera): e.g. *Statilia maculata*
- Predatory wasps (Hymenoptera): e.g. *Vespa spp*

Parasitoids:

- Egg parasitoid: e.g. *Trichogramma spp.*
- Larval parasitoid: e.g. *Apanteles spp.*, *Cotesia spp.*, *Bracon sp.*
- Egg-larval parasitoid: e.g. *Chelonus blackburni*,
- Larval-pupal parasitoid: e.g. *Ceromomia auricaudata* (Diptera: Tachinidae)
- Pupal parasitoid
- Adult parasitoid:
- Nutrient cycling:
- Detritus and dung feeders e.g. Termites, dung beetles etc.
- Human food:
- Over 500 spp. like crickets, grasshoppers, beetles, caterpillars, termites are used as food by human beings in different parts of the world.

Aesthetic value:

- Brightly coloured butterflies and beetles are used for various decorations

Harmful effects

- Greater importance of insects lies in their harmful effects than their beneficial effects.
- Only a few species (0.01%) are harmful and attain the status of pest.
- Higher the status of species as pest more important the species is.
- Crop losses by the insect pests vary from 10-40 per cent depending upon the crop and environment.
- Annual monetary losses of Rs. 60,000 crores despite using more than 4,800 m tons of technical grade pesticides.

Different pesticides used:

- Insecticides – 60%
- Fungicides – 19%
- Herbicides – 16%
- Bio pesticides- 2%
- Others – 3%

Harmful effects caused:

- Destruction and spoilage of food (Both fresh and in storage) including forests
 - Cutworms (reduce the no of plants in the field)
 - Fruit borer, fruit flies and other direct pests
 - Leaf eaters
 - Sap suckers
 - Stem borers
 - Chlorophyll eaters
 - Root feeders
 - Gall formers
- Damage to goods: leather, paper, textile, timber etc. (beetles cockroaches, silverfishes, termites, timber borers, etc)
- Vectors for impossible to control viral diseases in plants e.g. some aphids, whiteflies, thrips etc.
- Cause diseases in human beings and live stock (malaria, dengue etc.)
- Venoms, allergies, rustication etc. (ants, wasps, bees, hairy caterpillars, etc.)
 - Nuisance : Bush flies and ants
 - Phobias: such as hairy caterpillars

Lecture - 2 Ecology and Pest Management(Part - I)

Lecture - 2

Objective: Both biotic and abiotic factors influence the population of a particular insect, hence, it is very important to understand the role of these factors on the increase or decrease of the pest density for the effective management of that species. The main objective of this lecture will be to make the students aware of the role of different environmental factors on the buildup of pest populations. The students will also be taught about the concepts of EIL, ETL and eventually IPM.

Ecological Aspects

- Ecology: Study of complex interactions between living organisms and nonliving environment in a particular place.
- Ecosystem: The complex interacting system between living and nonliving factors is called as ecosystem.
- Existence and abundance of a species is determined by biotic and abiotic factors, besides the genetic makeup of the species.
- Biotic factors: Living factors like competition, predators, parasitoids, etc.
- Abiotic factors: Non living factors like temperature, RH, photoperiod, etc.

Important components responsible for population growth:

- Physical environment (abiotic factors), food, space, population itself, other species.
 - All these components act on the population through the pathways of natality, mortality and dispersal.

Characteristics of a population:

- Density, natality, mortality, dispersal, dispersion, age distribution, population growth
- Density: Number of individuals per unit area or space occupied.
 - Crude density: Number of individuals per unit of total space.
 - Ecological density: Number of individuals per unit of habitat space i.e. space occupied by the population.
- Natality: Number of new individuals produced per unit time i.e. birth rate.
 - Absolute natality/ physiological natality: Theoretical maximum number of individuals that can be produced under most ideal conditions.
 - Ecological natality: Number of individuals that can be produced under specific environmental conditions.

- **Mortality:** Number of individuals dying in a given population in a given period of time.
 - **Minimum mortality:** Mortality of individuals under most ideal or non limiting conditions.
 - **Ecological mortality:** Mortality of a population under specific environmental conditions.

Survivorship curves:

- **Convex curve:** High survival throughout most of the life span, until the near end of the life span. (common in mammals and social insects like honey bees)
- **Concave curve:** Mortality rate during early age is high followed by a period of much lower and relatively constant losses. (Found in parasites, grasshoppers, frogs, etc)
- **Constant curve:** This curve implies a constant rate of survival independent of age. Probably no population in reality posses a constant survival rate throughout the whole life. A modification of this curve, however, may be present in insects like butterflies.

Dispersal: The movement of individuals in to or out of the population

- **Immigration:** Movement in to the population.
- **Emigration:** Movement out of the population.
- **Migration:** Mass movement of the entire population. Such movements are generally seasonal or periodical.

Role of dispersal in population dynamics:

- Helps in shaping the population growth form by supplementing mortality and natality
- New or unpopulated areas are colonized.
- Helps to introduce genetic variability through interchange between populations
- Leads to an increase in the range of species

Dispersion: Distribution of individuals within a population at a particular time.

- **Random (Poisson):** Mean = Variance
- **Uniform (+ve binomial):** Mean > Variance
- **Clumped (-ve binomial):** Mean < Variance

Age distribution: Relative proportion of individuals of different age groups of a population is called age distribution or age structure.

- **More young individuals:** population is expanding
- **More older individuals :** population is declining
- **Even distribution of various age groups** means stationary population

Population growth:

Exponential growth model:

$$N_t = N_0 e^{rmt}$$

Where

N_t = Number of individuals at time t

N_0 = Number of individuals at time zero

e = base of natural log

rm = Innate capacity of increase

t = Time period

Population growth occurs due to the interplay of biotic potential and environmental resistance

- Biotic potential: Inherent property of individual to reproduce and survive i.e. to increase in number
- Environmental resistance: It is the sum total of environment's limiting factors that prevent the biotic potential from being realized

Logistic growth model:

$$dN/dt = rN (K-N)/K$$

dN/dt – Rate of population growth

r – Intrinsic rate of increase

N – Population number

K – Carrying capacity

FACTORS INFLUENCING PEST POPULATIONS:

- Abiotic factors (Temperature, humidity, light)
- Biotic factors (Food, predators, parasitoids, pathogens)

Temperature: Affects the following parameters of individuals of population

- Endocrine system
- Growth
- Development
- Reproduction

Humidity:

- Normal development and feeding activity.
- By encouraging diseases.
- Excessive body moisture during winter may reduce its capabilities to withstand low temperatures.

Light:

- Orientation, rhythmic behaviour, bioluminescence, periodicities of occurrence and periods of inactivity.
- Light acts as stimulus for insects to synchronize and regulate their life cycles with change in seasons.

- Influences the motor activity rhythm of insects such as locomotion, feeding, adult emergence, mating, oviposition, and also moulting and growth in some species.

Biotic factors:

- Food:
 - Food quality and quantity affects growth, development, survival, longevity, reproduction, distribution, etc.
 - When the food is in short supply there is intraspecific or interspecific competition.
 - Competition acts in density dependent manner.
 - Food supply may be affected by many factors
- Natural enemies: Predators, parasitoids and entomopathogens like bacteria, fungi, viruses, nematodes, rickettsiae, etc.
- Natural enemies act negatively on insect populations.
- Influence is variable because their own populations are influenced by various environmental factors.
- Predators generally respond to increase in pests population through:
 - Numerical response (By increasing their number)
 - Functional response (By increasing the consumption).

Lecture - 3 Ecology and Pest management (Part - II)

Lecture - 3

ECOLOGICAL BASES OF PEST MANAGEMENT:

- **CONCEPTS OF IPM**
- Avoidance of economic damage with minimum effects on the environment
- IPM: In simple language IPM is the utilization of all possible control tactics to suppress the pest population below economic injury level with minimum adverse impacts on environment.
- Economic Injury Level (EIL): It is the minimum pest population which causes the economic damage.
- Economic damage: The damage caused by the pest to a crop which justifies the cost of control or in other words it is the damage equal to the cost of control.
- Economic Threshold Level: It is the pest population where control measures should be initiated to prevent the pest population in reaching the EIL.

Basic necessities in IPM:

- Measurement of pest population intensity.
- Determining the influence of natural enemies on the pest population
- Crop loss assessment by the pest
- Monitoring of pest population for decision making.

COMPONENTS OF IPM:

- Cultural control
 - Tillage
 - Planting and harvesting time
 - Sanitation
 - Plant diversity
 - Trap cropping
 - Crop rotation
 - Nutrient and water management
- Mechanical control
 - Hand picking
 - Exclusion by screens and barriers
 - Clipping and pruning
- Physical control
 - Hot and cold treatment
 - Light trapping
- Legal control

- Legislation for foreign quarantine to prevent the introduction of new pests from abroad.
- Legislation for domestic quarantine to prevent the spread of established pests within country or a particular state.
- Legislation for notified campaigns of control against pests.
- Legislation to prevent the adulteration and mishandling of insecticides or other devices used for the control of pests.
- Biological control
 - Predators: Lady bird beetles, syrphid flies, lace wings, etc.
 - Parasitoids: *Trichogramma* spp, *Apanteles* spp, *Bracon* sp, etc
 - Bacteria: *Bacillus thuringiensis*
 - Viruses: NPVs and GVs have been successfully used.
 - Fungi:
 - *Beauveria bassiana*: Against beetles and caterpillars
 - *Metarhizium anisopliae*: Against beetles and caterpillars
 - *Nomuraea rileyi*: Against caterpillars
 - *Verticillium lecanii*: Against sucking pests
 - *Paecilomyces* sp: Against sucking pests
- Chemical control
- Semiochemicals
- Other components:
 - Growing resistant cultivars
 - Use of sex pheromones for monitoring, mass trapping, mating disruption and auto confusing the target pests.
 - Use of botanical pesticides especially neem based insecticides.
 - Need based, safe and judicious use of synthetic pesticides.

Advantages of IPM:

- It provides sustainable control of the pest and also adds to sustainable crop productivity.
- It is economically viable and is affordable by marginal farmers.
- It is environmentally safe.
- Less health hazards.
- Social and political stability
- Quality produce with minimum pesticide residues and hence will enhance the export of agricultural commodities

Lecture - 4 Pest Surveillance and Forecasting

Lecture - 4

Objectives: For effective management of any pest species, it is important to make timely prediction/ forecasting of the population buildup. Quantification of populations is another important aspect. Hence, in these lectures the students will be acquainted with different sampling techniques, population estimates and surveillance programmes through which we can forecast the pest populations and initiate timely control measures.

Survey and Sampling

- **Survey:** Survey is a planned activity to collect some data.
- **Surveillance:** When survey of the same area/ plot or locality is carried out at regular intervals to record some observation or to ascertain the changes in the subject of study, it is called as surveillance. In other words pest surveillance is the close and constant vigil on insect population in a particular area.

Objectives of survey and surveillance:

- To monitor the pest population and /or damage regularly to arrive at a decision whether control measures are required or not, if required when to initiate the control measures.
- Pest forecasting with reasonable precision.
- Endemic areas of various pests may also be marked
- To predict future population trends or the corresponding potential damage to the crops or both

Types of survey:

- **Qualitative:** To identify the different insect species present over an area or their density whether abundant, common, rare, in traces, etc
- **Quantitative:** To estimate the exact number of one or more species of insects in time and space.

Sampling insect populations:

- In quantitative survey a count of insects is required.
- Due to large number and/or secretive nature it is not possible or even desirable to count each and every individual in a population.
- Hence more efficient method is by sampling.
- Randomization and the choice of sampling unit are the fundamentals of sampling.
- The total number of samples to be taken depends upon the degree of precision required

Sampling unit:

- Sampling unit is a portion of the habitat from which insect counts are to be made e.g. a plant, branch, leaves or fruiting bodies, a clump, a micro plot of 1 m², etc.
- Sampling unit must be distinct and should not overlap.

Sample: A group of sampling units from which an estimate is made.

Sampling technique: It is the method used to collect information from a single sampling unit.

Sampling programme: Sampling programme is the procedure that employs the sampling technique to obtain sample and make a density estimate.

Sampling programmes:

Extensive programmes:

- Conducted over a large area to determine information like species distribution, status of injurious insect stages.
- Usually a single insect stage is sampled.
- Only one or few samples are taken per season.
- Only moderate levels of precision are required and emphasis on low cost.

Intensive programmes:

- Conducted as part of research in population ecology.
- Here sampling is done frequently, in a small area
- All or most stages in the life cycle are sampled
- High degree of precision is sought

Lecture - 5 Common Sampling Techniques

Lecture 5: Sampling Techniques

COMMON SAMPLING TECHNIQUES:

- Insitu count
- Knock down (By jarring, by chemicals, by heating)
- Netting
 - Sweep netting
 - Vacuum netting
 - Aerial netting
- Trapping
 - Light trap
 - Bait trap
 - Pheromone trap
 - Malaise trap
 - Suction trap
 - Window trap
 - Water trap
 - Sticky trap
 - Pitfall trap
- Mark, release and recapture technique
- Sequential sampling

Population estimates:

- Absolute estimates
 - Absolute estimates (number per ground surface area e.g. per hectare or acre or 1 m²)
 - Population intensity (per habitat unit e.g. leaf, plant, etc)
 - Basic population estimates (intermediate between above two e.g. per 5 cm of stem)
- Relative estimates (don't give definite number per unit area)
- Population indices (insects themselves are not counted but their products)

Criteria of estimates:

- The estimates must be evaluated for:
 - Fidelity: accuracy with which estimates follow the actual number in the population.
 - Precision: It is the reproducibility of the results and measures the degree of error
 - Cost: Cost is very important. Any estimates having great fidelity and precision will be of no use until and unless it is cost effective.

Parameters of sampling programme:

- Insect stage to be sampled
- Number of sampling units
- Time of sample
- Pattern of sampling
- Types of sampling

Sampling unit:

- The size should be such that every unit of the universe should have the chance of selection.
- Sampling unit must be easily delineated in the field
- Sampling unit should be of such that it provides a reasonable balance between precision and cost

Number of samples:

$$N = [(t \times s) / (d \times m)]^2$$

Where

N = no. of sampling units required,

t = student 't' value

s = standard deviation

d = precision (RV) expressed as decimal

m = mean density

Pattern of sampling:

Random, diagonal, double diagonal, zigzag diamond, 'W' pattern, micro plot, 'U' pattern etc.

Types of sampling:

- Random sampling
- Stratified random sampling
- Systematic sampling
- Sequential sampling

Lecture - 6 Insect Pests of Cruciferous Crops (Part - I)

Lecture - 6

Objectives: The main objectives of these lectures will be to teach the students about the major as well as minor pests of cruciferous crops. Emphasis will be on the host range, identification, nature of damage, life cycle and ecofriendly management of these pests. **INSECT PESTS OF CRUCIFEROUS CROPS**

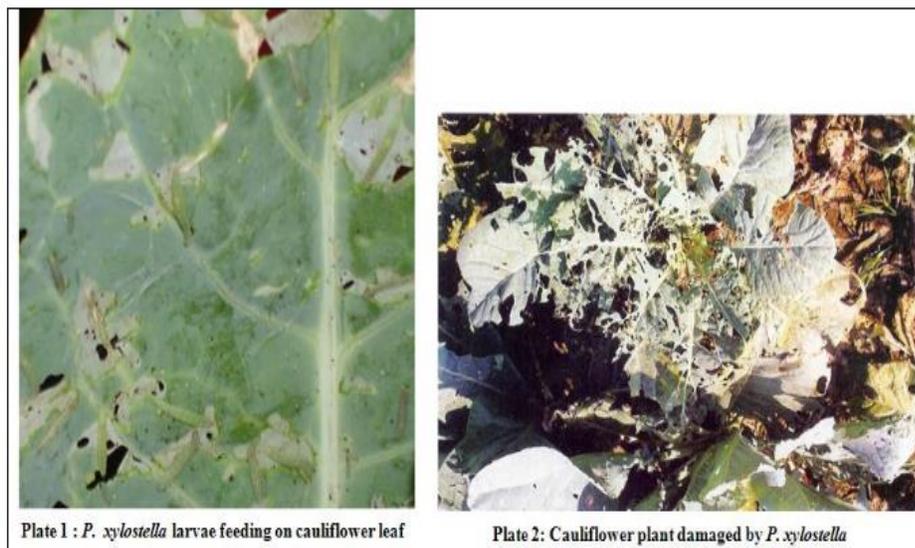
1. Diamondback moth, *Plutella xylostella* (Yponomeutidae : Lepidoptera)

Distribution: Cosmopolitan

Hosts: All cruciferous crops, also reported from Solanaceous and Liliaceous plants.

Nature of damage:

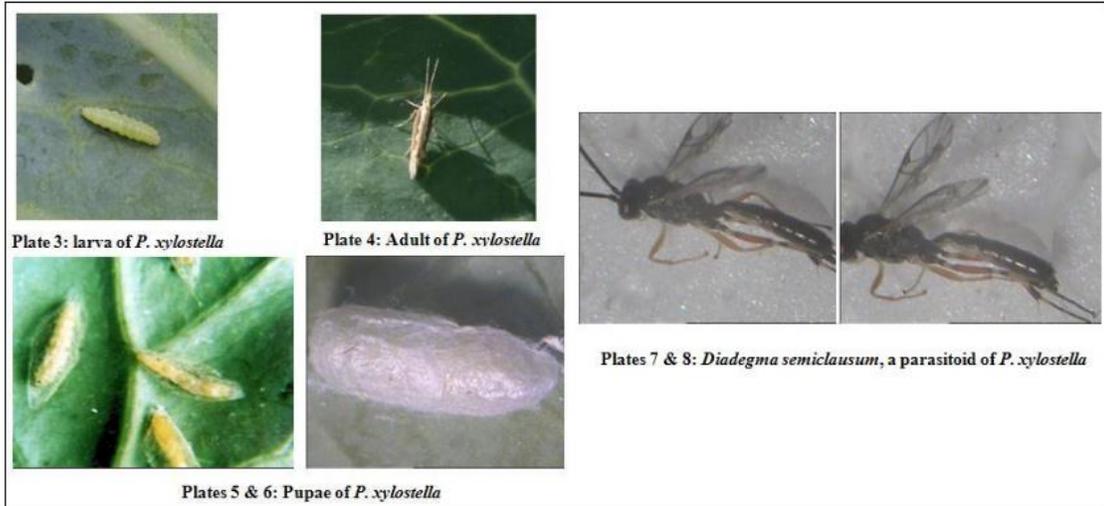
- Young caterpillars scrap epidermal leaf tissue, producing typical white patches.
- Older larvae bite holes on the leaves.
- The infestation is more severe in dry season, when it causes growth retardation (under sized heads).



Identification:

- Egg: Yellowish white with greenish tinge.
- Larva: Full grown larvae are 8-12 mm long, green in colour
- Pupa: pupate in silken cocoon which is about 20 mm

- Adult: 8-10 mm, grayish brown having pale white narrow wings with inner margins yellow. 3 pale white triangular markings on hind margins of each fore wing which appears as three diamond shaped spots when at rest



Life cycle:

- Incubation period 3-8 days
- Larval period 10-30 days
- Pupal period 7-14 days
- Total life cycle 4-5 weeks.
- Adult longevity 16-18 days.
- There are 8-10 generations in a year.

Salient features:

- Lay eggs singly or in clusters of 2-40 glued to the ventral surface of the leaf.
- Each female lays 20-300 eggs
- Pest is active during winter in plains, where as in hills it is active from March-April to October- November.
- Moths hide under the remnants of plants during winter.

Management:

- Indian mustard as trap crop
- Removal and destruction of plant debris after harvest and ploughing
- Intercropping with tomato or carrot reduces the incidence.
- NSKE @ 4.0 per cent and Bt formulation (Halt/ Dipel) @ 500g/ ha are also effective against the DBM.
- Periodic releases of *Trichogramma brassicae* @ 100000/ha
- Larval parasitoid, *Diadegma semiclausum* in nature.

- Need based use of insecticides like fenvalerate (0.01%) or cypermethrin (0.0075%) or deltamethrin (0.0028%) can also be used if population persists.

Cabbage butterfly

2. Cabbage butterfly, *Pieris brassicae* (Pieridae: Lepidoptera)

Distribution: All over the world

Host range: Cabbage, cauliflower, knol khol, turnip, raddish, mustard, toria, etc.

Nature of damage:

- Young caterpillars feed gregariously and skeletonise leaves
- Late instars disperse and move to adjacent plants/ fields and feed on the leaves voraciously.
- Plants are sometimes completely defoliated resulting in heavy yield losses

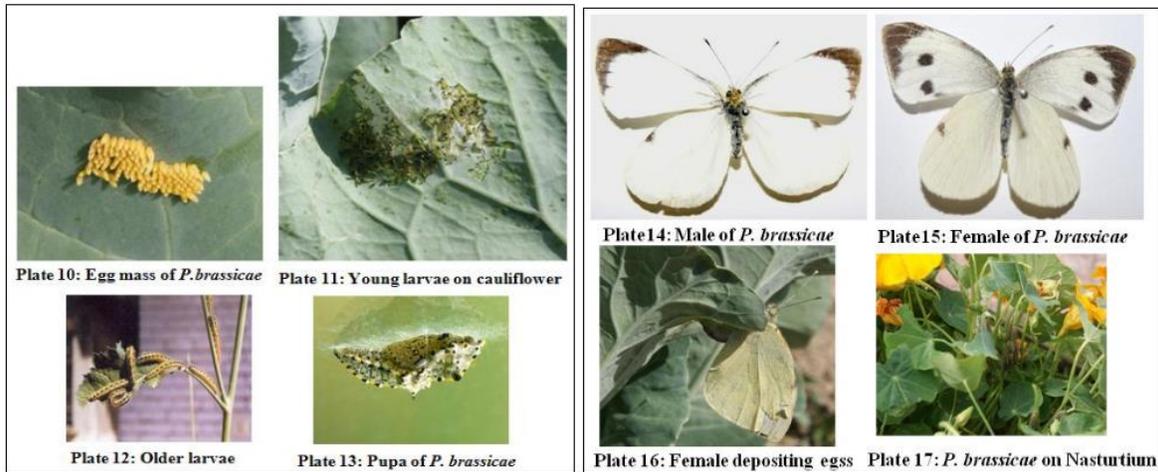


Plate 9: *P. brassicae* larvae feeding on cauliflower

Identification:

- **Eggs:** Yellow cylindrical eggs are laid in clusters of 50-90 on ventral surface of leaves
- **Larvae:** Pale yellow when young and become greenish yellow later on. The head is black and the dorsum is marked with black spots and short hairs.
- **Adults:** Butterflies are pale white having smoky shade on the dorsal side of the body. The wings are pale white with a black patch on the apical angle of each hind wing. The females measure about 6.5 cm across the wings and have two conspicuous black spots on

the dorsal side of each fore wing. The males are smaller than females and have black spots on the underside of each fore wing.



Life cycle:

- Incubation period: 3-7 days.
- Larvae period: 15-20 days (summer) and 30-40 days (winter).
- Pre-pupal period : 1.5-2
- Pupal periods : 8-10 days
- Adult longevity: 3-12 days.

Salient features:

- Eggs are laid in clusters of 50-90 on ventral surface of leaves.
- *P. brassicae* prefers clumped vegetation for oviposition
- Five larval instars.
- Pupate on the leaves and stems of the host.
- Temperature between 15 and 30 is ideal
- The pest remains active from October to April in plains and from May to September it breeds only in the mountains.

Management:

- Collection and destruction of the egg masses and early gregarious caterpillars
- NSKE @ 4.0 % and Bt @ 500g/ha are also effective.
- Need based spraying of the crop with insecticides like malathion (0.05%) or cypermethrin (0.01%).
- In nature, *Cotesia glomerata* has been reported as major mortality factor of this pest.

Cabbage Aphid

3. Cabbage aphid, *Brevicoryne brassicae* (Aphididae: Hemiptera)

Host range: All cruciferous crops

Nature of damage:

- Suck the cell sap from tender leaves/shoots
- Stunted growth and poor head formation.
- Under severe infestation the entire plant may dry up.
- When seedlings are infested they loose vigor, gets distorted and become unfit for transplanting.
- Excrete honeydew which attracts sooty mould and interferes with photosynthesis.
- If attack starts early, heavy losses can occur

Identification:

- Eggs: Pale-yellow with greenish tinge.
- Nymphs: 1-1.5 mm long and yellow green with light ash grey tinge.
- Adults: About 2 mm in length and ash grey in colour



Life cycle:

- Active from October to April
- In mid hills of HP it appears in the last week of January with peak during first week of April
- Reproduces through parthenogenetic vivipary however, during severe winter, sexual reproduction also occurs.

- Overcrowding coupled with high temperature and low humidity results in appearance of alates for migration.
- The nymphs mature in 10-15 days and immediately start laying
- There are 4 nymphal instars
- A single female can produce 40-45 young ones.
- Total life cycle is completed in 10-45 days
- Many generations in a year.

Management:

- Cut and destroy the infested leaves/ shoots mechanically as soon as the aphid attack appears.
- Spray of fine pulverized mica powder @ 0.2 per cent to repel the alates.
- Conventional insecticides like malathion (0.05%) or oxy- demeton methyl (0.025%) or dimethoate (0.03%).
- Predators like coccinellids, syrphids and chrysopids; and parasitoids like *Aphidius* spp also reduce the population.
- Cabbage cultivars like Red Drum Head and KK cross were moderately resistant to this aphid (Lal, 1991) and can be used.

Cabbage Semilooper

4. Cabbage semilooper, *Thysanoplusia orichalcea* (Noctuidae: Lepidoptera)

Distribution: North-Western India

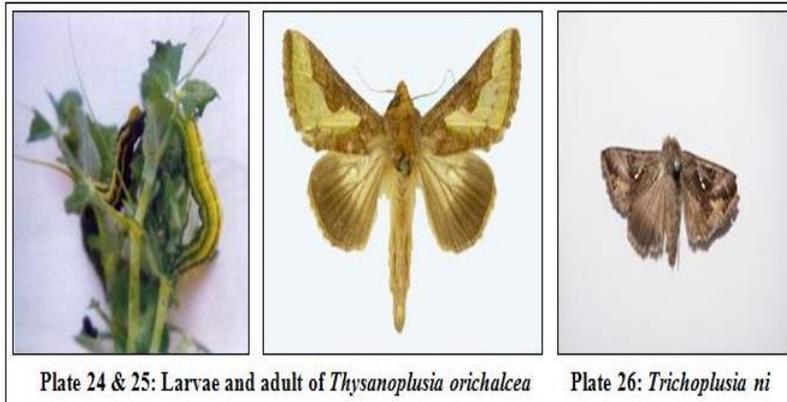
Host range: Cabbage, cauliflower and other winter vegetables

Nature of damage:

Larvae cause the damage by biting round holes into the leaves

Identification:

- **Larvae:** plump and pale green having three pairs of prolegs and are generally found mixed with the caterpillars of *P. brassicae*
- **Adults:** light brown with a golden patch on each fore wing and measures about 42 mm across the wings.



Life cycle:

- The pest is active from March to October.
- Moths lay eggs on the leaves
- Larvae feed individually biting holes of varying size depending on the stage of development.
- Pupate in plant debris.
- Moths are very active at dusk

Management:

Same as recommended for *Pieris brassicae*

Lecture - 7 Insect Pests of Cruciferous Crops (Part - II)

Lecture 7: Crucifer leaf weber

5. Crucifer leaf weber, *Crocidolomia binotalis* (Pyralidae: Lepidoptera)

Distribution: India, Srilanka, Myanmar.

Host range: Cabbage, cauliflower, raddish, mustard and other cruiferous crops. The pest has also been recorded from *Thymus vulgaris* (Family: Labiatae)

Nature of damage:

- Damage is caused by the larvae.
- Young larvae are gregarious and feed on chlorophyll
- Older larvae web leaves together and feed on lower surface.
- Up to 80 per cent of the plants may be attacked.
- Capable of destroying premordia and preventing the establishment of young plants



Plate 7.1: Cabbage plant damaged by *Crocidolomia binotalis*



Plate 7.2: Larva, pupa and adult of *Crocidolomia binotalis*

Life cycle:

- Eggs hatch in 4-8 days
- Larval stage is 14-24 days in summer and about 50 days in winter.
- Pupal period is 14-40 days
- Total life cycle in 40-80 days.
- Adult longevity is 6-12 days
- More than one generation in a year.

Salient features:

- Moths lay eggs on the under surface of the leaves in masses of 55-75 and each female lays 1-4 egg masses.
- Larvae pass through four to five stages.
- Pupate in soil in earthen cocoons at a depth of 10-20 cm.

Management:

- Remove and destroy webbed leaves having larvae inside.
- Mustard can be used as trap crop
- NSKE @ 4.0 per cent or other neem based insecticides
- Bt formulations @ 500g /ha
- Natural enemies like *Apanteles oblique*, *Apanteles* sp, *Enicospilus xanthocephalus*, *Palexorista solennis* and *Eocanthecona furcellata* also take care of the pest in nature
- Need based spraying of crop with malathion(0.05%), methyl demeton(0.025%), chlorpyrifos(0.04%)
- A waiting period of 7 days should be observed.

Cabbage head borer

6. Cabbage head borer, *Hellula undalis* (Pyralidae: Lepidoptera)

Distribution: Japan, Taiwan, India.

Host range: Serious pest of all cruciferous crops.

Damage:

- Damage is caused by the caterpillars.
- Caterpillars first mine into leaves and feed on the chlorophyll
- Later on feed on the leaf surface sheltered within the silken passage.
- As they grow bigger they bore into the heads of cabbage and cauliflower.
- When the attack is heavy, the plants are riddled with caterpillars

Identification:

- Caterpillars: Creamy yellow with a pinkish tinge and has seven purplish brown longitudinal stripes.
- Moths are slender, pale yellowish-brown, having grey wavy lines on the fore wings. Hind wings are pale dusky.



Life cycle:

- Eggs hatch in 2-4 days
- Caterpillars become full fed in 6-18 days
- Pupal period is 4-19 days
- Adult longevity is 3-8 days (female) and 2-6 days (males).
- 12 generations from April to November.

Salient features:

- Active throughout the year but more active during autumn.
- Females lay pinkish and oval eggs singly or in clusters on the under surface of the leaf.
- Five larval instars
- Full grown larva spins a cocoon among the leaves for pupation.
- Each female can lay 28-214 eggs

Management:

- Monitoring of pest at seedling or early growth stage.
- Collection and destruction of early stage caterpillars
- Indian mustard as trap crop
- Bt products
- Some cauliflower lines like Early Kumari, 78-1S, 234-S, Sel.916 and Sel.1012 were resistant to this pest (Brar et al., 1993).
- The pest can also be controlled by spraying the crop with malathion @ 0.1 per cent.

Mustard sawfly 7. Mustard sawfly, *Athalia lugens proxima* (Tenthredinidae: Hymenoptera)

Distribution: All over the Indian sub continent.

Host range: Cruciferous crops

Nature of damage:

- It has a great potential to defoliate the crop plant at seedling stage.
- Adults inflict damage by act of laying eggs with the help of their saw like ovipositor.
- Larvae nibble margins of tender leaves and later bite holes in the leaves.
- Larvae generally feed during dawn and dusk

Identification:



Plates 7.6 & 7.7: Larvae of sawfly



Plate 7.8: Adult of sawfly

Life cycle:

- Developmental periods (days):
 - Egg: 6-8
 - Larval: 20-30
 - Prepupal: 3-4
 - Pupal: 7-10
 - Adult longevity: 10
 - Fecundity: 100-170

Salient features:

- Winter season pest
- 1st appears on Radish during July-August
- Completes 10 generations in south India
- In North India, active from September- March
- Pupate in silken cocoons between leaves but before aestivation enters in soil
- 5 instars in male and 6 in female

Management:

- Hand picking of larvae and their destruction.
- Irrigation results in drowning of the larvae.
- Use of neem is also effective.
- Bt formulations @ 0.05- 0.2 per cent exhibits excellent control
- Application of quinalphos (0.025%) or malathion (0.05%) or dichlorvos (0.05%) is effective in controlling this pest.

Painted bugs

8. Painted bugs, *Bagrada cruciferarum* and *Eurydema pulchrum* (Pentatomidae: Hemiptera)

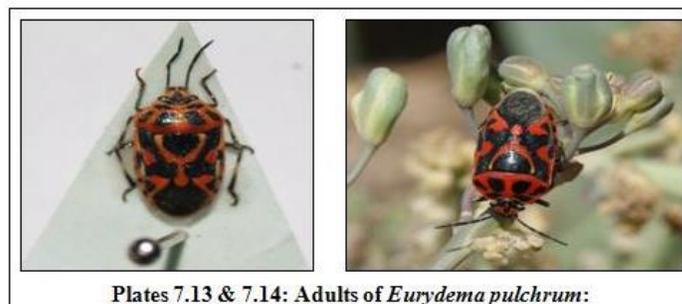
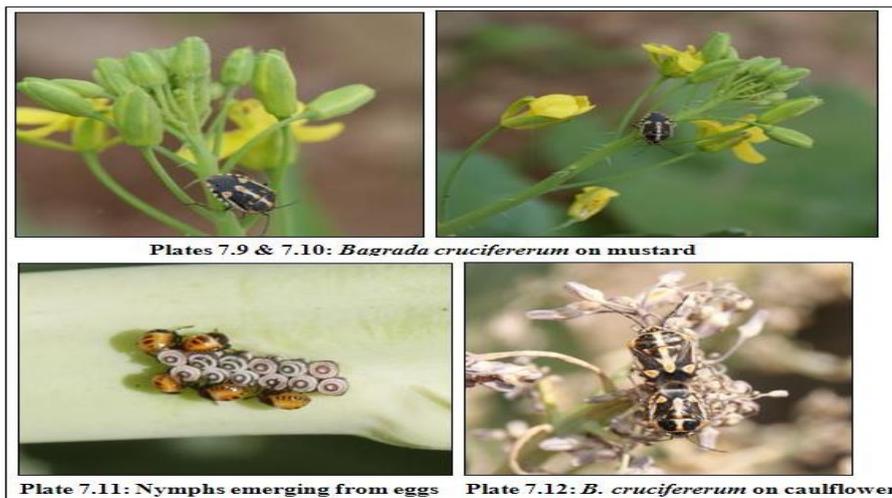
Distribution: India, Srilanka, Pakistan, Afghanistan, East Africa, South East Asia.

Host range:

- These bugs are important pests of cruciferous crops at flowering and podding stage.
- Has also been reported from Maize, Bajra, Black gram, Vigna mungo, etc

Identification:

***Bagrada cruciferarum*:**



Damage:

- Both nymphs and adults suck cell sap from the leaves and the developing pods which gradually wilt and dry up.
- On leaves palish or whitish markings appear and later on these leaves turn brown.
- In case of severe infestation, the seed formation is reduced.
- The nymphs and adults also excrete a sort of resinous material which spoils the pods.

Life cycle:

- Incubation period is 2-5 days
- Nymphal period is 18-20 days.
- Adult longevity is 16-18 days
- Total life cycle was completed in 21-27 days
- Pre-oviposition period is about one week.
- Each female can lay on an average 230 eggs @ 15-20 eggs per day.
- There can be 6-8 generations in a year

Salient features:

- Appears March-April and peak activity coincides with pod formation stage.
- In Haryana the pest remains active throughout the year with two peaks (October-November and March-April)
- The eggs are laid singly or in batches of 2-12 on leaves, stems and flower buds
- The incidence is negatively correlated with RH and positively correlated with temperature.
- Mating takes place immediately after final nymphal molt

Management:

- These bugs can breed on a number of weeds, so clean cultivation is imperative to avoid infestation.
- The pest can also be controlled by spraying the crop with oxy-demeton methyl (0.025%) or malathion (0.05%) or permethrin (0.008%) or fenvalerate (0.01%) or deltamethrin (0.0028%) or dimethoate (0.03%).
- Observe 7-10 days waiting period

Lecture - 8 Insect Pests of Cruciferous Crops (Part - III)

Lecture - 8

9. Cutworms

- Common name: Cutworms
- Important species:
 - *Agrotis segetum*
 - *A. ipsilon*
 - *A. flammata*
 - *A. Spinifera*
- Family: Noctuidae
- Order: Lepidoptera
- Distribution: Cosmopolitan reported from China, India, North Europe, Canada, Japan, South America and New Zealand. In India cutworms are more serious in northern region than in south.
- Host range: polyphagous

Damage:

- Caterpillars are damaging
- Cut the seedling at ground level
- Drag the seedling into the soil
- Reduce the plant stand
- Some time replanting is required
- Caterpillars also nibble the tubers of plants

Identification:

Eggs: globular in shape, 0.5 mm in diameter, ribbed and whitish in colour.

Caterpillars: smooth, stout, cylindrical, 40-50 mm long, blackish- brown dorsally and grayish green laterally with dark stripes. They coil up at the slight touch.

PPE 322: Cutworms - Mozilla Firefox

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Course: Insect Pests of Vegetable, O... PPE 322: Cutworms PPE 322: Tobacco caterpillar PPE 322: Cabbage flea beetle

Eggs: globular in shape, 0.5 mm in diameter, ribbed and whitish in colour.

Caterpillars: smooth, stout, cylindrical, 40-50 mm long, blackish- brown dorsally and grayish green laterally with dark stripes. They coil up at the slight touch.



Plates 8.1 & 8.2: larvae of cut worm

Pupae: 18-22m long and reddish brown in colour.

Adult: Moths are medium sized, stout, dark greenish brown with reddish tinge and have grayish brown wavy lines and spots on the fore wings. Hind wings are hyaline having ark terminal fringe which is darker in female than in male. Wings expanse is 45-50mm.



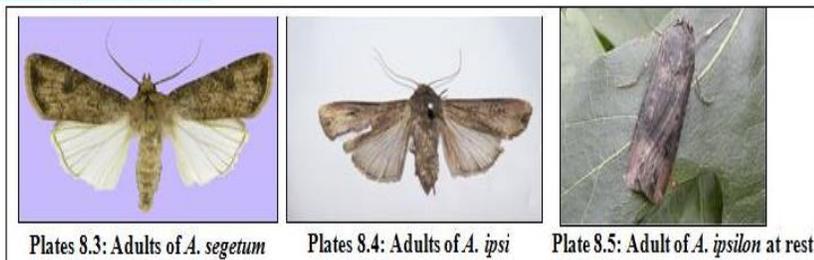
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Pupae: 18-22m long and reddish brown in colour.

Adult: Moths are medium sized, stout, dark greenish brown with reddish tinge and have grayish brown wavy lines and spots on the fore wings. Hind wings are hyaline having ark terminal fringe which is darker in female than in male. Wings expanse is 45-50mm.

er in female than in male. Wings expanse is 45-50mm.



Life cycle:

- Each female lays on an average 300-450 eggs in clusters of 30-50.
- Incubation period is 2-13 days
- Larval period is 10-30 days
- Pupal period is 10-30 days.
- Total life cycle is completed in 30-68 days depending on the climatic conditions.

Salient features:

- Moths appear soon after dusk, mate and lay eggs on ventral surface of leaves or moist soil.
- Freshly ploughed fields are preferred for oviposition.
- Tiny caterpillars feed gregariously on foliage for a few days and then segregate and enter into the soil.
- The caterpillars are nocturnal
- Loss caused is much more than what is actually eat
- Pupate in soil

Management:

- Flooding of fields. (Caterpillars are exposed to birds and other enemies)
- Deep ploughing & stirring of soil.
- Hand picking & destruction of caterpillars found just under the damaged plant.
- Soil application (drenching) of chlorpyrifos @ 0.1%
- Mixing of insecticidal dust.
- Poison baits containing wheat bran + carbaryl + molasses be spread on the ground to attract and kill larvae.

Tobacco caterpillar

10. Tobacco caterpillar, *Spodoptera litura* (Noctuidae: Lepidoptera)

Distribution: Throughout the tropical and subtropical parts of the world.

Host plants: Polyphagous

Damage:

- Damage is caused by the caterpillars
- Feed on leaves and fresh growth.
- They are active at night and more serious on tobacco.
- Young caterpillars bite holes on leaves
- Older larvae defoliate entire foliage
- Fruits are also destroyed

- **Identification:**



Plate 8.6: Newly emerged larvae of *S. litura* from egg mass

Larvae: About 35-40 mm in length when fulfed .They are velvety black with yellowish green dorsal strips and lateral white bands.

- **Adults:** The moths are about 22 mm in length and about 40 mm across the wings. The fore wings have beautiful golden and grayish brown pattern



Plate 8.7 & 8.8: Larvae of *S. litura*



Plate 8.9: Pupae of *S. litura*

Plate 8.10 & 8.11: Adults of *S. litura*

Life cycle:

- Each female may lay 300 eggs in clusters covered with brown hair.
- Eggs hatch in 3-5 days.
- Larvae become full fed in 15-30 days
- Pupal period is 7-15 days.
- Adult longevity is 7-10 days
- Total life cycle is completed in 32-60 days.
- 8 overlapping generations in a year.

Salient features:

- Breeds throughout the year, although development is retarded during winter.
- Each female may lay 300 eggs in clusters covered with brown hair.
- Young larvae feed gregariously initially
- Old larvae disperse to feed individually.
- Six larval instars.
- Pupation takes place in soil

Management:

- Clean cultivation to expose the larvae to natural enemies

- Pheromone traps to predict egg laying.
- Hand picking and destruction of egg masses and early gregarious instars.
- Spray of NSKE @ 4.0 per cent at early growth stage of the crop.
- Spray of SINPV @ 250 LE per hectare
- Malathion (0.05%) in emergency.
- Natural enemies like *Bracon* sp, *Telenomus* sp , Bt and entomopathogenic fungi

Cabbage flea beetle

11. Cabbage flea beetle

Common name: Cabbage flea beetle

Important species

- *Phyllotreta cruciferae*
- *P. chotanica*
- *P. birmanica*
- *P. oncera*
- *P. downesi*

Family: Chrysomelidae

Order: Coleoptera

Distribution: Europe, Erst while USSR, North and South America, Australia, Japan, India

Host range: Mustard, raya, toria, taramira, radish, turnip, cabbage, cauliflower, knol khol, cotton, cereals, dahlia, antirrhinum, sweet pea, etc

Damage:

- Larvae live in soil and feed on roots of plants.
- Adults feed on the cotyledons and leaves of young plants making round holes.
- The stems, flowers and even pods may also be attacked.
- The old leaves dry up and young leaves rendered unfit for consumption.
- The attacked plants give decaying odour.

Identification:

- The larvae are dirty white with pale white head, 5 mm in length. The adults vary in colour from shiny black to black. All species have very stout femora with which they jump like fleas.

Life cycle:

- Oviposition period is 25-30 days
- Incubation period is 5-10 days.
- Larval period of 9-15 days
- Prepupal period is 2-4 days
- Pupal period is 8-14 days.
- 7-8 generations in a year.

Salient features:

- Over wintered adult beetles emerge in last week of February or first week of March.
- The female lays 50- 80 creamy white eggs in the soil around the host plants
- The larvae moult thrice
- pupates in an earthen cell 0.5 mm long

Management:

- Deep summer ploughing to kill the over wintering population.
- In endemic areas the off season/ late season crop should be avoided.
- In early planted crop or seedlings, malathion (5%) dust @ 10-15 Kg/ha should be used.
- Oxy- demeton methyl @ 0.025%
- Parasitoid *Microctonus indicus* also parasitizes adult *P. cruciferae*

Minor pests:

| S.N. | Common name | Scientific name | Family | Order |
|------|-------------------------|-------------------------------|-------------|--------------|
| 1 | Mustard aphid | <i>Lipaphis erysimi</i> | Aphididae | Hemiptera |
| 2 | Green peach aphid | <i>Myzus persicae</i> | Aphididae | Hemiptera |
| 3 | Cotton thrips | <i>Thrips tobaci</i> | Thripidae | Thysanoptera |
| 4 | Bihar hairy caterpillar | <i>Spilarctia obliqua</i> | Arctiidae | Lepidoptera |
| 5 | Green semi-looper | <i>Trichoplusia ni</i> | Noctuidae | Lepidoptera |
| 6 | Pea leaf miner | <i>Chromatomyia horticola</i> | Agromyzidae | Diptera |

| | | | | |
|---|----------------|-----------------------------|---------------|-------------|
| 7 | Mites | <i>Tetranychus urticae</i> | Tetranychidae | Acarina |
| 8 | Gram pod borer | <i>Helicoverpa armigera</i> | Noctuidae | Lepidoptera |

Lecture - 9 INSECT PESTS OF TOMATO (Part - I)

Lecture - 9

Objectives: Tomato is another important cash crop grown throughout India and is attacked by a large number of direct as well as indirect pests during all the growth stages. So, in these lectures students will be taught about the host range, identification, nature of damage, life cycle and ecofriendly management of different pests attacking this crop. **Tomato fruit borer**

1. Tomato fruit borer, *Helicoverpa armigera* (Noctuidae: Lepidoptera)

Distribution: Cosmopolitan in distribution

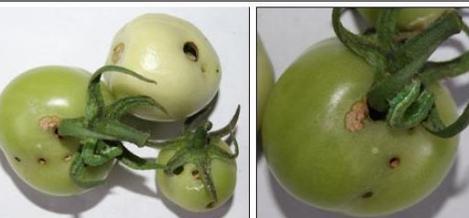
Host plants: Polyphagous, infests over 100 host plants including chickpea, cotton, castor, tomato, cowpea, millets, linseed, tobacco, safflower, pigeon pea, okra, carnation etc.

Damage:

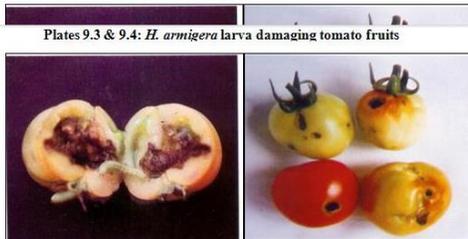
- Damage is caused by the larva
- Feed on the foliage, flowers, buds and fruits.
- Small green fruits are preferred
- Single larva can destroy many fruits
- The damage is more pronounced during March to June

Identification:

- Eggs: yellowish white, ribbed, dome shaped and 0.4-0.5 mm in dia.
- Larvae: Newly emerged are yellowish white where as older can be of many colours depending upon the food they consume. Full grown caterpillars are 40-48 mm long with whitish and dark gray longitudinal stripes.
- Adults:
 - Medium sized stoutly built moths.
 - Forewing is light yellow in males and brown in females.
 - On the apical margin of forewings, wavy lines in the form of light black band are visible and a black spot appears on the upper side of the wing.
 - On the tip of the abdomen there is a tuft of hairs in case of females, nevertheless, the tuft of hairs is absent in males.

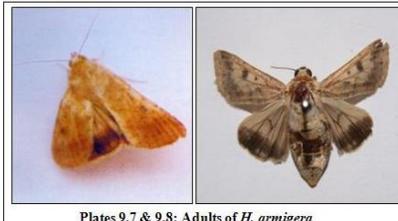


Plates 9.3 & 9.4: *H. armigera* larva damaging tomato fruits



Plates 9.3 & 9.4: *H. armigera* larva damaging tomato fruits

Plates 9.5 & 9.6: damaged fruits



Plates 9.7 & 9.8: Adults of *H. armigera*

Life cycle:

Life cycle:

- Incubation period: 2-5 days
- Larval period: 15-22 days
- Prepupal period: 1-2 days
- Pupal period: 10-14 days
- Adult longevity: 6-10 days
- Fecundity: 300-800 eggs

Salient features:

- Eggs are laid singly on leaves, flower and fruits.
- Young larvae feed on tender foliage and older bore fruits
- Caterpillars thrust only a part of their body inside the fruit and feed on the inner contents.
- Single larva can destroy 2-8 fruits
- Partially damaged fruits are attacked by other microbes
- The caterpillars are cannibalistic.

Management:

- Use of resistant varieties like Punjab Kesari, Punjab Chhaura, Pant Bahar, Azad, Pusa Hybrid-4 etc.
- Deep summer ploughing to expose the pupae to the sunlight and natural enemies.
- African marigold as trap crop.
- Pheromone traps (5 traps/ ha) of moths for monitoring
- Monitoring of top three leaves for egg laying
- Spray of HaNPV @ 250 LE/ha at weekly intervals
- Bt formulation @ 0.5 Kg/ha.
- Periodic releases of egg parasitoid, *Trichogramma chilonis* or *T. pretiosum* @ 100000 /ha.
- Spray of NSKE @ 4.0 per cent
- Emergency spray of cypermethrin (0.0075%) or deltamethrin(0.0028%)
- Natural enemies like *Camptoclis chloridae*, *Bracon brevicornis* and *Trichogramma* spp are active in nature

Serpentine leaf miner

2. Serpentine leaf miner, *Liriomyza trifolii* (Agromyzidae: Diptera)

Distribution: All over the world.

Host plants: Large number of host plants including tomato, capsicum, potato, black gram, cowpea, peas, beans, cruciferous crops, cucurbits, okra, cotton, many ornamental plants and weeds

Damage:

- Damage is caused by the larvae
- Feed on the palisade mesophyll tissue in between the two epidermis of the leaf.
- Infested leaves become transparent papery in the mined areas
- Photosynthesis is reduced.
- The attack appears during April and is more pronounced from June onwards.

Identification:

- Eggs: Newly laid eggs are white, translucent and turn opaque as the development advances.
- Larvae: The larvae are orange yellow, apodous. They move through peristaltic action between the two epidermis. Full-grown maggots are 1.88 x 0.70 mm.
- Pupae: Orange yellow initially which turn dark-brown on maturity. They measure 1.84 X 0.68 mm
- Adults: The adults are minute grayish black flies with plum red eyes and a yellow spot on the scutellum. The females are bigger (2.01x0.61mm) in size than males (1.79x0.52 mm).

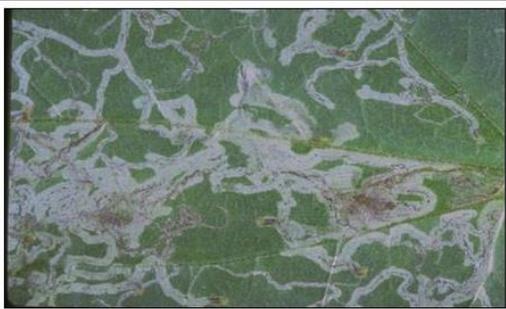


Plate 9.9: Mines on the leaf



Plate 9.10: Larva feeding in the mine



Plate 9.11: pupae of *L. trifolii*



Plate 9.12: Adult of *L. trifolii*

Life cycle:

- Eggs hatch in 2-3 days
- First, second and third larval stages develop in 2-3, 1-3 and 5-7 days
- Pupal period lasts for 8-10 days.
- Preoviposition period 1-3 days
- Oviposition period is 8-15 days.
- Post-oviposition period is for 1-3 days.
- Male longevity is 8-12 days
- Females live up to 13-17 days

Salient features

- The eggs are deposited singly in close proximity by embedding them in to the leaf tissue.
- Larvae feed through peristaltic action between the two epidermis
- Fecundity is 22-186 eggs
- Many generations in a year

Management:

- Judicious use of nitrogenous fertilizer reduces the build up of the pest in endemic areas.
- Severely infested leaves should be removed and destroyed.
- NSKE @ 4.0 per cent along with sticker is effective.
- The pest can be controlled by spraying the crop with triazophos (0.15%) or deltamethrin (0.0028%) or imidacloprid (0.0075%).
- Natural enemies especially larval and pupal parasitoids are active during July-August

Greenhouse whitefly

3. Greenhouse whitefly, *Trialeurodes vaporariorum* (Aleyrodidae: Hemiptera)

Distribution: Cosmopolitan

Hosts: Polyphagous

Damage:

- Caused by nymphs as well as adults
- Suck the cell sap from leaves
- Leaves turn yellow and dry away.
- Nymphs also excrete honey dew on which sooty moulds develops
- Photosynthesis of the plant is reduced.

Identification:

- Greenhouse whiteflies are small insects with white coloured wings
- The eggs are 0.2 to 0.25 mm x 0.08 to 0.12 mm
- Newly emerged nymphs are light yellow in colour
- Last nymphal instar is 0.70 to 0.90 x 0.40 to 0.60 mm



Plate 9.13: Adult greenhouse whitefly



Plates 9.14 & 9.15: Nymphs and exuviae of greenhouse whitefly



Plate 9.16: Sooty mould growth on honey dew on tomato leaf

Life cycle:

- Incubation period is 3 to 8 days
- Development of first, second, third and fourth instar nymph is completed in 2 to 6, 5 to 8, 3 to 5 and 3 to 6 days, respectively.
- The total life cycle is completed in 15 to 32 days.

Salient features:

- Remain hidden on the under surface of leaf.
- Eggs are stalked and remain suspended on the lower surface of the leaf
- Four nymphal stages
- Full grown nymph pupates in a yellow pupal case surrounded by a waxy palisade and waxy fringe.
- Many generations in a year

Management:

- Removal of weed hosts is important to reduce the incidence.
- Protect the nursery by using nylon nets (200 mesh) for 25-30 days.
- The pest can be controlled by need based spraying of crop with imidacloprid (0.0075%) or triazophos (0.15%) or deltamethrin (0.0028%).

Fruit flies

4. Fruit flies, *Bactrocera tau* (Tephritidae: Diptera)

Damage: Damage is caused by larvae which feed inside the fruit on fruit pulp and the fruit is rendered unfit for human consumption

Identification:

- Adults are light brown with lemon yellow curved vertical markings across the thorax
- On the apical margin of the forewing, grayish brown patches are present.
- Larvae are pale or reddish white which tapers anteriorly.
- The pupa is barrel shaped with dull to reddish yellow in colour.



Life cycle:

- Each female can lay 60 to 100 eggs.
- Eggs hatch in 1 to 4 days

- Maggots become fullfed in 4 to 7 days.
- Pupal period lasts for 7 to 13 days.

Salient features:

- Lay eggs inside the fruit.
- Larvae feed on pulp
- Full grown larvae come out of the fruit and pupate in soil
- Adults require proteins for their ovaries to mature

Management:

- Collect and destroy the fallen infested fruits regularly on campaign bases
- Frequently rake the soil to expose pupae.
- Apply poison baits (40 ml malathion + 200g gur / molasses per 20L of water) in the form of spray or bait stations.
- Mass trapping of adults using cue lure
- Larval parasitoid, *Biosteres dacusii* also attack the pest in nature

✓

Lecture - 10 INSECT PESTS OF TOMATO (Part - II)

Hadda beteles

5. Hadda beteles

Important species:

- *Henosepilachna vigintioctopunctata*
- *H. duodecastigma*
- *H. demurili*

Family: Coccinellidae

Order: Coleoptera

Distribution: India, south-east Asia

Host range: *H. vigintioctopunctata* and *H. duodecastigma* attack solanaceous and cucurbitaceous crops, while *H. demurili* attack only cucurbitaceous vegetables only.

Damage:

- The damage is caused by the beetles and the grubs
- The leaves are damaged by feeding on the chlorophyll tissue between veins
- Leaves are skeletonized

Identification:

- The grubs are about 6mm, yellow, with six rows branched spines.
- Beetles measure about 8 to 9 mm in length and 5 to 6mm in breadth.
- *H. vigintioctopunctata* beetles are deep copper coloured having 14 black spots on each elytron whose tip is somewhat pointed
- Beetles of *H. duodecastigma* are deep copper coloured with 6 black spots on each elytron whose tip is more rounded.
- *H. demurili* beetles are dull in appearance and light copper coloured with each elytron bearing 6 black spots surrounded by yellow margins.



Life cycle:

- The incubation period is 2- 3days
- Larval period is 14-18 days
- Pre-pupal period is 1-2 days
- Pupal period 4-5 days .
- Pre-oviposition period is 5-6 days
- Oviposition period is about 40-50 days
- Post-oviposition period is 10 days
- Adult longevity is 60-65 days (male) and 65-70 days (female)
- Several generations from March to October.

Salient features:

- Beetles resume their activity during March-April
- Hibernate as an adult in heaps of dry plants or in cracks and crevice in soil.
- Yellow cigar shaped eggs are laid mostly on the under surface of the leaves in clusters of 5 to 55 each.
- A single female can lay 200 to 700 eggs

Management:

- Collection and destruction of various stages of the pest.
- Larval parasitoids such as *Pediobius foveolatus* and *Uga menoni* are active in nature.
- The pest can be controlled by spraying the crop with malathion (0.05%

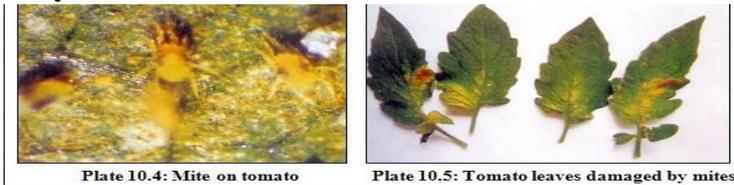
Phytophagous mites

6. Phytophagous mites, *Tetranychus urticae* (Tetranychidae: Acarina)

Damage:

- Caused by the larvae, nymphs and adults by sucking the cell sap from under side of leaves, flower buds and flowers.
- When population is high it results in bronzing and curling of leaves and discoloration of flowers and leaves.
- Webbing of leaves, sepals and petals occur which give untidy look to the plant.
- The infestation is more severe under poly house conditions.

Identification: Life cycle:



- Eggs hatch is about 2-4 days
- Newly emerged larva becomes protonymphs in about 2 days
- Protonymph stage is 2-3 days
- Deutonymph stage lasts for 1-3 days
- Male longevity is 9-13 days and females live for 14-20 days.

Salient features:

- Eggs are laid mostly along the midrib and side margins on the lower surface of the leaves.
- Weather factors play an important role
- Under dry and hot conditions the multiplication of these mites is very high and the infestation is also severe.
- High humidity and temperature reduces the reproduction of the pest and hence the incidence is low.

Management:

- Remove the old and infested leaves and burn them
- Try to avoid dry conditions and spray frequently with plain water at least twice a week with sprinkler.

- Observe the plants regularly for mite population and if incidence is noticed spray the crop with insecticides like or profenofos (0.05%) or fenazaquin (0.0025%) or propargite (0.057%)

Thrips

7. Thrips:

Important species: Blossom thrips, *Frankliniella schultzei*; Onion thrips, *Thrips tabaci*; Ground nut thrips, *Caliothrips indicus*

Distribution: Cosmopolitan

Host range: Polyphagous

Identification: Adults are fragile, slender, and minute with fringed wings.

Damage:

- Severely infested flowers wilt, fade and drop prematurely without bearing fruits.
- Lacerate the leaf tissue and imbibing the oozing sap.
- Pale and silvery sheens appear on the affected leaves.
- Blossom thrips, *Frankliniella schultzei* is also a vector for tomato spotted wilt virus which causes bud necrosis.

Life cycle:

- Parthenogenesis is the main mode of reproduction, though sexual reproduction also occurs.
- A female lays on an average 50 eggs and the life cycle is completed in about 13-33 days.
- Females live longer than males
- Several overlapping generations in a year

Management:

- Application of endosulfan @ 0.05 % or any other insecticide with low residual toxicity
- **Minor pests of tomato:**

| SN | Common name | Scientific name | Family | Order |
|----|---------------------|---|------------------------|----------------------------|
| 1 | Fruit sucking moths | <i>Otheris fullonica</i> , <i>O. materna</i> | Noctuidae Noctuidae | Lepidoptera Lepidoptera |

| | | | | |
|---|-----------------|---|------------------------------|------------------------|
| 2 | Cotton whitefly | <i>Bemisia tabaci</i> | Aleyrodidae | Hemiptera |
| 3 | Mealy bug | <i>Ferrisia virgata</i> | | Hemiptera |
| 4 | Aphids | <i>Aphis gossypii</i> <i>Myzus persicae</i> | Aphididae Aphididae | Hemiptera Hemiptera |
| 5 | Cotton jassid | <i>Amrasca bigutulla</i> <i>bigutulla</i> | | Hemiptera |
| 6 | Potato jassid | <i>Empoasca punjabensis</i> | | Hemiptera |
| 7 | Bugs | <i>Cyrtopeltis tenuis</i> <i>Nezara viridula</i> | Pentatomidae Pentatomidae | Hemiptera Hemiptera |

Lecture - 11 Insect Pests of Egg Plant

Brinjal shoot and fruit borer

1. Brinjal shoot and fruit borer, *Leucinodes orbonalis* (Pyraustidae: Lepidoptera)

Distribution: Indian sub continent, South Africa. Congo, Laos, Thailand and Malaysia.

Host plants:

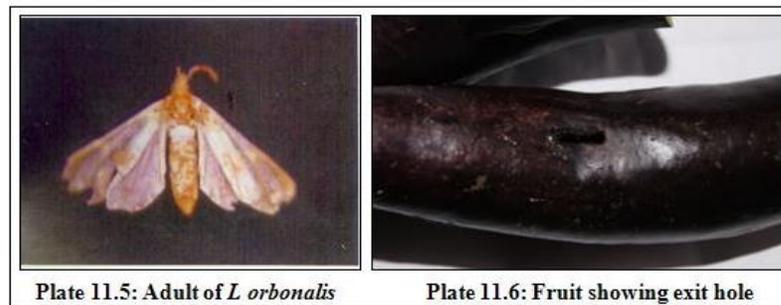
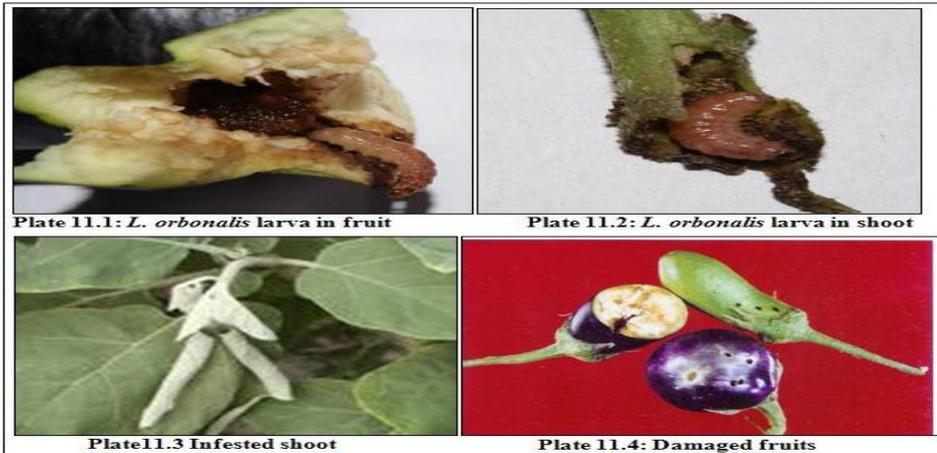
- Most destructive pest of egg plant.
- Has also been reported from potato, and other solanaceous vegetables

Damage:

- Damages the crop from seedling stage till the harvest
- In young plants, the caterpillars result in dead hearts
- Later on they bore into flower buds and fruits
- Enter from under the calyx, seal the hole with excreta
- The damaged flower buds are shed without blossoming
- Fruits show circular exit holes.
- These fruits become unfit for human consumption and lose market value
- Infestation up to 70 per cent may be recorded

Identification:

- Eggs are flattened elliptical, 0.5 mm, creamy white
- Full grown caterpillars are 15-18 mm long and light pink in colour
- Moths are medium sized with white wings.
- Fore wings have conspicuous black and brown patches and dots.
- Hind wings are opalescent with black dots along the margins.
- Wing span is 22-26 mm.



Life cycle:

- A single female lays about 250 eggs
- Eggs hatch in 3-5 and 7-8 days during summer and winter, respectively.
- Larval duration is 12-15 days (summer) and 22 days (winter).
- Prepupal period is 3-4 days
- Pupal period lasts for 7-10 days during summer and about 15 days during winter.

Salient features:

- The pest remains active throughout the year in moderate climate
- Eggs are laid singly on ventral surface of leaves, shoots, flower buds and sometimes on fruits also
- Pupation takes place on stems or fruits in grey colours tough cocoons.
- Pest over winters in the larval stage.

Management:

- Avoid continuous cropping.
- Grow less susceptible varieties like Arka Kesav, Pusa Purple Round, Arka Kasumakar, Pusa Purple Cluster, Pusa Purple Long, Punjab Barsati, Kalyanpur 2, Punjab Chamkila
- Intercropping with coriander/ fennel as single row/ double row or border crop
- Collect all attacked shoots and fruits at regular intervals and bury them deep.

- Use sex pheromones @ 100/ ha (10x10m)
- Periodic releases of *Trichogramma chilonis* @ 100000 parasitised eggs/ha
- Bt formulations @ 500g/ha
- NSKE @ 4.0 per cent.
- Spray cypermethrin (0.01%) of fenvalerate (0.01%) or deltamethrin (0.0028%) or cartap hydrochloride (0.2%).
- Parasitoids like *Trathala flavoorbitalis* and *Goryphus nursei* are also active against this pest in nature.

Brinjal stem borer

2. Brinjal stem borer, *Euzophera perticella* (Phycitidae: Lepidoptera)

Distribution: All over the Indian subcontinent.

Host range: Brinjal, potato, chillies, tomato, etc.

Damage:

- Damage is caused by the caterpillars
- Feed inside the stem
- Bore in to the stem and move down ward
- The attacked plants wither and wilt, growth remains stunted and bear less fruits
- Infestation is generally seen in the late stage of the crop.

Identification:

- The eggs are cream coloured, scale like
- Full grown caterpillars are 16-18 mm in length and light brown in colour.
- Pupae are dark brown.
- Moths are medium sized, fore wings are pale rufous with distinct dentate vertical black lines
- Hind wings are whitish in colour.
- Wing expanse is 26 and 32 mm in male and female of, respectively.

Life cycle:

- A single female may lay 104-363 eggs
- Adult longevity is about 7 days.
- The incubation period is 3-10 days.
- The larvae become full fed in 26-58 days
- Five larval stages.
- Pupal period is 6-8 days
- Total life cycle is completed in 35-76 days
- 5-6 overlapping generations in a year.

Salient features:

- The insect is active from March to October
- Hibernates as larva in the stems of old plants from November to beginning of March
- Eggs are laid singly or in batches on tender leaves, petioles and branches
- They pupate inside the feeding galleries or in cracks and crevices in soil after making silken cocoons.

Management:

- Control measures suggested for brinjal shoot and fruit borer are effective against this pest.
- Check the infestation at the initials stage by uprooting and destroying the infested plants.
- Ratoon crop should be avoided.
- Parasitoids like *Pristomerus testaceous* and *P. euzopherae* are active in nature.

| Brinjal lace wing bug, Hadda beetles and Egg plant leaf roller | | | | |
|---|--|-------------|-------------|------------|
| 3. | Brinjal | lace | wing | bug |
| Common name: | Brinjal | lace | wing | bug |
| Family: | | | | Tingidae |
| Order: | | | | Hemiptera |
| Important species: | | | | |
| | <ul style="list-style-type: none"> • <i>Urentius sentis</i> • <i>U. hystricellus</i> | | | |
| Distribution: | North | western | parts | of India. |
| Host range: | | | | Brinjal |
| Damage: | | | | |
| | <ul style="list-style-type: none"> • Both adults and nymphs cause the damage by sucking the cell sap from leaves. • Infested leaves show yellowish spots • Excreta impart mottled appearance to the infested leaves. • Young nymphs feed gregariously on the lower surface of the leaves • Inject some toxic saliva. • Under severe infestation upto 50% of the crop may be destroyed. | | | |
| Identification: | | | | |

- Nymphs are about 2 mm, pale, stoutly built with prominent spines.
- Adults are about 3 mm, straw coloured dorsally and dark brown to black ventrally.
- Females are oval and males are elongated.
- Pronotum and elytra are reticulated
- Coastal area is hyaline with strong spines on the outer margins.
- Hind wings are whitish and transparent

Life cycle:

- Each female lays 35-44 eggs
- Adult longevity is 30-40 days
- The eggs hatch in 3-12 days
- Nymphs pass through 5 instars
- Nymphal period is 10-23 days.
- 8 overlapping generations in a year

Salient features:

- The pest is active from April to October
- Hibernates as an adult in cracks and crevices in the soil
- Eggs are laid singly in the tissue on the under side of the leaves
- Young nymphs fed gregariously
- The older nymphs feed individually
- Nymphs pass through 5 instars

Management:

- Apply dimethoate 30EC @ 1L /625L / ha

4. Hadda beetles

Described under the insect pests of tomato

5. Egg plant leaf roller

Common name: Egg plant leaf roller

Scientific name: *Antoba (Eublemma) olivacea*

Family: Noctuidae

Order: Lepidoptera

Host range: Brinjal, wild solanaceous plants.

Damage:

- Caterpillars fold leaves from tip down ward and feed within by scrapping the green matter
- Folded leaves wither and dry.
- Caterpillars may also bore into green shoots
- Withering of entire plant.

Identification:

- Full grown caterpillars are about 20 mm long, stout, purple, brown in colour and ornamented with yellow spots and hairs
- Moths are medium sized and ochreous white in colour
- Fore wings are slightly suffused with brown tinge and a large triangular olive green patch on the outer area
- Hind wings are white suffused with fuscous towards outer margin
- Wing expanse is 22-26 mm.

Management:

- Collect and destroy the rolled leaves with caterpillars and pupae inside.
- Spray carbaryl 0.1%.

Last

Leaf hoppers

6. Leaf hoppers

- Important species:
 - *Amrasca biguttula biguttula*
 - *Empoasca binotata*
 - *E. parathea*
 - *E. punjabensis*
- **Family:** Cicadellidae
- **Order :** Hemiptera

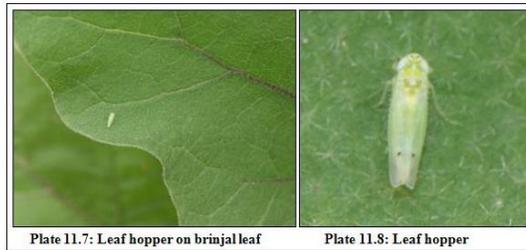
A. *Biguttula* is more common and destructive

Damage:

- Nymphs and adults suck the cell sap from ventral surface of leaves and inject toxic saliva into plant tissue
- Transmit viral disease called as little leaf

Identification:

Identification:



Detailed life cycle and management have been discussed under insect pests of okra

7. Aphids

Important species:

- Cotton aphid (*Aphis gossypii*)
- Peach green aphid (*Myzus persicae*).

Family: Aphididae

Order: Hemiptera

Distribution: Cosmopolitan

Hosts: Polyphagous

Damage:

- Nymphs and adults, suck the cell sap from leaves and tender apical shoots.
- The affected parts turn yellow, get deformed and dry away.
- Excrete honey dew on which sooty mould grows
- Interferes with the photosynthesis
- The infested plants become weak, pale and stunted in growth and consequently bear small sized fruits

Identification:

- Nymphs of *Aphis gossypii* are greenish brown or yellowish in colour
- Adults are yellowish green to dark green, 1mm, a pair of siphunculi near the posterior side of the abdomen.
- Wings when present are transparent with black veins.
- Adults of *M. persicae* are usually green in colour but may be pale brown to pinkish, 1.5-2.5 mm long with long clavate siphunculi.

Life cycle:

- *A. gossypii* breeds during winter on a number of vegetables including egg plant
- Migrate in the month of April to melon and by June end return to cotton.
- Reproduction is parthenogenetic viviparous but during cooler winter, eggs laid
- When the temperature rises, the eggs hatch and nymphs start feeding on blossoms.
- They mature in 3-4 days and reproduce parthenogenetically.
- When temperature rises and there is overcrowding, the alates are produced which migrate to other crops including egg plant.
- With the fall of temperature during winter again these aphids migrate to temperate fruits.

Management:

- Two to three sprays of dimethoate (0.05%) or metasystox (0.025%).
- Less susceptible varieties: GB1, GB6, Selection 1 and selection 4 should be preferred
- Predators like coccinellids, nymphets and some parasitoids are also active against these pests naturally

Minor pests of egg plant:

| | | | |
|----|----------------------|--|----------------------------|
| 1. | Cotton Aphid | Aphididae | Hemiptera |
| 2. | Brinjal leaf roller, | <i>Eublemma olivacea</i> | (Noctuidue: Lepidoptera) |
| 3. | Leaf roller | <i>Antoba olivacea</i> | (Noctuidue: Lepidoptera) |
| 4. | Green potato bug | <i>Nezara viridula</i> | (Pentatomidae: Hemiptera) |
| 5. | Jassids | <i>Amrasca devastans</i> , <i>Amrasea biguttula</i> | (Cicadellidae: Hemiptera) |
| 6. | Pumpkin stink bug | <i>Aspongopus janus</i> | Pentatomidae: Hemiptera |
| 7. | Brinjal meely bug | <i>Planococcus insolita</i> | Pseudococcidae: Hemiptera) |
| 8. | Leaf webber | <i>Parsa bipunctalis</i> | Pyraustidae: Lepidoptera |

Lecture - 12 Insect Pests of Chillies

Lecture - 12

Objectives: Chillies are the important cash crops grown throughout India which are attacked by a large number of pests. In the present lecture students will be taught about the host range, identification, nature of damage, life cycle and management of different pests attacking this crop.

Thrips, Aphids, White grubs and White flies

1. Thrips

Important species:

- Chilly thrips, *Scirtothrips dorsalis*
- Ground nut thrips, *Caliothrips indicus*
- Blossom thrips, *Frankliniella schultzei*

Family: Thripidae

Order: Thysanoptera

Host plants: Polyphagous

Damage:

- Nymphs and adults lacerate the host tissue and imbibe on the oozing sap.
- Tender leaves and growing shoots are preferred
- Sometime buds and flowers are also attacked
- Infested leaves start curling and crumbling
- Buds become brittle and drop down
- Incidence is more in dry weather
- Transmit leaf curl disease.
- 30-50 per cent crop may be destroyed.
- In mixed cropping of onion and chillies, both crops suffer badly.

Identification:

- Eggs are minute and dirty white
- Nymphs and adults are small, slender, fragile and yellowish-straw in colour.
- Fringed wings which are uniformly gray in colour.

Life cycle:

- Reproduction is both sexual and parthenogenetic
- Eggs are laid on just under the leaf tissues
- Oviposition period is about one month
- Each female lays about 100 egg
- Total life cycle is completed in 14-18 days
- Many overlapping generations in a year.

Management:

- Spray the crop with dimethoate @ 0.03% or methyl demeton @ 0.025% or phosphamidon @ 0.04%
- Predatory thrips like *Scolothrips indicus* and *Frankliothrips megalops* have been found feeding upon *Scirtothrips dorsalis* in the nature.

2. Aphids

Cotton aphid (*Aphis gossypii*)

Green peach aphid (*Myzus persicae*)



Details have been discussed under brinjal pests

3. White grubs

Discussed under potato

4. White flies

Discussed under tomato

Fruit borers, Fruit flies and Storage pests

5. Fruit borers

Longitarus nigripennis (Chrysomelidae: Coleoptera):

Helicoverpa armigera (Noctuidae: Lepidoptera)

Spodoptera litura (Noctuidae: Lepidoptera)

Euzophera perticella (Noctuidae: Lepidoptera)

Pepper top shoot borer, *Laspeyresia hemidoxa*

Fruit borer, *Longitarus nigripennis*

- serious pest of pepper
- Eggs are generally laid on fruits
- Grubs bore inside and feed within the fruits.
- Egg, grub and pupal periods are 5-8, 20-30 and 6-7 days, respectively
- Total life cycle is completed in 40-50 days
- 4 overlapping generations in a year.
- The pest over winters as adult stage.

Management:

- Insecticides recommended for the control of *H. armigera* are effective

6. Fruit flies

Bactrocera cucurbitae

- *B. tau*
- *B. dorsalis*

7. Storage pests

Cigarette beetle, *Lasioderma serricorne*

Drug store beetle, *Stegobium paniceum*

Family: Anobiidae

Order: Coleoptera

Identification and life cycle

- Grubs of *L. serricorne* are white, fleshy, crescent shaped with dense hairs all over the body
- Grubs of *S. peniceum* are also white and fleshy but not hairy
- *L. serricorne* beetles are 2-3 mm long, robust, oval
- Beetles of *S. paniceum* are slightly bigger in size, cylindrical in shape and light brown in colour having striated elytra.
- Incubation, Laval and pupal periods are 6-7, 17-29 and 4-8 days, respectively.

Management:

- If the quantity of chillies is small, spread them in thin layers under sunshine.
- If quantity is large, then fumigation with any good fumigant like ethylene bromide or methyl bromide @ 1kg/30 m³ space may be used.
- Fumigation should be done only in air tight containers or chambers.

Lecture - 13 Insect pests of Okra

Lecture - 13

Objectives: Okra is an important kharif vegetable grown all over the country. It is attacked by a large number of insect pests throughout the growth period. In this lecture the students will therefore be taught about the host range, damage symptoms, life cycle and management strategies for these pests. **Cotton leaf hopper and Shoot and fruit borers**

1. Cotton leaf hopper

Common name: Cotton leaf hopper

Scientific name: *Amrasca biguttula biguttula*

Family: Cicadellidae

Order: Hemiptera

Distribution: Cosmopolitan

Host range: Cotton, okra, eggplant, castor, cucurbits, hollyhock, potato, sunflower, and many other Malvaceous plants

Damage:

- Both nymphs and adults suck cell sap from the leaves.
- Also inject toxic saliva in to plant tissues
- Affected leaves turn yellowish and curl.
- In case of heavy infestation the leaves turn dark brick red, become brittle and crumble.

Identification

- The eggs are pear shaped, elongated and yellowish white in colour.
- Nymphs are whitish pale green, wingless
- Adults are wedge shaped, 2-3 mm long, pale green in colour with a black dot on posterior portion of each forewing
- Adults of winter generation are slightly reddish in colour.

Life cycle

- Incubation period is 4-10 days

- Nymphal period is 7-21 days
- Adult longevity is 5-8 weeks
- 10-12 overlapping generations in a year
- Each female lays 15-30 eggs
- Mating takes place 2-16 days after emergence
- Oviposition begins 2-7 days after copulation.

Salient features

- Eggs are laid singly in the tissues of main veins on the under surface of leaves
- There is no true hibernation or diapause but the adults have the ability to tide over the adverse climatic conditions.
- The pest appears with the onset of cloudy weather and their population is adversely affected after heavy monsoon showers.

Other species

- Jassids like:
 - *Empoasca binotata*
 - *Corizus rubicundatus*
 - Family: Cicadellidae
 - Order: Hemiptera

Management

- Seed treated with imidacloprid (3g/Kg) gives protection up to 40-50 days after sowing.
- Soil application with carbofuran @ 1.0 kg/ha at the time of sowing.
- Spraying the crop with insecticides like phosphamidon @ 0.04% or dimethoate (0.03%) or oxy- demeton methyl (0.025%) or imidactoprid (0.0075%).

2. Shoot and fruit borers

- Important species:
 - *Earias vittella*
 - *E. fabia*
 - *E. insulana*

Family: Noctuidae

Order: Lepidoptera

Distribution: North Africa, India, Pakistan and many other countries

Host range: Cotton, okra, sonchal, gulkhauca, holly hock and other malvaceous plants.

Damage:

- Larvae cause the damage
- Larvae bore into growing shoots, flower, flower buds and fruits
- Fruits become distorted and rendered unfit for consumption.

Identification

- Caterpillars are dull green, 20 mm, having tiny stout bristles and a series of longitudinal black spots on the body.
- The moths are yellow, about 25mm across the wings



Plates 13.2: Okra fruits damaged by *E. vittella*



Plate 13.3: Larva of *E. vittella*



Plates 13.4: Adult *E. vittella*

Life cycle

- The moths live for 8-22 days
- Lay 200-400 eggs
- Eggs hatch in 3-4 days
- Caterpillars become full grown in 10-16 days
- Six larval stages.
- Pupal period is 4-9 days.
- During winter the life cycle is prolonged
- Several overlapping generations in a year.

Salient features

- The pest breeds throughout the year but during winter only pupae are found hiding in plant debris
- Lay eggs singly on flower buds, brackets and tender leaves
- Pupation takes place either on the plant or on the ground among fallen leaves

Management:

- Neglected okra fruits left in the field should be collected and destroyed.
- Clean cultivation and destruction of alternate host in the vicinity.
- Deep ploughing during summer to expose the pupae
- Grow tolerant varieties like Parkins Long Green, AE-57, PMS-8, Karnal Special etc.
- Avoid over use of nitrogenous fertilizers.
- Soil application with carbofuran (1.0 kg/ha)
- Need based application of triazophos @ 0.15% or cypermethrin 0.01% or deltamethrin 0.0028% or fenvalerate 0.01%.

Cotton whitefly, Green house white fly and Red cotton bug **3. Cotton whitefly**

- Common name: Cotton whitefly
- Scientific name: *Bemisia tabaci*
- Family: Aleyrodidae
- Order: Hemiptera
- Distribution: Throughout the northern and western regions of the Indian sub continent.
- Host range: Cotton, okra, cabbage, cauliflower, sarson, toria, melon, potato, egg plant, tobacco and some weeds

Damage:

- Nymphs and adults suck the cell sap
- Lower the vitality of the plant
- They also excrete honey dew on which sooty mould grows which interferes with the photosynthesis of the plants
- Affected plants give a sickly black appearance.
- *B. tabaci* also transmits a number of viruses including vein clearing disease of okra

Identification

- The eggs are stalked, sub-elliptical and light yellow at first and turns brown later on
- Nymphs on emergence look elliptical
- They are sluggish creatures, clustered together on the underside of the leaves
- Their pale bodies make them stand out against the green background

Life cycle

- Incubation period is 3-5 days in April-September
- Nymphs grow through three stages
- Become pupae in 9-14 days during April to September
- Pupal period is 2-8 days
- Total life cycle is completed in 14-122 days.

Salient features

- The insect breeds throughout the year

- Lay eggs singly on the under side of the leaves
- Life cycle is prolonged during winter
- Nymphs grow through three stages

Management:

- Clean cultivation
- Seed treatment with imidacloprid @ 2.5 g/ Kg
- Protect nursery by using nylon nets (200 mesh)
- Insecticides like phosphamidon @ 0.04% or dimethoate @ 0.003% or oxy-demeton methyl @ 0.025% or imidacloprid @ 0.025%
- Parasitoids like *Eretmocerus sp* and *Encarsia sp.* and predator ,*Chysoperla zastrowi sillemi*

4. Green house white fly

Discussed earlier

5. Red cotton bug

- Common name: Red cotton bug
- Scientific name: *Dysdercus koenigii*
- Family: Pyrrhocoridae
- Order: Hemiptera
- Distribution: All over the Indian subcontinent.
- Host range: Cotton, okra, holly hock, maize, sorghum, millets , musk melon, hemp, rose and other malvaceous plants .

Damage:

- Both nymphs and adults suck the sap from fruits and leaves
- Devitalize the plants
- Feeding deprives the plants of carbohydrates, free amino acids and proteins

Identification

- The eggs are spherical, bright yellow
- Young nymphs have flabby abdomens



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- e
 - more slender and develop black markings on the body
 - Adults are red coloured bugs.

Life cycle

- lay on an average 100-300 eggs
- Eggs hatch in 7-8 days
- Nymphs complete their development in 49-89 days
- Five stages
- Adults' longevity is variable and may live up to 3 months during winter.

Salient features

- The insect is active throughout the year
- Passes winter in the adult stage
- During spring bugs become active
- Lay eggs in moist soil or in cracks and crevices in the ground in clusters

Management:

- Same as discussed under cotton jassids

Dusky cotton bug and Others

6. Dusky cotton bug

- Common name: Dusky cotton bug
- Scientific name: *Oxycarenus laetus*
- Family: Lygaeidae
- Order: Hemiptera

- Distribution: All over the Indian subcontinent
- Host range: Cotton, okra, hollyhock, and other malvaceous plants.

Damage:

- Nymphs and adults are damaging
- Suck the cell sap from leaves and fruits
- Reduces the vitality of the plants

Life cycle

- Eggs hatch in 5-10 days
- Nymphal period is 30-40 days
- 7 stages.
- Total life cycle is completed in 36-50 days

Salient features

- The pest is active throughout the year, but during winter only adults are found
- During spring cigar shaped eggs are laid on the leaves of okra or Hibiscus
- Eggs initially are whiteish but turns light pink before hatching

Management:

- Same as cotton jassid

7. Cotton leaf roller

- Common name: Cotton leaf roller
- Scientific name: *Sylepta derogata*
- Family: Pyralidae
- Order: Lepidoptera
- Distribution: Orient, Africa, Indian sub continent
- Host range: Cotton, okra and other malvaceous plants

Damage:

- Newly emerged caterpillars feed on epidermis of ventral surface of leaves
- Roll the leaves and feed within eating away large proportion of the rolled leaves.
- Initially more than one larvae can be found in one leaf roll
- Later on caterpillars disperse and attack more and more leaves.

Identification

- The eggs are round in shape and yellowish green in colour
- Caterpillars are shiny green in colour and more or less transparent

- Pupae are reddish brown
- Moths are yellowish white with both the fore and hind wings having brown lines and distinct markings
- Wing expanse is 30-38 mm.

Life cycle

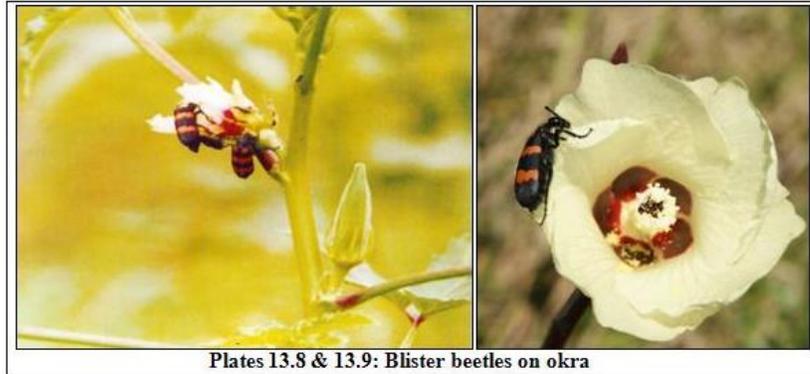
- Each female lay 200-300 eggs
- Incubation period is 2-6 days
- Larval development is completed in 15-35 days
- 7 stages.
- Pupal period is 6-12 days
- Adult longevity is about a week
- Total life cycle is completed in 23-53 days
- There are 5-6 overlapping generations in a year

Salient features

- The pest is active from March to October
- Passes the winter as a full grown caterpillar in plant debris or soil
- The hibernating larvae pupate by the end of February
- Moths emerge during March
- Lay eggs singly on the underside of the leaves
- Pupate inside the rolled leaves or plant debris in the soil
- Low temperatures, high RH, cloudy and rainy days favour hibernation
- Warm weather is conducive for rapid multiplication.

Management:

- Collect and destroy the rolled leaves with caterpillars inside.
- Irrigate & plough the field after harvesting to kill the hibernating caterpillars
- Chemicals recommended for *E. vittella* also control this pest.
- Parasitoids like *Trichogramma* spp. *Apanteles* spp.



Plates 13.8 & 13.9: Blister beetles on okra

- Discussed under bean

9. Phytophagous mites

- Discussed earlier

10. Cutworms, *Agrotis* spp

- Discussed earlier

11. Leaf miner



Plates 13.10 & 13.11: serpentine leaf miner on okra



Plates 13.12, 13.13 & 13.14: beetles on okra

Lecture 14 Insect Pests of Cucurbits

Lecture - 14

Objectives: The main objectives of this lecture will be to teach the students about the major as well as minor pests of cucurbits. Emphasis will be on the host range, identification, nature of damage, life cycle and ecofriendly management of these pests. **Fruit flies and Beetles**

1. Fruit flies:

- Important species:
 - *Bactrocera cucurbitae*
 - *B. tau*
- Family: Tephritidae
- Order: Diptera
- Distribution: India, Pakistan, Myanmar, Malaysia, China, Formosa, Japan, East Africa, Australia, Mauritius, Bangladesh, Sri-Lanka, Indonesia, Thailand, Philippines, Taiwan etc.
- Host plants: Melons, gourds, tomato, chillies, guava, citrus, pear, fig, cauliflower, cotton, sunflower, lettuce and other cucurbits.

Damage:

- The larvae feed inside the fruits
- Fruits become unfit for consumption and drop prematurely
- The young fruits can be destroyed in a few days,
- Older fruits show less symptoms, but on split opening, a mass of maggots in pulp is found
- In melons the infestation sometimes reaches up to 100 per cent
- Infested fruits are also attacked by microbes

Identification

- The maggots are apodous, dirty white
- Full grown maggot measures 9-10 mm in length and 2 mm in breadth
- The adult flies are reddish brown with lemon yellow marking on the thorax
- Fuscous areas on the outer margins of their wings

Life cycle

- Adult longevity is 14-54 days
- Each female on an average lays 58-95 eggs

- The incubation period is 1-9 days
- Larval period extends from 3 days in summer to 21 days in winter
- Pupal period is 5-9 days in summer and may be extended upto 30 days in cold weather
- Total life cycle is completed in 12-34 days
- There are several generations in a year

Salient features

- The flies hibernate during winter months
- Become active in hot weather and breed during monsoon.
- After mating it takes few days for eggs to mature inside the body
- Lay eggs inside the fruits singly or in groups of 4-10
- Freshly hatched maggots bore into the pulp forming galleries.
- Full grown maggots come out of the fruits and drop to the ground and pupate in the soil at a depth of 1.5-15 cm

Management

- Collection and destruction of infested fallen fruits regularly
- Frequent raking of the soil under the vine
- Ploughing the infested field after the crop is harvested
- Bait spray or bait stations
- Attractants/ lures

2. Hadda beetles:

- Discussed under tomato

3. Red pumpkin beetle, *Aulacophora foveicollis* (Chrysomelidae: Coleoptera)

- Distribution: Tropical, sub-tropical and temperate regions of the world
- Hosts: Cucurbits.

Damage:

- Both grubs and beetles are damaging
- Grubs feed on underground plant parts
- Beetles damage cotyledons, flowers and tender leaves
- Adults are very destructive particularly during the initial stage of crop growth
- Some times resowing is required

Identification:

- Adults are orange coloured, 6-8 mm long with black ventral surface clothed with hairs.



Plate 14.1: Red pumpkin beetle

Plate 14.2: Damage by red pumpkin beetle

Life cycle

- Each female can lay 150-300 eggs
- The egg, larval and pupal period varies from 6-15, 13-25 and 7-17 days, respectively
- Total life cycle is completed in 1-2 months
- There are 3-4 generations in a year

Salient features

- Lay eggs, singly or in clusters of 8-9, in moist soil around the base of the plants
- Pupation takes place in oval, water proof earthen cells in the soil.
- Adults hibernate during winter in the soil
- Beetles resume activity during March and remain in the field till October
- Peak activity is in April-June
- September onwards, the population starts declining.

Management:

- After the crop is over, plough the field deep to kill the grubs present in the soil.
- Collection and destruction of adult beetles reduces the population.
- Spray of carbaryl 0.1% or malathion 0.05%.

4. Blister beetles

- Discussed under okra/ bean



Plates 14.3 & 14.4: Blister beetles on okra
Stink bugs and Other

5. Stink bugs

- Common name: Stink bugs
- Scientific name: *Aspongopus janus*, *A. brunneus* and *A. observus*
- Family: Pentatomidae
- Order: Hemiptera
- Distribution: All over India
- Host range: Cucurbits especially pumpkins and gourds

Damage:

- Both nymphs and adults suck the cell sap and there by devitalizing the plant and retarding their growth
- Life cycle
- The eggs are deposited in long rows clinging to the leaves and tender shoots.
- Incubation period is 9-10 days
- Nymphal duration lasts for 24-28 days
- The bugs emit characteristic buggy smell hence the common name stink bug.

Identification

- Adults are flat, medium sized bugs.
- *A. janus* is about 30 mm long, pronotum and base of elytra are bright red while head and wings membranes are black.
- *A. brunneus* is pale brown in colour and slightly smaller in size.

Management

- In early stage of attack collect and destroy the leaves and twigs bearing congregating bugs.
- Spary carbaryl 0.1%

6. Serpentine leaf miner

- Discussed under tomato

7. Phytophagous mites

- Discussed under tomato

8. Green house whitefly

- Discussed under tomato

Minor pests

| S.N. | CN | SN | Family | Order | Feeding habit |
|------|-----------------------|-------------------------------|---------------|-------------|---------------|
| 1. | Cotton aphid | <i>Aphis gossypii</i> | Aphididae | Hemiptera | Sap sucker |
| 2. | Flea beetle | <i>Phyllotreta cruciferae</i> | Chrysomelidae | Coleoptera | Leaf feeder |
| 3. | Green peach aphid | <i>Myzus persicae</i> | Aphididae | Hemiptera | Sap sucker |
| 4. | Leaf footed plant bug | <i>Leptoglossus australis</i> | Coreidae | Hemiptera | Sap suckers |
| 5. | Leaf hoppers/ jassids | <i>Eutettix phycitis</i> | Jassidae | Hemiptera | Sap suckers |
| | Leaf hoppers/ jassids | <i>Empoasca binotata</i> | Cicadellidae | Hemiptera | Sap suckers |
| 6. | Mirid bugs | <i>Creontiades pallidifer</i> | Miridae | Hemiptera | Sap suckers |
| | | <i>Cyrtopeltis tenuis</i> | Miridae | Hemiptera | Sap suckers |
| 7. | Noctuid caterpillar | <i>Anadevidia peponis</i> | Noctuidae | Lepidoptera | |
| 8. | Plume moth | <i>Sphenarches caffer</i> | Pterophoridae | Lepidoptera | |
| 9. | Pumpkin | <i>Diaphania indica</i> | Pyraustidae | Lepidoptera | |

| | | | | | |
|-----|---------------------|---------------------------|---------------|------------|-------|
| | caterpillar | | | | |
| 10. | Stem gall fly | <i>Lasioptera falcata</i> | Cecidomyiidae | Diptera | Borer |
| 11. | Stem boring beetles | <i>Apomecyna spp</i> | Lamiidae | Coleoptera | Borer |

Lecture 15 Insect Pests of Peas

Lecture - 15

Objectives: Pea is an important vegetable grown all over the country. In Himachal Pradesh, it is mainly grown as off season vegetable and is an important source of income for the farmers. But, at the same time it is attacked by a large number of insect pests throughout the growth period. In this lecture efforts have been made to discuss the host range, damage symptoms, life cycle and management strategies for important pests of peas.

Pea pod borers and Leaf Miner

1. Pea pod borer/ Lentil pod borer, *Etiella zinckenella* (Phycitidae: Lepidoptera)

- Distribution : India, Myanmar, Sri Lanka
- Host range : Serious pest of lentil, peas and other pulse crops

Damage

- Damage is caused by the caterpillars.
- Feed on floral parts, newly formed pods and seeds inside the developing pods
- Heavy reduction in the yield.

Identification

- Newly emerged caterpillars are greenish
- Full grown larvae are rosy with purplish tinge
- The moths are grey with a wing expanse of about 25 mm
- The forewings have dark marginal lines and orcheous scales.

Life cycle

- Eggs hatch in 5 days at 25°C,
- The larval stage is completed in 10-27 days.
- Pupal development is completed in 10-15 days.
- Completes five overlapping generations.

Salient features

- The moths emerge during February-March
- Lay eggs singly and/or in clusters on various parts
- The newly emerged larvae feed on floral parts
- Subsequently bore into the pods and feed on the developing seeds.
- Pupate in the soil at a depth of 2-4 cm

- Breeds throughout the year

Management:

- At flower initiation, spray the crop with deltamethrin @ 0.0028%
- Insecticides recommended for the control of *H. armigera* are also effective

2. Tomato fruits borer, *Helicoverpa armigera*

- Discussed under the insect pests of tomato.

3. Pea Leaf miner, *Chromatomyia horticola* (Agromyzidae: Diptera)

- Hosts: Peas, Brassica crops and some ornamentals.

Damage:

- Maggots mine in to leaves
- feed on mesophyll leaving the two epidermal layers intact
- The mines start from the periphery and ends up towards the mid rib
- Photosynthesis is considerably reduced
- Under severe infestation leaves wither away and are shed
- Flowering and fruiting is reduced considerably.

Identification

- The eggs are oval, spherical, translucent white when freshly laid but turns dull white before hatching
- The larva is translucent white and the inverted 'Y' shaped oral hook is clearly visible
- Pupa is fusiform with distinctly defined segments
- Initially it is light brown but turns dark towards maturity.
- Adults are two winged flies having grayish black mesonotum.
- Females are black with brown head



Plate 15.1: Mines on pea leaves



Plate 15.2: Adult pea leaf miner



Plate 15.3: Pupae inside the mines

Life cycle

- Incubation is 1-2 days.
- Larval period is 6 days.
- Pupal stage lasts for 9-10 days
- Adult longevity is 27 days (females) and 10 days (males)
- Mating occur after 1-8 days of emergence
- A female on an average lays 294 eggs during its life.

Salient features

- Lay eggs inside the leaf tissue.
- One egg is laid in one insertion.
- Most of the eggs are laid near the leaf margin.
- Pupate inside the mine

Management:

- Application of oxy- demeton methyl, dimethoate, chlorpyrifos, have been reported effective against this pest.
- Large number of larval (*Diglyphus* sp, *Neochrysocharis* sp, *Asecodes* spp, etc.) and larval- pupal (*Opius* sp) parasitoids are active in nature
- Avoid insecticides when parasitoids are active.

Pea stem fly, Pea aphid and Pea leaf roller

4. Pea stem fly or bean fly, *Ophiomyia phaseolii* (Agromyzidae: Diptera)

- Distribution: Sri Lanka, India, China, Indonesia, Malaysia, Philippines, Singapore and many African countries.
- Host range: Cowpea, peas, lima bean, soybean and many other beans.

Damage:

- The maggots mine through the leaf petioles into stems
- Females also puncture the leaves.
- Leaves turn yellow, giving the plants a dry appearance.
- The stems turn brown, become swollen and break down.
- Spring crop suffers less than the late summer crop
- The attacked plants bear fewer pods which are mostly empty or having very small seeds.

Identification

- Eggs are slender, oval, less than 0.5 mm long and white in colour.
- Maggots are initially white, but later turn yellowish.
- They are small in size (less than 1mm)
- Pupae are barrel shaped and brown in colour.
- Adults are metallic black flies, 2.0 to 2.5 mm
- Hyaline wings having a distinct notch in the coastal regions.
- Female are slightly bigger than males, wing expanse is on an average 5mm.

Life cycle

- Total life cycle is completed in 2-3 weeks.
- As many as seven generations.
- The flies mate 2-6 days after emergence
- Start oviposition 2-4 days after mating.
- Incubation, larval and pupal periods last for 2-4, 9-12 and 18-19 days, respectively, during Nov-Dec.
- Average longevity of male is 11 days; however, females can live up to 22 days.

Salient features

- Eggs are laid singly in holes made on the upper surface of young leaves, especially near the petiole end.
- On hatching, the maggot forms a short linear leaf mine
- Further tunnels to the stem through leaf stalk
- Pupation takes place inside the stem.

Management:

- Remove and destroy all the affected branches during the initial stage of attack
- In case of wide spread incidence, spray the crop with diamethoate @ 0.03% or oxydemeton methyl @ 0.025%
- Soil application of phorate 10G @ 10kg/ha is effective up to 40 days of sowing.

5. Pea aphid, *Acyrtosiphum pisum* (Aphididae: Hemiptera)

- Distribution: Cosmopolitan
- Host range: Peas

Damage:

- Nymphs and adults such the cell sap
- Affected leaves get cupped or become irregularly distorted
- Shoots become stunted and malformed
- Also excrete honey dew which encourage sooty mould
- Photosynthesis is affected
- Plants become weak and the pod formation is adversely affected.

Identification

- Adult aphids are large pear shaped, green, yellow or pink in colour with long conspicuous cornicles.
- Both alates as well as apterous forms are present

Life cycle

- Both alates as well as apterous forms are present
- Only females and males are rare.
- Males have been reported from Europe and USA but not from India.
- Reproduction is parthenogenic and viviparous
- About a week to complete one generation
- Several overlapping generations in a year.

Management

- This pest can be controlled by spraying the crop with dimethoate @ 0.03 per cent or oxydemeton methyl @ 0.025 per cent.
- Parasitoids also take care of this pest in nature

6. Pea leaf roller, *Hedylepta (Nacoleia) indicata* (Pyraustidae: Lepidoptera)

- Hosts: Peas

Damage

- Young caterpillars feed on green tissues of leaves
- Later stages of caterpillars web the leaves together and feed within the folds
- Skeletonizing the leaves completely.

Identification

- Eggs are flat and scale like
- Moths are fulvous yellow with abdomen showing white rings
- Wings are suffused with fuscous except costa of fore wing and have discocellular spot
- Fore wings have obliquely curved antemedial black line

- Hind wings have post medial line bent outwards between vein 5 and 2.
- Wing expanse is about 20 mm.

Life cycle

- Incubation period is 4-6 days,
- Larval period is 13-15 days
- Pupal period is 5-6 days,
- Adult longevity is 5-6 days.

Salient features

- Eggs are laid on the leaves in clusters of about 15 eggs each
- On hatching the young caterpillars feed on green tissues of leaves
- Latter they web leaves together and feed within the folds

Management

- In nature, *Cardiochila fulvus* and *Xanthopimpla punctata* have been recorded parasitizing the caterpillars.
- Need based spray of deltamethrin @ 0.0028%

Pea blue butterfly and Groundnut thrips

7. Pea blue butterfly, *Lampides boeticus* (Lycaenidae: Lepidoptera)

- Distribution: India, Myanmar, China, Japan, Europe etc.
- Host plants: Pea, Lima bean, Hyacinth bean, Snap bean, Urd bean, moong bean, pigeon pea etc.

Damage:

- Damage is caused by caterpillars
- Bore in to the buds, flowers and green pods
- Reduce the yield considerably.

Identification

- Newly emerged larva is green with yellowish tinge, black head
- The full grown larva is yellowish green to yellowish red.
- Pupa is dark brown
- Adult is a blue coloured butterfly

Life cycle

- Eggs hatch in 4-6 days
- The larva passes through five instars
- larval period varies from 22-35 days
- The pupal stage lasts for 6-7 days
- Adult longevity is 2-5 days.

Salient features

- Lay eggs on buds, flowers and green pods
- Larvae feed on developing seeds
- Five instars
- Pupation takes place on leaves or in the infested pod itself

Management:

- Carbaryl 0.1%

8. Groundnut thrips, *Caliothrips indicus* (Thripidae: Thysanoptera)

- Host range: Peas, cowpea, Indian bean etc.

Damage:

- Damage is caused by both nymphs and adults by feeding on cell sap
- They lacerate the leaf surface and suck the oozing sap
- White patches develop on the infested leaves
- The pest is active at flowering and both the yield and viability of the seeds are reduced
- A severe infestation results in the formation of white silvery sheens all over the leaf surface

Life cycle

- The pest is active at flowering
- On garden pea the pest has been recorded from germination stage till harvest
- Life cycle is completed in 2-4 weeks
- Several overlapping generation is a year.

Management:

- Systemic/other insecticides with low residual toxicity recommended for other pests are also effective against this pest.

Minor pests of peas:

| | | |
|----|-------------------------|--|
| 1. | Bihar hairy caterpillar | <i>Spilarctia (Spilosoma) obliqua</i> (Arctiidae: Lepidoptera) |
|----|-------------------------|--|

| | | |
|-----|---------------------|--|
| 2. | Rice army worm | <i>Mythimna separata</i> (Noctuidae: Lepidoptera) |
| 3. | Tobacco caterpillar | <i>Spodoptera litura</i> (Noctuidae: Lepidoptera) |
| 4. | Tussock moth | <i>Euproctis fraterna</i> (Lymantriidae: Lepidoptera) |
| 5. | Tussock moth | <i>Porthesia scintillans</i> (Lymantriidae: Lepidoptera) |
| 6. | Pea stem borer | <i>Grapholita (Lasperesia) torodelta</i> (Eucosmidae: Lepidoptera) |
| 7. | Pea stem borer | <i>Leguminivora (Laspeyresia) tricenra</i> (Eucosmidae: Lipidoptera) |
| 8. | Leaf eating beetle | <i>Madurasia obscurella</i> (Chrysomelidae: Coleoptera) |
| 9. | Gujhia weevil | <i>Tanymecus indicus</i> (Curculionidae: Coleoptera) |
| 10. | Cotton whitefly | <i>Bemisia tabaci</i> (Aleyrodidae: Hemiptera) |
| 11. | Leaf hoppers | <i>Empoasca kerri motti</i> (Cicadellidae: Hemiptera) <i>Empoasca binotata</i> (Cicadellidae: Hemiptera) |
| 12. | Sunnhemp bug | <i>Ragmus importunitas</i> (Miridae: Hemiptera) |
| 13. | Coreid bug | <i>Anoplocnemis phasiana</i> (Coreidae: Hemiptera) |
| 14. | Pod borers | <i>Adisura atkinsoni</i> Noctuidae: Lepidoptera) <i>Exelastis atomosa</i> (Pterophoridae: Lepidoptera) <i>Maruca testulalis</i> (Pyraustidae: Lepidoptera) |

Lecture 16 Insect Pests of Beans

Lecture - 16

Objectives: Like Peas, bean is also an important source of income for the farmers, but attacked by a large number of insect pests throughout the season. Through this lecture students will be acquainted with the host range, damage symptoms, life cycle and management strategies for important pests of beans. **Black bean bug, Beetles and Pod Borers**

1. Black bean bug, *Chauliops nigrescens* (Lygaeidae: Hemiptera)

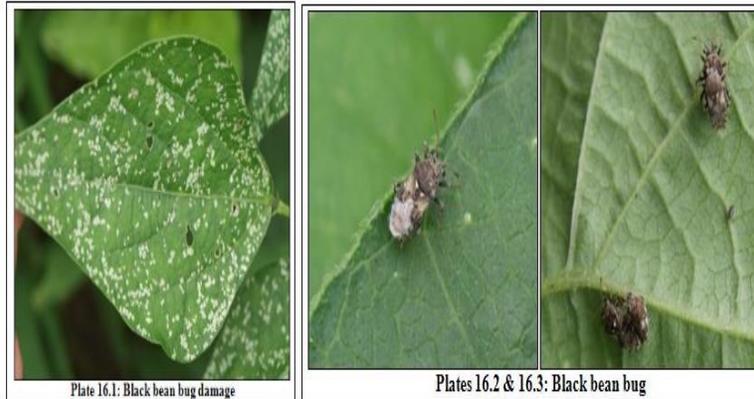
- Distribution: Sri Lanka, Japan, south-eastern Australia, India etc. In India it is serious in northern states on many beans.
- Host range: Soybean, cowpea, mothbean, French bean, horse gram and green gram.

Damage:

- Both nymphs and adults suck the cell sap
- Reduction of chlorophyll content
- Less photosynthesis
- Quality and the yield both are greatly reduced.
- Severely damaged leaves show several minute yellow specks and small black pustules of excreta.
- Leaves gradually wither and fall of.

Identification

- The eggs are cylindrical, dark brown
- Newly emerged nymphs are light orange in colour and 0.07 x 0.02 mm
- Fourth instar nymphs are dull red and 1.9 x 0.9 mm.
- Fifth stage nymphs are dark brown, 2.4 x 1.2 mm
- The average size of female and male is 2.75 x 1.00 and 2.85 x 1.25 mm, respectively.



Life cycle

- Incubation period is about 8 days
- Nymphs mature through 5 instars
- The total nymphal period is completed in 18-23 days.
- Pre-oviposition period is about 9 days,
- oviposition period is 15 days.
- Adult longevity is about 25 days in females and in 21 days in males.

Salient features

- The adult bugs appear during the on set of monsoon
- The eggs are laid singly or sometimes in pairs glued to the leaf surface
- Fecundity is 45 eggs.
- There are 3 overlapping generations in a year.

Management:

- Spray of phosphamidon, dichlorvos, dimethoate or oxy-demeton methyl at 0.05 per cent and malathion at 0.1 per cent

2. Blister beetles

- Discussed earlier

3. Bean pod borer, *Adisura atkinsoni* (Noctuidae: Lepidoptera)

- Distribution: All over the Indian subcontinent

Damage:

- Caterpillars bore into developing pods
- Feed on ripening seeds
- Reduces the yield considerably.

Identification

- Eggs are small and spherical.
- Caterpillars are cylindrical, brownish green in colour, 25-33 mm long when full fed
- Moths are medium sized and pale yellowish brown in colour
- Fore wings are brown with grey tinge and outer margins pinkish
- Hind wings are straw yellow in colour
- Wing expanse is 30-35 mm

Life cycle

- Incubation, larval and pupal periods last for 3, 14-15 and 11 days, respectively.

Salient features

- The eggs are laid singly on leaves, buds, flowers and young pods
- On hatching, caterpillars bore inside the developing pods and feed inside
- Usually pupate in the soil, sometimes on flower spikes also.

4. Plume moth, *Exelastis atomosa* (Pterophoridae: Lepidoptera)

- Distribution: All tropical regions of the world
- Host range: Indian bean, red gram, horse gram, pigeon pea etc.

Damage:

- Tiny caterpillar bore into the pods and feed on developing seeds
- Do not bore completely, but the posterior abdominal portion remains out side
- Sometimes the caterpillars emerging from eggs laid on flower buds enter into these buds and feed inside.

Identification

- Eggs are minute in size, about 0.5 mm long oval in shape and pale green in colour.
- Full grown caterpillars are 10-14 mm long, moderately stout, greenish and covered with spine like hairs

Legume Pod borer and Hairy Caterpillars

5. Legume pod borer or spotted pod borer, *Maruca testulalis* (Pyraustidae: Lepidoptera)

- **Distribution:** All tropical and subtropical regions of the world.
- **Host range:** Beans, peas, castor, ground nut, tobacco etc.

Damage:

- Caterpillars feed on reproductive parts of the flower
- Later they web the inflorescence with leaves, pods and then feed within
- Infested flowers do not develop into pods
- Affected pods become malformed
- Occasionally the older caterpillars also bore into peduncles and stems.

Identification

- Eggs are elongated oval in shape, less than 1mm in length, light yellow in colour
- Full grown caterpillars are 20mm long, light brown in colour with irregular brownish black dorsal, lateral and ventral spots
- Adults are medium sized slender moths.
- Hind wings are semi hyaline white with a brown distal patch.
- Wing expanse is 20-30 mm fore wings are brown with white spots.

Life cycle

- Eggs are laid singly on or near flower buds of the host plants
- Incubation period is 2-3 days
- Larval period is 8-4 days
- Prepupal period is 2 days
- Pupal period is 6-9 days
- Pupation takes place in debris or on soil surface.

6. Other pod borers

- Gram pod borer, *Helicoverpa armigera* (Noctuidae: Lepidoptera)
- Pea pod borer, *Etiella zinckenella* (Phycitidae: Lepidoptera)
- Pea pod borer, *Sphenarches caffer* (Pterophoridae: Lepidoptera)
- Blue butterfly, *Eucharysops cnejus* (Lycaenidae: Lepidoptera)
- Pea blue butterfly, *Lampides boeticus* (Lycaenidae: Lepidoptera)

Management of pod borers:

- Control measures recommended for *H. armigera* are effective against these borers also.
- Larval parasitoids *Macrobracon hebetor*, *M. greeni*, *M. brevicornis* are effective

7. Bihar hairy caterpillar, *Spilarctia obliqua* (Arctiidae: Lepidoptera)

- Distribution: Distributed in the orient. In India, it is serious in Bihar, MP, UP and Punjab.
- Host range: Polyphagous

Damage:

- Damage is caused by the caterpillars
- Eat away leaves and soft portions of stems and branches

- In severe, infestation the entire plant can be defoliated

Identification

- Eggs are light green and spherical
- Larvae are 40-45 mm when full grown and are covered profusely with grey hairs.
- Moths measure about 50 mm across the wings
- The head, thorax and under side of the body are dull yellow
- Antennae and eyes are black.



Life cycle

- The eggs hatch in 8-13 days
- Larval development is completed in 4-8 weeks
- Passing through seven stages
- Pupal stage last for 1-2 weeks
- Moths live for about a week
- Total life cycle is completed in 6-12 weeks
- 3-4 generations in a year.

Salient features

- The pest breeds during March-April and again from July to November
- Passes the hot summers and winter in pupal stage in plant debris.
- Adults emerge from the over wintering larvae in March
- Lay eggs in clusters on the underside of leaves
- Early instars are gregarious but later on they disperse
- Pupate in plant debris or in the soil

Management

- Collection and destruction of early gregarious caterpillars
- Pupae may be collected and destroyed at the time of summer ploughing
- Spray malathion @ 0.05% or dichlorvos @ 0.04%

8. Red hairy caterpillar, *Amsacta moorei* (Arctiidae: Lepidoptera)

- **Distribution:** Widely distributed in the orient including India.
- **Host range:** Polyphagous

Damage

- Caterpillars are damaging
- Young caterpillars prefer the growing points
- Older ones feed voraciously on all types of vegetation
- Moving army destroy field after field.
- Under sever infestations there can be complete failure of the kharif crops.

Identification

- Caterpillars are 25 mm, reddish amber with numerous long hairs
- Moths are stoutly built and have white wings with black spots
- The outer margins of the fore wings the anterior margin for the thorax and the entire abdomen is scarlet red
- There are black bands and dots on the abdomen.

Life cycle

- A single female can lay up to 1500 eggs
- Eggs hatch in 2-3 days
- Caterpillars grow through six stages
- Larval period is 15-23 days
- Pupate in soil
- Moths emerge next year.

Salient features

- This pest is active from mid June to the end of August
- Passes rest of the year in pupal stage in the soil
- Moths emerge usually with the first shower of the monsoons
- Eggs are laid in clusters on the under surface of the leaves
- The young caterpillars feed gregariously
- Pupate in soil

Management

- Use light traps.
- Collect and destroy young gregarious larvae
- Pupae may be collected and destroyed at the time of summer ploughing
- The pest can be controlled by spraying the crop with either of the following insecticides.
- Quinalphos @ 0.025% or malathion @ 0.05% or dichlorvos @ 0.04%

9. Other caterpillars

- Gram pod borer, *H. armigera*
- Tobacco caterpillar, *Spodoptera litura* and *S. exigua*
- *Acherontia styx*
- *Pericallia ricini*

MINOR PESTS OF BEANS

- **Leaf miners:**
- *Cosmopteryx mimetis* (Cosmopterigidae: Lepidoptera)
- *C. Phaeogastra* (Cosmopterigidae: Lepidoptera)
- *Cyphostichia coerulea* (Gracilaridae : Lepidoptera)
- **Pod boring bugs:**
- *Riptortus fuscus* (Coreidae: Hemiptera)
- *R. linearis* (Coreidae: Hemiptera)
- *R. pedestri* (Coreidae: Hemiptera)
- **Thrips:**
- *Caliothrips indicus* (Thripidae, Thysanoptera)
- *Sericothrips ramaswomiahii* (Thripidae, Thysanoptera)
- *Frankliniella schultzei* (Thripidae, Thysanoptera)
- *Taeniothrips* spp. (Thripidae, Thysanoptera)
- Stem boring beetle, *Sagra nigrita* (Chrysomelidae: Coleoptera)
- Leaf feeding beetle, *Platypria histix* (Hispididae: Coleoptera)
- Indian bean weevil, *Colobodes dolichotis* (Curculionidae: Coleoptera)
- Grey leaf weevil, *Episomus lacerta* (Curculionidae: Coleoptera)
- Stem gall weevil, *Alcidodes* spp. (Curculionidae: Coleoptera)

Lecture - 17 Insect Pests of Onion & Garlic

Lecture - 17

Objectives: Onion and garlic are the important cash crops grown throughout India which are attacked by a large number of pests. In the present lecture students will be taught about the host range, identification, nature of damage, life cycle and management of different pests attacking these crop.

Onion thrips, Fly and Caterpillars

1. Onion thrips or cotton thrips, *Thrips tabaci* (Thripidae: Thysanoptera)

- Distribution: This pest is widely distributed throughout India.
- Host range: Onion, garlic, cotton, cabbage, cauliflower, potato, tobacco, tomato, cucumber, peas, pine apple etc.

Damage:

- Adults and nymphs lacerate the epidermis of the leaf and lap the exuding sap
- The affected leaves show silvery white blotches which later become brownish
- Retardation of growth
- Bulbs remain undersized and get distorted
- Also transmit viruses.

Identification

- Eggs are tiny, kidney shaped and white in colour
- Nymphs and adults are slender, fragile and yellowish in colour
- Adults have fringed wings heavily with fine hairs.
- Males are 0.8-1.0 mm long while the females are 1.0-1.2 mm long



Life cycle

- Adult longevity is 2-4 weeks
- Eggs hatch in 4-9 days
- Nymphs become full grown in 4-6 days
- Pass through four stages
- Pupate in soil
- Preupal and pupal periods are 1-2 & 2-4 days
- Several overlapping generations in a year.

Salient features

- The pest is active throughout the year
- Breeds on different hosts during different seasons
- Eggs are laid singly in slits made in leaf tissue
- On onion and garlic they are usually congregated at the base of the leaf or in the flower
- Full grown nymphs fall on to the ground and pupate at a depth of about 2.5 cm

Other thrips species

- Ground nut thrips, *Caliothrips indicus* (Thripidae : Thysanoptera)
- Blossom thrips, *Aeolothrips collaris* (Thripidae : Thysanoptera)

Management:

- Grow resistant varieties of onion like White Persia, Grano, Sweet Spanish, Crystal Wax etc:
- The pest can also be controlled by spraying the crop with any of the insecticides like malathion @0.05% and dimethoate @ 0.03%
- After the application of insecticides observe a waiting period of 7 days

2. Onion maggot or onion fly, *Delia antiqua* (Anthomyiidae: Diptera)

- Distribution: France, Germany, Canada, USA, Japan, erstwhile USSR, England, India etc.
- Host plants: Onion & garlic

Damage:

- The maggots bore into the bulbs causing the plants to become flabby and yellowish
- They mine through the small bulbs completely, leaving only the outer sheath
- Larger bulbs are attacked by many maggots at a time
- Partially attacked bulbs get rottened
- Attach in storage also

Identification

- Eggs are elongate in shape and white in colour
- Maggots are also white in colour and 18 mm in length when full grown
- Adult flies are slender about 6 mm in length and greyish in colour having large wings.



Plate 17.2: Onion maggots in onion

Life cycle

- Eggs hatch in 2-7 days
- Maggots become full fed in 2-3 weeks
- Pupal period is 2-3 weeks
- Three generation

Salient features

- Eggs are laid near the base of the plant in cracks in the soil
- Newly emerged maggots crawl up to the plant and enter the leaf sheath and reach the bulb.
- Large bulb can be attacked by many maggots, each carving out a small cavity

- In third generation, pest attacks the crop near harvest which is responsible for rotting of bulbs in storage.

Management:

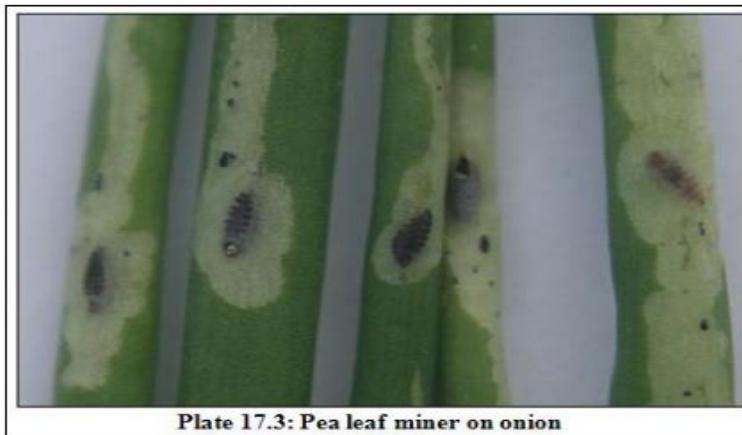
- Treat soil with phorate 10 G followed by irrigation
- Spray the crop with malathion @ 0.05% at 15 day interval is also effective.

3. Leaf eating caterpillars:

- Cutworms, *Agrotis* spp
 - See insect pests of cole crops
- Tobacco caterpillar, *Spodoptera litura*
 - See insect pests of cole crops
- Fruit borer, *Helicoverpa armigera*
 - See insect pests of tomato

4. Ground nut earwig, *Euborellia annulipes* (Labiduridae: Dermaptera)

- Cause damage by boring into onion bulbs. Incubation period is 7-11 days, larval period in 106-252 days.
- Control: drenching with chlorpyrifos @ 0.04 %.



6.

Other storage pests:

- *Anthrenus jordanicus* (Dermastidae: Coleoptera)
- *A oenicus* (Dermastidae: Coleoptera)
- *Alphitobius laevigatus*, (Tenebrionidae: Coleoptera)

INSECT PESTS OF TARO

INSECT PESTS OF TARO (ARUM) I.E. COLOCASIA AND ALOCASIA

1. White spotted flea beetle, *Monolepta signata* (Chrysomelidae: Coleoptera)

- Distribution: Pest is more active in south India than in north India.
- Host range: Taro, beat roots, cabbage, cauliflower, radish, etc..
- Beetles bite holes in leaves
- Damage the leaf lamella thus reducing the yield
- In young plants severe infestation may result in its complete destruction.
- The adult beetle is 3-4 mm, reddish brown
- Elytra pale brown with two big white spots
- Control: Spray carbaryl @ 0.1%

2. Leaf eating caterpillars

- *Pericallia ricini*, commonly known as woolly bear
- *Agrius convolvuli* (Sphingidae : Lepidoptera)
- *Theretra gnoma*
- *T. Pinastrina*

Management

- As soon as the attack is noticed spray the crop with either of the following insecticides
- Carbaryl @ 0.1% or malathion @ 0.05%

3. Aphids

- Banana aphid, *Pentalonia nigronervosa*
- *P. galadii*
- Cotton aphid, *Aphis gossypii*

4. Thrips

- Groundnut thirps, *Caliothrips indicus*
- Banana leaf thrips, *Heliethrips kadaliphilus*
- Greenhouse thirps, *H. haemorrhoidalis*

INSECT PESTS OF ELEPHANT FOOT

- Leaf eating beetle, *Galerucida bicolor*, (Gallerucidae: Coleoptera)
- Leaf eating caterpillars
 - *Pericallia ricini* (Arctiidae: Lepidoptera)
 - *Spodoptera littoralis* (Noctuidae: Lepidoptera)

- *Theretra gnoma*

INSECT PESTS OF YAM

- **Leaf eating beetles:**
- *Galerucida bicolor* (Galerucidae : Coleoptera)
- *Lema lacorelairei*
- *Crioceris impressa*
- **Mealy bugs:**
- *Geococcus coffeae*
- *Planococcus citri*
- *Phenacoccus gossypii*

Lecture - 18 Insect Pests of Leafy vegetables

Lecture - 18

Objectives: The main objectives of this lecture will be to teach the students about the major as well as minor pests of leafy vegetables like amaranthus, spinach, etc. Emphasis will be on the host range, identification, nature of damage, life cycle and ecofriendly management of these pests. **Stem weevil and Leaf caterpillar**

1. Amaranthus stem weevil, *Hypolixus truncatulus* (Curculionidae: Coleoptera)

- **Distribution:** India and neighboring countries
- **Host range:** Amaranthus (both wild and cultivated)

Damage:

- Newly emerged grubs tunnels the stem
- The affected stems become weak and often split longitudinally due to excessive transpiration and evaporation
- The plants desiccate and ultimately dry up completely
- Adults feed on tender leaves and stems but the loss caused by them is negligible.

Identification

- Eggs are smooth, oval, about 1 mm, pale yellow
- Grubs are stout, curved, legless, white and about 13-17 mm long
- Pupae are yellowish brown in colour
- Adult weevils are ash-grey, 10-15 mm long

Life cycle

- Eggs hatch in about 2-4 days during summer and 10-12 days during winter
- Grub stage lasts for about 12 days during summer and 20-24 days during winter
- Pupate inside the stem
- Adults on emergence remain inside the stem for 5-6 days
- Adult longevity varies from 12-66 days.

Salient features

- Each female lays about 30 eggs singly inside the plant stem
- Grubs feed inside the stem by making tunnels
- 17-18 grubs/stem have been reported
- Full fed grubs cut a small round hole in the stem, leaving thin semi transparent apidermal tissue

- Pupate in the stem
- Adults after 5-6 days cut epidermal membrane and emerge out

Management

- Destroy all wild amaranthus plants in the vicinity
- As soon as infestation is observed, remove and destroy promptly all the affected plants with grubs inside.
- Spraying with malathion @ 0.05% or dichlorvos @ 0.05% is also effective.
- After spraying the crop with insecticides observe a waiting period of 7-10 days.

2. Amaranthus leaf caterpillar, *Hymenia recurvalis*

- **Distribution:** Tropical and sub-tropical regions of Africa, Asia, Australia and Hawaii Islands.
- **Host range:** Grasslands and pastures, beans, Coleus, Luffa spp, melons, spinach, amaranthus, etc.

Damage:

- Young caterpillars feed on epidermis and palisade tissues of leaves.
- Older ones web the leaves together and feed with in.
- Webbed leaves become completely devoid of chlorophyll and dry up.

Identification

- Eggs are spherical in shape and snow white in colour.
- Caterpillars are greenish in colour with white lines.
- Full grown larva measures 17-20 mm in length.
- Pupae are 10-14 mm long and brownish in colour.
- Adults are black coloured.
- Both pairs of wings are dark fuscous in colour, outer margins are fringed with short hairs.
- Wing expanse is 15-20 mm.

Life cycle:

- Eggs hatch in about 3-4 days
- Larval period is 12-16 days
- Pupal period lasts for 8-12 days
- Total life cycle is completed in 3-4 weeks.

Salient features

- Each female lays 50-80 eggs singly or in batches of 2-5 usually on grooves of leaf veins
- Larvae feed on leaves
- Pupate in soil

Control:

- Spray with malathion @ 0.05%

Leaf caterpillar and Spinach beetle

3. Leaf caterpillar, *Eretmocera impactella* (Heliodinidae: Lepidoptera)

- **Distribution:** Distributed in the Indian subcontinent
- **Hosts:** It is a sporadic pest of amaranthus

Damage

- Caterpillars web the leaves and feed inside

Identification

- Full grown caterpillars are 9-12 mm long, cylindrical, brownish yellow to brownish grey in colour
- Pupae are about 6 mm long and uniformly brown in colour
- Moths have cupreous head and thorax and yellow abdomen with second, third and terminal segments cupreous in colour
- Fore wings are also cupreous with yellow spots, hind wings are pale in colour.
- Wing expanse is 14-18 mm.

Life cycle

- Eggs are laid on leaves preferably on top shoots
- Pupation takes place in white silken cocoons attached to the leaves
- Life cycle is completed in 3-4 weeks.

Control:

- Same as described under *Hymenia recurvalis*

Minor pests of Amaranthus

Leaf eating caterpillars:

- *Hymenia fascialis*
- *Dichocrocis punctiferalis*
- *H. perseptalis*
- *Psara basalis*
- *Helicoverpa armigera*
- *Plusia eriosoma*
- *Spodoptera spp*

Aphids:

- Ground nut aphid, *Aphis craccivora*
- Mustard aphid, *Lipaphis erysimi*
- Green peach aphid, *Myzus persicae*

Mealy bug:

- *Ferrisia virgata*

Scales:

- *Coccus hesperidum*

Thrips: *Aeolathrips collaris*

- *A. fulvicollis*
- *Frankliniella intonsa*
- Leaf eating beetle, *Aspidomorpha exilis*
- Leaf twisting weevil, *Apoderus transque baricus*

INSECT PESTS OF SPINACH

1. Spinach blue beetle, *Altica caerulescens* (Alticidae: Coleoptera)

- **Hosts:** Spinach, cabbage, strawberry and plums

Damage

- Freshly emerged grubs scrap and feed on chlorophyll containing tissues
- Later grubs mine inside the leaves and feed on the mesophyll tissue
- Adults nibble the leaf margins causing very little damage.

Identification

- Grubs are 5-10 mm long, dark brown in colour
- Pupae are 12-15 mm long and brown in colour when freshly formed and turns blackish brown later on
- Adults are 5-7 mm long steel blue in colour

Management

- Spray carbaryl @ 0.1% or malathion @ 0.05%
- Observe a waiting period of about 10 days

Minor pest

- Mustard aphid, *Lipaphis erysimi*
- Green peach aphid *Myzus persicae*
- *Hyadaphis (Siphocoiryne) indobrassicae*
- Leaf eating caterpillar, *Hymenia recurvalis*

Lecture -19 Polyphagous Pests

Lecture - 19

Objectives: Polyphagous pests like locusts, termites, hairy caterpillars, etc. will be discussed in this lecture. Students will be taught about the host range, identification, nature of damage, life cycle and ecofriendly management of these pests. **Locusts**

1. Locusts

- Locusts are the swarming phase of short-horned grasshoppers.
- They can breed rapidly under suitable conditions and subsequently become gregarious and migratory.
- Nymphs form bands and adults swarms.
- They can travel great distances, rapidly stripping fields and greatly damaging crops.
- The origin and apparent extinction of certain species of locust (some of which were 150 mm in length) is unclear

Important species

- Desert locust (*Schistocerca gregaria*), probably the best known owing to its very wide distribution
- Migratory locust (*Locusta migratoria*)
- Red locust (*Nomadracis septemfasciata*)
- Australian plague locust (*Chortoicetes terminifera*)
- American desert locust (*Schistocerca americana*)
- Brown locust (*Locustana pardalina*)
- Moroccan locust (*Dociostaurus maroccanus*)
- Rocky Mountain locust (*Melanoplus spretus*) in North America had some of the largest recorded swarms, but died out in the late 19th century.
- Bombay locust, *Patanga succincta* (Acrididae : Orthoptera)
- Sporadic grasshopper, *Oxya nitidula*
- Surface grasshopper *Chrotogonus trachypterus*

Identification:

- Though the female and the male look alike, they can be distinguished by looking at the end of their abdomens.
- The male has a boat-shaped tip, while the female has two serrated valves that can be either apart or kept together.
- These valves aid in the digging of the hole in which an egg pod is deposited.
- Desert locusts can measure roughly 75 millimetres (3.0 in) in length.

- Some grasshopper species such as the Senegalese grasshopper *Oedaleus senegalensis*, and the rice grasshopper *Hieroglyphus daganensis* also display locust-like behaviour and change morphologically on crowding.

Swarming behaviour and extinction:

- There is no taxonomic difference between locust and grasshopper species.
- The term "locust" is used for grasshopper species that change morphologically and behaviourally on crowding, to form swarms or hopper bands (of immature stages).
- These changes, or phase polymorphism, were first identified by Sir Boris Petrovich Uvarov, who studied the desert locust, whose solitary and gregarious phases had previously been thought of as separate species.
- Charles Valentine Riley and Norman Criddle were also involved in the understanding and destructive control of locusts.
- Research at Oxford University has identified that swarming behaviour is a response to overcrowding.
- Increased tactile stimulation of the hind legs causes an increase in levels of serotonin which causes the locust to change colour, eat more, and breed more easily.
- The transformation of the locust to the swarming variety is induced by several contacts per minute over a four-hour period.
- It is estimated that the largest swarms have covered hundreds of kilometers and consisted of many billions of locusts.
- Plagues of locusts appear in both the Bible and the Koran, including one of the biblical plagues, where locusts ate all the crops of Egypt.
- Six stages of development, from newly hatched nymph to fully winged adult.
- The extinction of the Rocky Mountain Locust has been a source of puzzlement.
- Recent research suggests that the breeding grounds of this insect in the valleys of the Rocky Mountains came under sustained agricultural development during the large influx of gold miners destroying the underground eggs of the locust.
- In a paper in the 30 January 2009 edition of the AAAS magazine *Science*, Anstey & Rogers et al. showed that when desert locusts meet up, their nervous systems release serotonin, which causes them to become mutually attracted, a prerequisite for swarming.

Locust swarms

- Swarming grasshoppers have short antennae and hearing organs on the abdomen.
- As winged adults, flying in swarms, locusts may be carried by the wind hundreds of miles from their breeding grounds; on landing they devour all vegetation.
- Locusts occur in nearly every continent.
- The migratory locust (*Locusta migratoria*) ranges from Europe to China, and even small swarms may cover several square miles, and weigh thousands of tons.
- They eat the equivalent of their own weight in a day
- Flying at night with the wind, may cover 500 kilometres
- The largest known swarm covered 1,036 square kilometres comprising approximately 40 billion insects.

Damage

- Adult and nymphs cause the damage
- Gregarious and voracious feeders
- Eat up the entire vegetation
- In spite of some expensive control measures, the damage caused to crops by locusts during 1926-31 cycle was estimated to 100 million.
- They also climb on walls, invade kitchens, store rooms thus causing nuisance

Life cycle

- Incubation period depends upon the soil conditions, temperature and moisture.
- Eggs laid during Feb-March hatch in 3-4 weeks and those laid during May-June hatch in 12-15 days.
- In very dry soils the eggs may remain unhatched until rain shower occurs.
- Nymphal stage lasts for 6-8 weeks during spring and 3-4 weeks during summer.
- There are two broods in a year.

Salient features

- Eggs are laid in soil in egg pods.
- Each female can lay up to 11 egg pods, each pod containing up to 120 eggs.
- Before egg laying each female with the help of its ovipositor, bores a 5-10 cm deep hole into the loose soil.
- Having laid a pod, female secretes a frothy material over the eggs, which hardens on drying and makes the pod water proof.

Management

- Spreading poisoned food among the bands is very effective
- It is cheaper to spray spray lindane (2%) from aircraft over the insects or the vegetation on which they feed.
- Lindane dust (2.0%) on crops be dusted
- Adults can be beaten to death with thorny stick, broom and swept to gather and burry.
- Eggs are laid in a well defined area, a trench around it may be dug to restrict the movement of young hoppers.
- Dig trenches in front of the moving army to stop their further advancement
- During night locusts rest on bushes where they can be burnt with flame throwers
- Number of birds also eats locusts, Indian mynah is the common
- Dried fungal spores sprayed in breeding areas pierce the locust exoskeleton on germination and invade the body cavity, causing death.
- The fungus is passed from insect to insect and persists in the area, making repeated treatments unnecessary.

- The International LUBILOSA Programme was set up to find methods of nonchemical control of locusts. Not only did it successfully develop the mycoinsecticide 'Green Muscle', but over its 12-year period, programme staff also contributed a large number of scientific papers on subjects as diverse as fungal production, (bio)pesticide application, socio-economics and thermal ecology.

Termites

2. Termites:

- Commonly known as white ants
- Distributed in tropical and subtropical regions of the world.
- Social insects and live in colonies (underground)
- Make small earthen mounds or passages which are visible above the ground.

Different castes:

a) Reproductive castes:

- Colonizing individuals:
- Queen:
- King:
- Complementary castes:

b) Sterile castes

- Workers:
- Soldiers:

a) Mandibulate type

b) Nasute type

Life cycle:

- In the rainy season, the colonizing forms leave their parent colony.
- Most of them fall prey to many predators
- left over mates and start building the nest in the soil
- Initially only few eggs are laid which develop into workers and take over the colony work.
- During first season the reproductive castes are not produced.
- Gradually the queen grows in size and number of eggs laid also increases.
- Reproductive castes when produced mature in 1-2 years.
- Queen is capable of laying many million eggs throughout her life.

Management

- Destroy the termitarium and kill the queen

- To avoid the attack of white ants in cultivated fields, care should be taken not to grow green manure crops or use raw FYM.
- Use insecticidal dust or drench the soil with chlorpyrifos (0.1%) at the time of field preparation.

3. Hairy caterpillars:

- Discussed earlier

4. Cutworms:

- Discussed earlier

Lecture - 20 Insect Pests of Potato

Lecture - 20

Objectives: Potato is another important cash crop grown throughout India and is attacked by a large number of pests in the field as well as storage. So, in this lecture students will be taught about the host range, identification, nature of damage, life cycle and ecofriendly management of different pests attacking this crop. Main emphasis will be on the IPM strategies for potato tuber moth and white grubs

Potato tuber moth

1. Potato tuber moth, *Phthorimaea operculella* (Gelechiidae: Lepidoptera)

- **Distribution:** Cosmopolitan in distribution.
- Native of South America and was introduced to India in 1906 with seed potatoes imported from Italy. It has
- Host range: It is a major pest of potato but has also been reported from crops like egg plant, tomato, tobacco, etc.

Damage:

- Larvae which mine the leaves, petiole and terminal shoots causing wilting.
- After tuberization, the larvae enter into the tubers and feed on them.
- Bore the tubers in stores also
- Larvae tunnel into the pulp which ultimately becomes unfit for use as seed or for human consumption.
- The infested tubers are further exposed to microbial infection which leads to rotting.
- The extent of damage to stored tubers varies from 20 - 85 per cent

Identification

- The eggs are oval and measure less than 1mm in diameter.
- Newly emerged larvae are gray yellowish white with brown head.
- Pupate in silken cocoons

Life cycle

- Each female can lay 150-200 eggs.
- Incubation period is 3-6 days,
- Larval period is 10-25 days
- Pupal period lasts for 5-9 days.

- Total life cycle is completed in 20-30 days at optimum conditions
- There are 8-9 overlapping generations in a year.

Salient features

- This pest breeds throughout the year under favorable conditions.
- The females lay eggs either on the under surface of leaves or on exposed tubers near eyes.
- Full grown caterpillars come out of the tubers/ foliage and pupate in silken cocoons either in dried leaves, soils, over the stored tubers or in cracks and crevices in the store.

Management:

- Plant tubers slightly deeper (10 cm) and follow proper earthing up
- Lift all the tubers from the field at harvest
- Destroy self grown potato plants
- Intercropping with chillies, onions or peas.
- Harvested potatoes should be lifted to cold stores immediately.
- If cold store facilities are not available, only healthy tubers should be stored.
- Cover the stored tubers with 2.5 cm layer of chopped dry leaves of Lantana or Eucalyptus or Eupatorium below and above the potato
- Mass trapping of adults with sex pheromones
- Under field conditions more than 20 traps/ha (some times up to 40 traps/ha) are required
- Spray of crop with chlorfenvinphos (0.4 Kg a.i./ha) or quinalphos (0.375 Kga.i./ha) or acephate (0.5Kg a.i./ha)
- In stores dusting the tubers with 5% malathion or 1.5 5 quinalphos dust @ 125g dust/100 Kg of potatoes.
- Alternatively, dipping of tubers before storage with 0.0028% deltamethrin
- Parasitoids like *Chelonus curvimaculatus*, *Bracon gelechiaae*, *Apanteles* sp, *Melanis* sp and *Diadegma molliplum* are also found to reduce the population of PTM.
- *Bacillus thuringiensis* has also been reported to suppress this pest.

White grubs

2. White grubs

Family: Scarabaeidae, Order: Coleoptera

Important species under the family Scarabaeidae are given sub-family wise as under

Melolonthinae:

- *Brahmina coriacea*
- *B. crinicollis*
- *B. flavoserica*
- *Melolontha indica*
- *Holotrichia longipennis*

- *H. repitita*
- *H. rustica*
- *H. serrata*
- *H. conferata*
- *H. excise*
- *H. torticollis*
 - **Rutelinae:**
- *Anomala dimidiata*
- *A. polita*
- *A. rugosa*
- *A. rufiventris*
- *A. communis*
- *A. nathani*
 - **Dynastinae:**
- *Xylotrupes gideon*
- *Phyllognathus dionysius*

Distribution: Cosmopolitan in distribution

Host range: Polyphagous, damage almost all the vegetable crops, pulses, oilseeds, cereals, millets, potato, tobacco, sorghum, groundnut, maize, soybean, chillies, ornamental plants, forest nurseries, etc

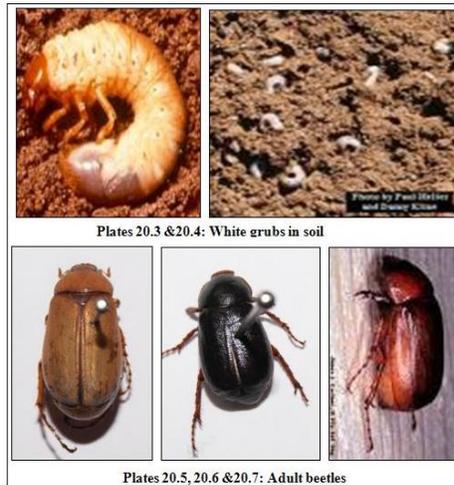
Damage:

- Both grubs and adults are damaging.
- Grubs feed on underground plant parts of various crops.
- Potato grown during summer as rainfed is prone to attack by these grubs.
- Older second instar and third instar grubs are more damaging
- Due to concealed feeding white grubs generally remain unnoticed and at harvest a large number of tubers are found infested/damaged.
- Sometimes up to 80 per cent of the crop may be lost.
- White grubs are also found to feed on the roots of horticultural/ forest nurseries and some ornamental plants.
- White grubs are serious pests of turf grass too
- Adult beetles feed on the foliage of many trees

Identification

- Freshly laid eggs are creamy white which turns dirty white before hatching.
- Full grown larvae of *Brahmina coriacea* are 35-38 mm in length “C” shaped.
- Beetles are of different colours

different colours



Life cycle

- Incubation period is 7-12 days.
- There are three larval instars.
- The duration of respective instars is about 20, 30 and 75 day.
- Total larval duration is about 125 days.
- Pupal period ranges from 12-20 days.
- Adult longevity ranges between 15 and 145 days.
- There is only one generation in a year

Salient features

- Beetles emerge during monsoon
- Lay eggs in soil
- Eggs are laid singly in 2-7 installments.
- Each female lays 4-40 eggs in its life span.
- The pest passes winter as grub in earthen cells.
- Pupate in cells during April – May.

Management:

- Two to three deep ploughings immediately after harvest before potato planting.
- Collect grubs from soil while ploughing the field and kill them.
- Remove weeds from bunds and super fluous plants from the vicinity of potato fields.
- Seed potatoes should be planted little deep (8-10 cm) instead of normal depth (6 cm).
- Apply only well rotten FYM
- Collect/trap adult beetles during May-June at night and kill them

- Spray host trees with chlorpyrifos (0.04%) or quinalphos (0.1%) immediately after first monsoon shower.
- Application of phorate 10G (25-30Kg/ha) or carbofuran 3G (80-100Kg/ha) near plant base at the time of earthing up or drenching of ridges with chlorpyrifos 20 EC @ 2.5L/ha is effective against these pests. Drenching can be repeated after 20-25 days.
- Potato crop should be harvested immediately after required maturity i.e. by September. Crop left beyond September suffers more

Other pests

- Hadda beetles: Discussed under egg plant
- Cutworms: Discussed under cole crops
- Tomato fruit borer: Discussed under tomato
- Aphids: *Myzus persicae* and *Aphis gossypii*
- Leaf hoppers, *Amrasca biguttula biguttula*
- Whitefly, *Bemisia tabaci*
- Phytophagous mites
- Green potato bug, *Nezara viridula*

Lecture - 21 Insect Pests of Rose

Lecture - 21

Objectives: Rose is an important ornamental crop grown throughout India in open and greenhouse conditions. The crop is attacked by a large number of pests. In the present lecture students will be taught about the host range, identification, nature of damage, life cycle and management of different pests attacking this crop.

Aphid and Sawfly

1. Rose aphid, *Macrosiphum rosaeformis* (Aphididae: Hemiptera)

Distribution: In India this aphid has been reported from rose from Punjab, Delhi, Mysore, Andhra Pradesh and Nilgiri hills

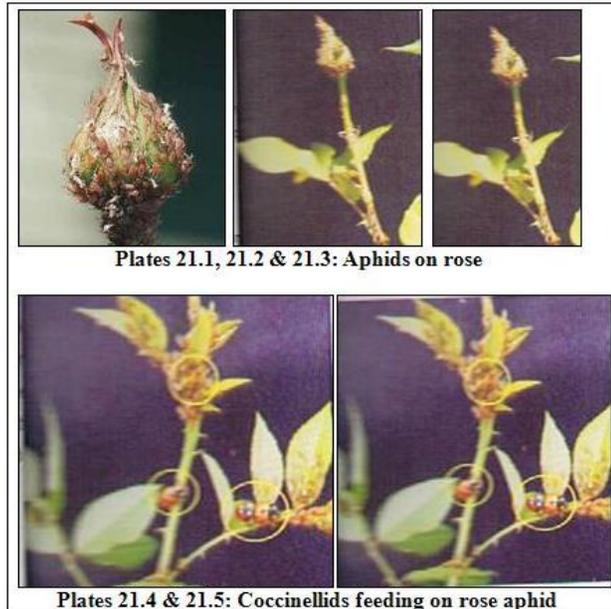
Host: Rose

Damage:

- The aphids suck the sap from the tender parts
- Particularly injurious to tender buds, resulting in the disfigurement and withering of flowers
- A black fungus also develops on the honey dew giving ugly appearance to the plant
- Deteriorates the market value the produce.

Identification:

- Small (about 2.5mm long) wingless aphids having large red eyes, black cornicles and a yellowish green tip of abdomen.



Life cycle:

- The pest is active from November to April in North India.
- Nymphal development of non winged forms is in 11-14 days and of winged forms in 14-19 days.
- The growth is quickest in March.
- Population starts increasing from November and is highest during March.
- The population starts declining from April as the temperature starts increasing.
- There is an increase in winged forms from December onwards with peak in March (90% alates)
- The pest multiplies most rapidly in late spring and with the increasing in temperature its population declines.

Management:

- The pest can be controlled by spraying the crop with oxy- demeton methyl (0.025%) or phosphamidon (0.03%) or malathion (0.05%) as soon as the attack is noticed.
- Natural enemies like coccinellids, syrphids, chrysopids, etc. also take care of these aphids
- Avoid application of insecticides when these natural enemies are active.

2. Ground nut aphid, *Aphis craccivora* (Aphididae: Hemiptera)

Distribution: Through out India.

Hosts: Ground nut, rose, Bougainvillea spp and many other plants of economic importance.

Identification: Adults are black or brown with variable size

Damage:

- Both nymphs and adults suck the cell sap from tender plant parts.
- Downward cupping of leaves and premature drop of flowers.

Life cycle:

- The offsprings of winged form may be wingless.
- Reproduction is parthenogenetic and viviparous
- Each female can produce 8-30 young ones in a life span of 10-12 days.
- Nymphs pass through four moults and become adult in 5-8 days.
- Apterous females start producing brood within 24h of attaining the stage.
- Pest breeds throughout the year
- Both alatae as well as apterae forms are present.

Management:

- Same as for rose aphid

3. Rose sawfly, *Arge fumipennis* (Argidae: Hymenoptera)

Host: rose

Damage:

- Damage is caused by larvae
- feed voraciously on the leaves and cause complete defoliation
- Female makes an ovipositional slit on the stem and side branches with the help of saw like ovipositor

Identification:

- Newly emerged larvae are green in colour with black head and thoracic legs
- The adults on emergence are dull in colour which soon changed into shining black orange in colour.
- Males are lightly smaller in size than females.



Plate 21.6: Sawfly larvae feeding on rose

Plate 21.7: Rose leaves damaged by sawfly

Life cycle:

- The pest appears during first week of July with the onset of monsoon and remains active through out the rainy season
- Newly emerged larvae feed on leaves in groups
- Larval development is completed in about 15 days
- Five larval instars.
- Pupate in debris in protected silicon cocoons.
- Pupal period lasts for 1-2 days.

Management:

- Apply malathion (0.05%) or carbaryl (0.1%).
- Repeat the spray after 10 days if required.

Mites, Thrips and Scale

4. Phytophagous mites. : *Tetranychus urticae*

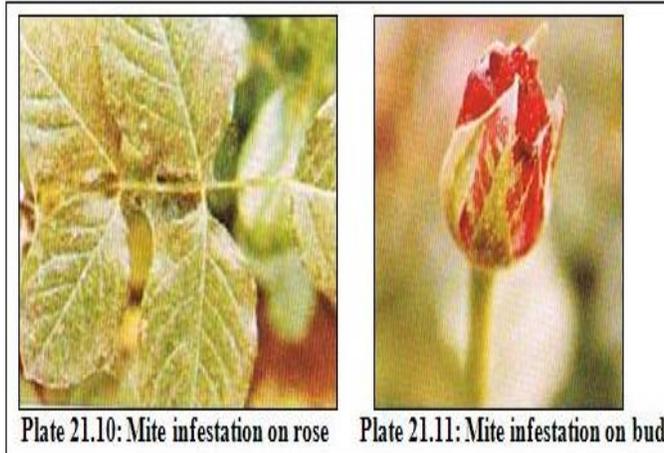
- Common name: Two spotted spider mite
- Scientific name: *Tetranychus urticae*
- Family: Tetranychidae
- Order: Acarina

Damage:

- Suck the cell sap from under side of leaves, flower buds and flowers.
- Bronzing and curling of leaves and discoloration of flowers and leaves.
- Webbing of leaves, sepals and petals occur which give untidy look to the plant.
- The infestation is more severe under poly house conditions.
- More severe in dry conditions

Identification:

- Eggs are Spherical, shiny white and translucent
- Newly emerged larva is dirty white in colour and possesses three pairs of legs
- Protonymphs possess four pairs of legs and is slightly green in colour.
- The male deutonymph is smaller than the female.
- Adults are bigger than deutonymphs.
- Adults are orange coloured mites with two black spots on their body.



Life cycle:

- • Eggs are laid mostly along the midrib and side margins on the lower surface of the leaves.
- • Eggs hatch is about 2-4 days
- • Larva becomes protonymphs in about 2 days
- • Protonymph after under going a quiescent stage develops into deutonymph.
- • At this stage sexes are determined.
- • Deutonymph stage lasts for 1-3 days and develops into an adult.
- • Male longevity is 9-13 days and females live for 14-20 days.
- • Weather factors play an important role
- • Under dry and hot conditions the multiplication of these mites is very high and the infestation is also severe.

Management:

- • Remove the old and infested leaves and burn them
- • Try to avoid dry conditions and spray frequently with plain water at least twice a week with sprinkler.
- • Observe the plants regularly for mite population
- • If incidence is noticed spray with profenofos (0.05%) or fenazaquin (0.0025%) or propargite (0.057%) or dicofol 0.04%.

5. Greenhouse whitefly, *Trialeurodes vaporariorum*

- Discussed earlier

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6. Thrips, *Thrips flavus* (Thripidae: Thysanoptera)

Identification:

- • These are very small, slender insects.
- • Adults are brown
- • Nymphs are reddish in colour.

Damage:

- • Their attack coincides with the appearance of new flush.
- • Both nymphs and adults scrap the surface and suck the oozing cell sap from leaves, tender shoots, apical buds and flowers.
- • Tip of the leaves get mottled and crumbled.
- • Brown scars and burnt margins occur on petals of infested flowers.
- • Severely attacked flowers remain unopened or half opened and ultimately dries away.

Management:

- • For monitoring of thrips, blue sticky cards should be placed 1-2" above the crop canopy at the rate of 2 per 1000 ft².
- • Spray of oxy- demeton methyl (0.025%) or dimethoate (0.03%) at 10 days interval is affective.

- • Soil application of phorate granules @ 1.0 kg/ ha or drenching with chlorpyrifos (0.04%) helps to kill the pupae of thrips

7. Armoured scale, *Aonidiella aurantii*

Damage:

- • Suck the cell sap from the tender shoots.
- • Affected plants loose vitality become weak and bear less and small sized flowers.
- • In case of severe infestation the twigs get dried and disfiguring of plant takes place.
- • Whole of the plant may also scumb to severe attack.
- • Attack is more sever during summer.

Identification:

- • Female scales are reddish brown with hard waxy scale covering on the body and are without legs and having vestigial antennae.
- • Scales are mostly found on the tender shoots



Plates 21.16 & 21.17: Scale attack on rose

Management:

- • Prune and destroy the infested leaves and twigs.
- • Scrap the scale and destroy the same by rubbing the affected stems with swab of cotton soaked in methylated sprit.
- • Spray the crop with chlorpyrifos (0.04%) or dimethoate (0.03%).

8. Digger wasp, *Crabro* sp

- • Brown yellow wasps which make nest in the pruned twigs.
- • The attacked twigs can be spotted by the presence of round hole.
- • Attack the branches soon after the pruning

- Wasps tunnel through the pith and build their nests within.
- They usually prey upon flies and don't feed on rose
- Attacked branches dry from top to down wards.
- These branches also become susceptible to fungal attack causing die back diseases.



Plate 21.18: Digger wasp attack

Management

- Soon after pruning, paint the pruned ends of branches with fungicidal pastes so as to prevent the entry of these wasps into the stem.

9. Bud borer, *Helicoverpa armigera* (Noctuidae: Lepidoptera)



Plates 21.19 & 21.20: Rose buds damaged by *Helicoverpa armigera*

Lecture - 22 Insect Pests of Carnation

Lecture - 22

Objectives: Carnation is another important ornamental crop grown in open and greenhouse conditions. The crop is attacked by a large number of pests. In the present lecture discussions will be on the host range, identification, nature of damage, life cycle and management of different pests attacking carnation **Bud borer**

1. Bud borer, *Helicoverpa armigera* (Noctuidae: Lepidoptera):

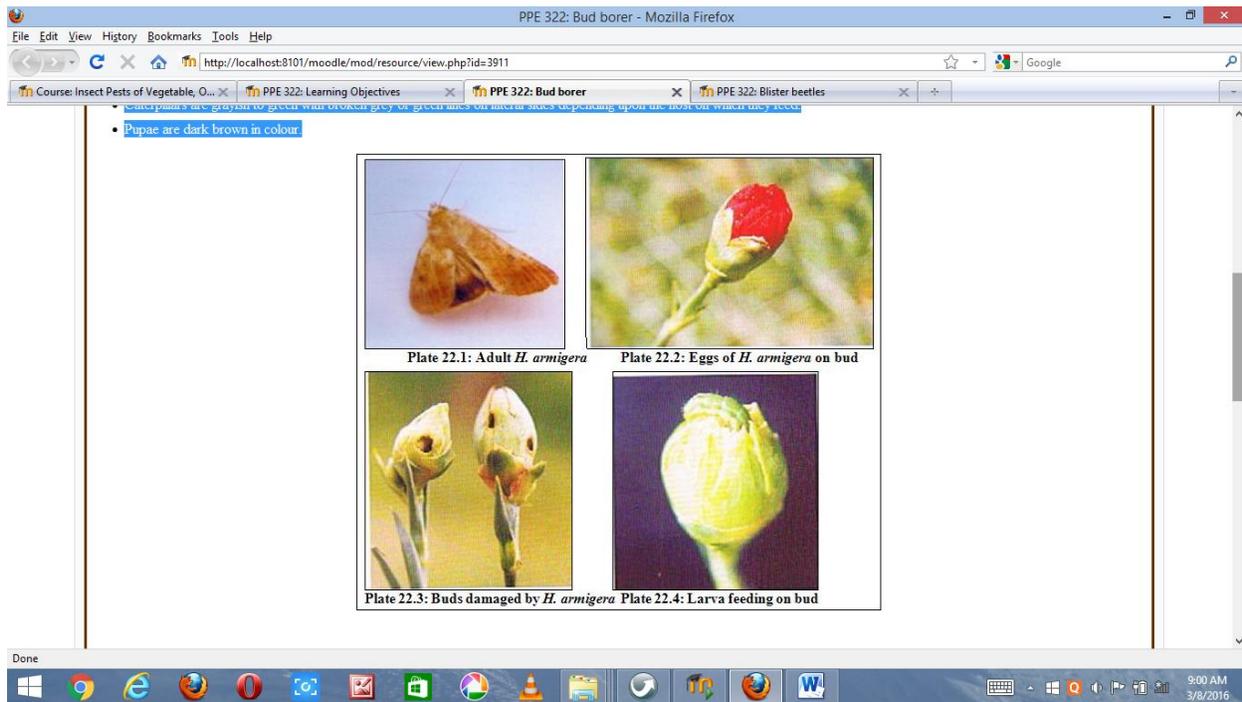
- **Distribution:** Cosmopolitan and widely distributed throughout India.
- **Hosts:** Polyphagous and attacks hosts like chickpea, pigeonpea, pea, mungbean, urdbean, lentil, soybean, cowpea, tomato, carnation, cotton, sorghum, okra, maize, sunflower etc.

Damage:

- Damage is caused by the caterpillars
- They bore into the developing buds and feed on petals inside them
- Infested buds never open and dry as such
- Partially damaged buds open into deformed flowers
- Infestation coincides with the bud initiation and peak activity is between March and June.

Identification

- Eggs are small, round, pale yellow
- Adult moths are stoutly built and are yellowish brown
- Darker area near the outer margins of the forewing.
- The forewings are marked with greyish wavy lines and black spots of varying sizes on the upper side
- The hind wings are whitish and lighter in colour with a broad blackish band along the outer margins
- Caterpillars are grayish to green with broken grey or green lines on lateral sides depending upon the host on which they feed.
- Pupae are dark brown in colour.



Life cycle:

- Eggs hatch in 2-4 days
- Larva becomes full fed in about 15-20 days
- Six larval stages
- Pupal period lasts for 8-15 days
- Adult longevity is 8-12 days

Salient features:

- Eggs are laid on closed and half opened buds
- Newly emerged larva enters the bud and feed inside
- Full grown larva enters the soil for pupation
- The infestation coincides with the bud initiation
- Peak activity is between March and June.

Management:

- Spray the crop with deltamethrin (0.0028%) at the time of bud formation
- Spraying should be done during evening hours to hinder the activity of adult moths
- Btk (Dipel) @ 0.5kg/ ha
- NSKE 4%
- *Trichogramma* spp

2. Phytophagous mites, *Tetranychus* sp.

- Discussed under the pests of rose.



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PPE 322



Blister beetles

3. Blister beetles, *Mylabris* spp. (Meloidae: Coleoptera)

- **Distribution:** Africa and south-east Asia.
- **Hosts:** Cururbits, okra, cotton, carnation, rose, groundnut, beans, millet etc.

Damage:

- Caused by the adults only
- Feed on the floral buds and flowers
- Attacked flowers become brownish and unattractive
- Larvae are beneficial
- Grubs feed on the eggs of various grass hoppers and locusts found in the soil

Identification

- Full grown grubs are coarctate and form pseudopupae, which become pupae later
- Beetles have three black and three yellowish orange bands running transversely and alternatively on elytra.
- Among different species, *M. pustulata* are the biggest (22-26 mm), *M. phalerata* are slightly smaller (20-24 mm) and has its yellowish red bands narrower than black bands.
- Beetles of *M. mecilenta* and *M. tflensis* are relatively smaller in size than the earlier two species.

Salient features:

- The eggs are laid in soil of cultivated fields.
- Full grown grubs are coarctate and form pseudopupae, which become pupae later.
- Adults emerge from soil in August and remain active till December
- Beetles have three black and three yellowish orange bands running vertically and alternatively on elytra
- When handled, beetles exude an acrid yellow fluid which contains, cantharidin
- It is irritant to touch and cause blisters on human skin, hence the common name.

Management

- Hand picking and destroying the beetles during morning hours when they are less active is effective.
- During severe infestation the crop can be sprayed with deltamethrin (0.0028%) or carbaryl (0.1%) at 10 days interval.

Lecture - 23 Insect Pests of Chrysanthemum

Lecture - 23

Objectives: Chrysanthemum is attacked by a large number of insect pests in open as well as greenhouse conditions. Through this lecture students will be taught about identification, nature of damage, life cycle and management of different pests attacking this crop.

Chrysanthemum aphid and Serpentine leaf miner

1. Chrysanthemum aphid, *Macrosiphoniella sanborni* (Aphididae: Hemiptera)

- **Distribution:** Through out the world
- **Host:** Chrysanthemum

Damage:

- Nymphs and adults by suck the cell sap from growing shoots and apical leaves
- Feeding results in the loss of vigour, yellowing of leaves, premature leaf fall and stunted growth of plants
- Flowers dry up prematurely
- Aphids excrete honey dew on which sooty mould develops and interferes with the photosynthesis.
- This pest is also responsible for transmitting viral disease

Identification:

- Nymphs are greenish black where as adults are chocolate brown which feed in groups
- Adult aphids can be winged or wingless.



Plates 23.1 & 13.2: Chrysanthemum aphid on shoots and terminal leaves

Life cycle:

- Alates appear with the environment changes (day length, temperature, etc), when aphid become over crowded or the plants begins to deteriorate and they need migration.
- Reproduction is both parthenogenetic vivipary as well as sexual

Done



Life cycle:

- Alates appear with the environment changes (day length, temperature, etc), when aphid become over crowded or the plants begins to deteriorate and they need migration.
- Reproduction is both parthenogenetic vivipary as well as sexual.

Management

- Spray dimethoate (0.03%) or oxy- demeton methyl (0.025%) as soon as the attack is noticed.
- Repeat the spray after 10 days if required.
- Parasitoids like *Aphidius* sp and predators such as coccinellids, syrphids and chrysopids are also active against these aphids in the nature.
- When these natural enemies are active, application of insecticides should be avoided.

2. Serpentine leaf miner, *Liriomyza trifolii* (Agromyzidae: Diptera)

- Distribution: cosmopolitan
- Hosts: Polyphagous

Damage:

- Larvae feed on the palisade mesophyll tissue in between the two epidermis of the leaf.
- Affected leaves give transparent papery appearance in the mined area
- Photosynthesis is reduced.
- Females puncture the leaf for egg laying and feeding
- The attack appears during April and is more pronounced from June onwards.

Identification (Also see under insect pests of tomato)

- Newly laid eggs are white and translucent and turn opaque as the development advances.
- The larvae are orange yellow without legs
- Pupae are orange yellow initially which turns dark brown on maturity.
- The adults are minute grayish black flies with plum red eyes and a yellow spot on the scutellum.
- The females are bigger than males.

Life cycle:

- Larval development is in 10-14 days
- Three larval instars.
- Pupal period is 8-10 days.
- Pre-oviposition, oviposition and post-oviposition periods varies from 1-3, 8-15 and 1-3 days, respectively.
- Male longevity is 8-12 days
- Female longevity is 13-17 days.
- Each female can lay 22-186 eggs

Management

- Natural enemies also suppress this pest
- Parasitoids are more during July-August.
- If attack is more, spray triazophos (0.15%) followed by another spray of deltamethrin (0.0028%) at 10 days intervals.

Pea leaf miner, Cabbage semilooper and Leaf folder

3. Pea leaf miner, *Chromatomyia horticola* (Agromyzidae: Diptera)

- **Distribution:** Widely distributed in northern India.
- **Host range:** peas, cruciferous crops, chrysanthemum, antirrhinum, nasturtium, potato, linseed, etc.

Damage:

- Larva is the destructive stage

- Adult females also puncture the leaves for oviposition and feeding.
- Larvae feed by making the prominent tunnels between epidermis of leaves
- Interfere with the photosynthetic activity
- Growth of the plants is reduced.
- Tunnels make the leaf unattractive and give yellowish look
- Reduces the quality and market value

Identification (Also see under insect pests of peas)

- The adults are small (2-2.5 mm in length) flies
- Transparent and shining wings
- Grayish black mesonotum and yellowish frons.
- Females are slightly bigger than males with pointed ovipositor.

Life cycle:

- Adults emerge in December and lay eggs singly in the leaf tissue
- The eggs hatch in 2-3 days
- Larvae become full fed in about 5 days
- Pupate within the galleries
- Pupal period is 6 days
- total life cycle is completed in 13-14 days
- Several generations from December to April- May.

Management

- Removal and destruction of severely mined leaves
- Spray of triazophos (0.04%) or oxy-demeton-methyl (0.025%) at weekly intervals help in controlling the pest.
- Parasitoids also check the pest

4. Cabbage semilooper, *Thysanoplusia orichalcea* (Noctuidae: Lepidoptera)

- **Distribution:** Through out the North western India.
- **Hosts:** Many vegetable and ornamentals

Damage:

- Larvae bite round holes in the leaves
- Under severe infestation the entire leaf and flower may be eaten.
- Yield and quality is reduced considerably

Identification (Also see insect pests of cole crops)

- The larvae are plump and pale green in colour.

- Adults are light pale brown moths with a golden patch on each fore wing.

Life cycle:

- Eggs hatch in 3-5 days
- Larval period is 15-20 days
- Five larval instars
- Pupal period about 12 days
- Adult longevity is 7-13 days

Salient features

- Eggs are laid singly on the foliage
- Larvae bite holes of varying size according to their stage of development.
- Full grown the larva enters into the plant debris lying on the ground for pupation.
- Moths are very active at dusk and can be seen in large number during spring season.

Management:

- As soon as the attack is noticed spray the crop with malathion @ 0.05%
- The spray can be repeated after 7-10 days if attack persists.

5. Leaf folder, *Hedylepta* sp. (Pyraustidae: Lepidoptera)

Damage:

- Larvae roll the leaves up wards and feed within on chlorophyll
- Attacked leaves get skeletonized and ultimately get dried
- The damage is more severe if the growing tip is attacked

Identification and life cycle

- Adult moths lay pale white eggs singly or in small batches on leaves and tender shoots
- The larvae are green in colour, about 10-12 mm in length
- Larvae remain hidden inside the leaves by folding them
- Incubation, larval and pupal periods are 4-6, 12-15 and 5-6 days, respectively.
- Adult longevity is 5-6 days.

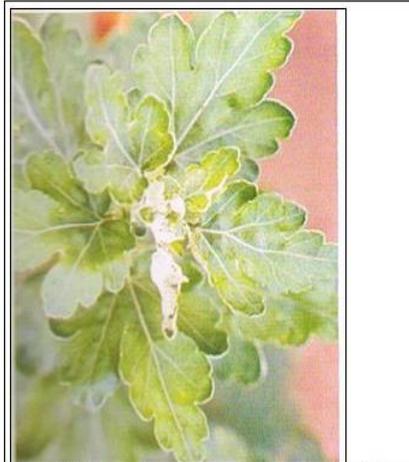


Plate 23.3: Terminal leaves attacked by leaf folder

Management

Apply deltamethrin (0.0028%) at 10 days interval.

Lecture - 24 Insect Pests of Gladiolus

Lecture - 24

Objectives: Gladiolus is another ornamental crop grown commercially in India. Many insect pests attack this crop and become limiting factors for its successful cultivation. Hence, the main objective of this lecture will be to teach the students about the identification, nature of damage, life cycle and management of different pests attacking this crop. **Gladiolus thrips and Bud borer**

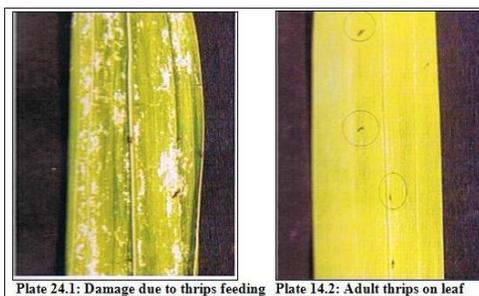
1. Gladiolus thrips, *Taeniothrips simplex* (Thripidae: Thysanoptera)

Damage:

- Both nymphs and adults are damaging
- Rasp the tissue and suck the oozing sap
- Affected parts develop silvery streaks which later on turn brown
- Attacked leaves get deformed and ultimately dries up
- If young plants are attacked, there is a reduction in flower production and quality
- Thrips also attack corms under storage
- Infested corms become sticky, shrivel and produce weak plants when planted.

Identification

- The nymphs are light yellow
- Adults are black in colour
- Wings have hairs which are arranged like the parts of the feather



Life cycle:

- Adults emerge in early spring and begin to feed on leaves and spikes
- After about 3 weeks they start laying eggs in the tissue of foliage
- On hatching young ones start feeding on the leaves and spikes
- Nymphs become full fed in about two weeks
- Pupate in soil.

- Pupal period is for about one week

Management:

- **Field:**
 - Monitoring with 'Blue' sticky cards
 - Spray oxy- demeton methyl (0.025%) or dimethoate (0.03%) at 10 day interval.
 - Soil application of phorate @ 1.0 kg a.i./ha
 - Drenching with chlorpyrifos (0.04%) or deltamethrin (0.0028%) to kill the pupae
- **Storage:**
 - Corms infested with thrips should be stored at 20 C for 6 weeks and later should be treated in hot (46°C) for 15 minutes.

2. Bud borer, *Helicoverpa armigera* (Noctuidae: Lepidoptera)

Damage:

- Larvae feed on leaves by eating leaf lamina.
- Caterpillars enter into the developing spikes and feed inside by damaging the flowers.

Bio-ecology:

- As described under carnation.

Management:

- As soon as the eggs or caterpillars are seen in the field, spray the crop with cypermethrin (0.0075%) or fenvalerate (0.01%) or deltamethrin (0.0028%).
- The pest can also be controlled by the application of Btk formulation (dipel) @ 0.5 kg/ha in the early stage of infestation.

Tobacco caterpillar and Others

4. Tobacco caterpillar, *Spodoptera litura* (Noctuidae: Lepidoptera)

- **Distribution:** Through out the tropical and subtropical parts of the world
- **Host plants:** Attacks tobacco, castor, cruciferous crops, tomato, chrysanthemum, gladiolus and many other plants.

Damage:

- Damage is caused by the caterpillars
- Early instars feed gregariously

- Scrapping the chlorophyll content from the leaves and skelotonising them
- Later instars scatter and feed voraciously eating the entire leaf

Tobacco caterpillar and Others

4. Tobacco caterpillar, *Spodoptera litura* (Noctuidae: Lepidoptera)

- **Distribution:** Through out the tropical and subtropical parts of the world
- **Host plants:** Attacks tobacco, castor, cruciferous crops, tomato, chrysanthemum, gladiolus and many other plants.

Damage:

- Damage is caused by the caterpillars
- Early instars feed gregariously
- Scrapping the chlorophyll content from the leaves and skelotonising them
- Later instars scatter and feed voraciously eating the entire leaf



Life cycle

- Eggs hatch in 3-5 days
- Larvae become full fed in 15-30 days
- Six larval stages.
- Pupal stage lasts for 7-15 days
- Total life cycle in completed in 32-80 day
- Many overlapping generations in a year.

Salient features

- The pest breeds throughout the year
- Lay eggs in cluster covered with brown hairs
- Newly emerged larvae feed gregariously

- Older larvae disperse to feed individually on the foliage
- Pupate in soil

Management:

- Collect early gregarious larval instars and destroy them before they get scattered.
- Spray the crop with deltamethrin (0.0028%)
- Repeat the spray as and when required

5.

Cutworms

Important species:

- *Agrotis segetum*
- *A. ipsilon*
- **Family:** Noctuidae
- **Order:** Lepidoptera
- **Distribution:** All over the world
- **Hosts:** Polyphagous

Damage: (Also see insect pests of cole crops)

- Damage is caused by the caterpillars
- Attack mainly the newly grown gladiolus plants
- Larvae feed during night on emerging shoots
- Also attack the under ground corms thus causing the yellowing of leaves

Life cycle:

- Moths are active during night and lay 200-350 eggs/ female.
- Oviposition continuous for 5-10 days.
- Incubation period varies from 2-12 days
- Larvae are nocturnal
- They cut the newly grown plant at the ground level and feed on the tender leaves
- Caterpillars also feed on the underground corms

Management:

- Light traps help in collecting and killing of adults.
- Use of poison bait consisting of carbaryl (0.1%) or malathion (0.1%) in wheat bran and molasses.
- Deep ploughing exposes larvae and pupae
- Drenching of infested area with chlorpyrifos (0.04%) help in controlling the larvae.

6. White grubs

- (For details see insect pests of potato)

7. Blister beetles

- (For details see insect pests of beans)

Lecture - 25 Insect Pests of Other Ornamental Crops

Lecture - 25

Objetives: Insect pests of ornamental crops not covered in the previous lectures but are grown in different parts of the country by the farmers will be covered in the present lecture

Cotton aphid

1. Cotton aphid, *Aphis gossypii* (Aphididae: Hemiptera)

- Nymphs and adults suck sap from Hibiscus rosa sinensis, Cossia glance, Tecoma capensis
- Bioecology and management have been discussed earlier

2. Dusky cotton bug, *Oxycarenus laetus* (Lygaeidae: Hemiptera)

Hosts: *Hibiscus rosa sinensis*, *Malvaviscus arboreus*, *Bougainvillea* spp, *Jasminum* spp., *Plumeria acuminata*.

- The nymphs and adults are commonly found feeding on its hosts throughout the year except during winter months
- *H. rosa sinensis* is the most preferred host
- Maximum population is found from March to May
- The flower buds of Hibiscus plants become pale as a result of its feeding and fall down without opening
- The adults usually feed on the terminal portions
- They hide in clusters of dry leaves and flowers during winter.

Life cycle and management of this pest has been discussed under insect pests of okra.

3. Hollyhock tingid bug, *Urentius euonymus* (Tingidae: Hemiptera)

Hosts: Garden holy hock, *Althaea rosea*, *Abutilon indicum*, *Sida cardifolia* and *Chrozophora rotilesi*.

Damage:

- Both nymphs and adults suck the cell sap from the under surface of leaves
- The infested leaves become pale yellow then turn brown and ultimately dry up after shriveling.

Identification

- The bugs are about 5-6 mm in length having densely reticulate body and wings
- The nymphs are spiny in appearance.

Life cycle

- This pest appears from March to June
- Adult females lay eggs on the upper surface of leaves
- The incubation period is 8-10 days
- There are five nymphal instars
- Larval period is 15-27 days
- The pest over winters in egg stage.

Management:

- Spray dimethoate @ 0.05%

4. Sunflower lace wing bug, *Cadmilos rotarius* (Tingidae: Hemiptera)

Hosts: Many garden plants like sunflower, gaillardia, daisy, chrysanthemum, marigold, etc.

Identification

- It is a small insect measuring about 4 mm
- Transparent shiny, reticulate wings
- Body is black

Damage:

- Both nymphs and adults suck the sap and the infested leaves turn yellowish brown and finally dry up.

Life cycle:

- Pest appears during July and remain active up to September
- Adult females lay eggs on the upper surface of the leaves
- The eggs are inserted strongly into plant tissue
- Only opercula exposed, which appear like white or brown dots
- The eggs hatch in 5-7 days
- Moults five times during 2-3 weeks.

Management

- Spray the crop with malathion @ 0.05%.

Red cotton bug

6. Red cotton bug, *Dysdercus koenigii* (Pyrrhocoridae: Hemiptera)

Damage

- Adults as well as nymphs suck the cell sap from plants
- Hibiscus rosa sinensis is the most preferred
- Plants lose their vitality and flower bearing capacity.

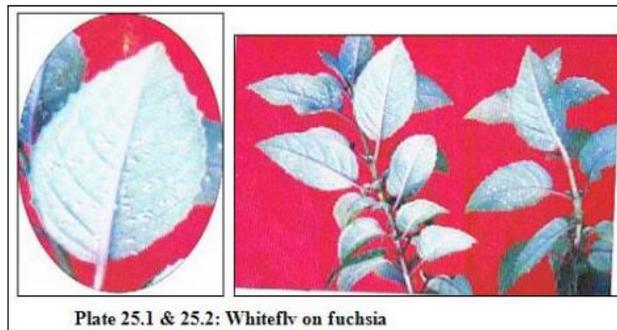
Life cycle and management of this pest has been described under the insect pest of okra

7. Cotton whitefly, *Bemisia tabaci* (Aleyrodidae: Hemiptera)

Hosts: Among ornamentals, it feeds on *Euphorbia pulcherima*, *Dombeya spectabilis*, *Poinciana pulcherima*

Damage

- Both adults and nymphs suck the cell sap
- Down ward cupping of the leaves
- Nymphs excrete honeydew on which sooty mould develops
- Blackish look to the plants especially leaves. Excessive sap sucking result in premature leaf fall.



8. Jasmine thrips, *Thrips orientalis* (Thripidae: Thysanoptera)

Damage:

- The dark coloured jasmine thrips is mainly found on *Jasminum multiflorum* from February to April
- Both adults and nymphs feed on flower by rasping the petals and feed on the oozing cell sap
- Attacked flowers give a decayed look and fall off prematurely.

Management

- Same as discussed under rose.

9. Lilly moth, *Polytela gloriosae* (Noctuidae: Lepidoptera)

Distribution: Sporadic and specific pest of lilies in India and Sri Lanka.

Identification

- The larvae have chocolate brown head
- They defoliate the lily plants
- The full grown larva measures 39-42 mm and possesses black, white and red mosaic pattern on the body
- The moth has mosaic pattern of red, yellow and black on fore wings with a row of black and yellow dots on the apical margins
- The hind wings are black.

Life cycle:

- Lays round eggs on the apical portion of the under surface of leaves in clusters of 13-42 eggs
- Larvae emerge from eggs after 3-6 days
- Feed on leaves for 16-20 days
- Adults emerge within 15-20 days

Salient features

- Adults moths emerge from the diapausing pupae after the first heavy shower during July
- Pupate in the soil in earthen cocoons
- The insect has two generations in a year
- Pupae of second generation hibernate



Plate 25.3: Thrips attack on marigold

Lecture - 26 Insect pests of Cardamom

Lecture - 26

Objectives: Cardamom is an important spice crop grown commercially in south India. Many insect pests attack this crop and become limiting factors for its successful cultivation. Hence, the main objective of this lecture will be to teach the students about the identification, nature of damage, life cycle and management of different pests attacking this crop.

Banana aphid

1. Banana aphid, *Pentalonia nigronervosa* (Aphididae: Hemiptera)

- **Distribution:** India, Sri Lanka and Australia.
- **Host range:** Banana, small and large cardamom, Colocasia sp and Allocasia sp

Damage:

- Both nymphs and adults suck the cell sap from leaf sheath and pseudo stem
- Vector of cardamom mosaic (Kattle disease), Amomum mosaic and forky disease of large cardamom

Identification

- Wingless aphid is dark brown, pyriform, 1.34 mm in length.
- Abdomen is dark brown, shining and slightly bulged.
- The winged form is dark brown elongated and pyriform
- They are larger than the wingless with less body width.

Life cycle

- The reproduction is parthenogenetic
- Adult longevity varies from 8-26 days with an average of 14 days
- Each female can lay 8-28 off springs with an average of 14 per female
- Nymphs become mature in 12-15 days
- Four nymphal stages.
- Several overlapping generations in a year

Management:

- Spray 300 ml of phosphamidon 85 WSC or 875 ml of dimethoate 30 EC in 250 L of water per hectare at an interval of two weeks

2. Cardamom thrips, *Sciothrips cardamom* (Thripidae: Thysanoptera)

- **Distribution:** All cardamom growing areas
- **Hosts:** Cardamom

Damage

- Nymphs and adults are damaging
- Lacerates all aerial parts and feed on oozing sap
- Infestation on panicle and flower buds results in stunted growth of panicles, shedding of flower buds and warty growth
- The infested capsules are light in weight, inferior in quality
- Low market price
- This insect is a serious pest of cardamom
- Pest population is high during dry months i.e. December in April.

Management:

- Spraying of quinalphos (0.03%) or phenthoate (0.03%) or phosalone (0.05%) or fenitrothion (0.05%) or dimethoate (0.05%)
- Application of insecticides can be skipped during June-July

3. Cardamom whitefly, *Dialeurodes cardamom* (Aleyrodidae: Hemiptera)

- **Hosts:** Cardamom

Damage

- This whitefly is serious on cardamom plants.
- Damage is caused by the nymphs and adults by sucking the cell sap from leaves
- Infested leaves turn yellow
- Attack first appear on the lower leaves and gradually progresses to the upper region
- Severe damage leads to drying up of plants.

Identification

- The eggs are oval shaped
- Nymphs are green in colour

Life cycle

- Each female lays 200-250 eggs
- Eggs hatch in 10-15 days
- Nymphs become pupa in 3-4 weeks
- Pass through 3-4 instars

Salient features

- Lay eggs mostly on the under surface of the leaf.
- Newly emerged nymphs crawl for few hours and after finding a suitable place settle down.
- There are two different seasonal activities i.e. April-May and October-November.
- However, the availability of pest in other seasons can not be ruled out.

Management

- Use of yellow sticky traps
- Need based use of systemic insecticides

Castor capsule borer

4. Castor capsule borer, *Dichocrosis punctiferalis* (Pyralidae: Lepidoptera)

Damage

- Serious pest of nursery plants and young green pods
- In nursery plants it bores into the stem and cause death of the central shoot
- It also eats away the tender seeds of young berries.

Identification

- Larvae are reddish brown with black blotches all over the body and a pale stripe on the lateral side.

Life cycle:

- Eggs hatch in about a week
- Larvae become full fed in 2-3 weeks
- Pass through 4-5 instars
- Pupal stage lasts for about a week
- Three generations in a year.

Salient features

- The moths lay eggs on leaves and soft part of the plant
- Larvae bore into the stems, berries
- Pupation takes place inside the seed or some times in frass that collects after feedings

Management:

- Collect and destroy the infested shoots and capsules
- Spray the crop with carbaryl (0.1%)

5. Cardamom hairy caterpillars:
a) *Lenodera vittata* (Lesiocampidae: Lepidoptera)

Hosts: commonly found feedings on cardamom in South India.

Identification

- The moth is stout, fairly big and densely covered with scales
- The larvae are clothed with a dense belt of capitate hairs
- About 106-110 mm in length
- Eggs are cream coloured, dome shaped

Damage

- Larvae are the damaging
- Feed on the leaves and other tender parts of the plant

Life cycle

- Oviposition period of 6-9 days
- Larvae emerge from the eggs in 10-13 days
- Moults six times in 112-115 days
- Pupal period is 5-7 months

Salient features

- The moths emerge during June
- Lay eggs in rows on both the upper and lower surface of the leaves
- Each female can lay 100-300 eggs
- Pupation takes place in the soil
- Only one generation in a year.

b) *Eupterote cardamomi* (Eupterotidae: Lepidoptera)

- **Distribution:** South India
- **Hosts:** Cardamom

Identification

- The adults are large moths, ochreous in colour, with post medial lines on the wings
- 70-80 mm in wing expanse
- The larvae are hairy, dark grey in colour with pale brown head, bearing conical tuft of hairs on the dorsal side of the body

- Full grown the caterpillar are 90 mm in length

Damage

- The larvae feed on leaves of the shade trees up to the 6th or 7th instar
- Later on they drop down to the cardamom plants growing underneath with the help of silken threads
- Feed on the leaves voraciously and defoliate the cardamom plants
- Heavy reduction in the yield

Lifecycle

- Eggs hatch in 15-17 days
- Larva passes through ten instars
- Larval period is 140-151 days
- Pupal period is 7-8 months
- The moth lives for about 20 days
- There is only one generation in a year.

Salient features

- Moths emerge with the commencement of the South West monsoon rains in June and July
- Female moth lay 400-500 eggs in flat masses on the under surface of leaves
- Each egg mass contains about 50-160 eggs
- It pupates in a silken cocoon at a depth of 5-8 cm for 7-8 months

c) Other hairy caterpillars:

- *Eupterote canarica*
- *E. testacea*
- *E. fabia*
- Sporadic and occasionally cause damage to cardamom plants
- The life cycle and habits are similar to earlier described species.

Management of hairy caterpillars:

- These hairy caterpillars can be controlled by spraying the crop with malathion (0.05%) or carbaryl (0.1%)

Rhizome weevil

6. Rhizome weevil, *Prodiocetes haematicus* (Curculionidae: Coleoptera)

Distribution: Different states of south India.

Damage

- Damage is caused by grubs
- Tunnel and feed inside the rhizomes
- Death of entire plumps of the cardamom plants.

Identification

- The adult is a brown weevil measuring 12 mm in length.

Life cycle

- Grubs emerge from the eggs in 8-10 days
- Larvae become full fed in three weeks
- Pupate for 3 weeks.
- Adult weevils live for 7-8 months.
- There is only one generation in a year.

Salient features

- The weevils emerge during April, soon after an early shower of the monsoons
- Bore into the rhizomes by making tunnels
- Larvae feed inside the rhizomes and become full fed in three weeks
- They pupate within the feeding tunnels

Management

- Destroy effected plants/seedlings
- If grub population is more in the soil, drench with 1.25 L of malathion 50 EC in 625 L of water per hectare

Insect pests of large cardamom

- Hairy caterpillars, *Clelea plumbiola*
- Stem borer, *Glyphipterix* sp.
- Beetles, *Chrysomela* sp
- *Georgia quadrimaculata*
- White grubs

Minor pests of cardamom:

- Wingless grasshoppers, *Orthacris* sp. (Acrididae: Orthoptera)
- Leafhopper, *Tettigoniella ferruginea* (Cicadellidae: Hemiptera)

- Spittle bug, *Aphrophora nuwarans* (Aphrophoridae: Hemiptera)
- Banana lace wing bug, *Stephanitis typica* (Tingidae: Hemiptera)
- Thrips, *Leewania maculans* (Thripidae: Thysanoptera)
- The bag worm, *Acanthopsyche bipars* (Psychidae: Lepidoptera)
- Root borer, *Hilarographa caminodes* (Plutellidae: Lepidoptera).
- Cutworm, *Nocloa plagiata* (Noctuidae: Lepidoptera)
- Root gall midge, *Hallomyia cardamomi* (Cecidomyiidae : Diptera)

Lecture - 27 Insect pests of Ginger and Turmeric

Lecture - 27

Objectives: The main objectives of this lecture will be to teach the students about the major as well as minor pests ginger and turmeric. Emphasis will be on the host range, identification, nature of damage, life cycle and ecofriendly management of important pests.

Ginger

1. Shoot borer, *Dichocrosis punctiferalis* (Pyralidae: Lepidoptera)

Damage:

- It is a serious pest of ginger
- Damage is done by the caterpillars
- bore into the central shoots of the plant
- Affected plants turns yellow and dry up

Management

- This pest can be controlled by cutting and removing the affected shoots and spraying the crop with malathion (0.05%).

2. Cotton thrips or onion thrips, *Thrips tabaci* (Thripidae: Thysanoptera)

- **Distribution:** Kerala, Himachal Pradesh, Madhya Pradesh and Maharashtra.
- Discussed under pests of onion

3. Spice beetle, *Stegobium paniceum* (Anobiidae: Coleoptera)

Damage

- The grubs and adults feed on dry ginger in ware houses
- The grubs tunnel rhizomes by cutting microscopic holes and continues feeding from inside

Management

- This pest can be controlled by giving a heat treatment (54-66°C for 6 h) to rhizomes.
- Dusting of warehouse with pyrethrin also controls this pest.

Minor pests of ginger

- Scale, *Aspidiotus hartii* (Diaspididae: Hemiptera)
- Termeric skipper, *Udaspes folus* (Hesperidae: Lepidoptera)
- Maggots:
 - *Calobata* sp. (Micropezidae : Diptera)
 - *Chalcidomyia atricornis* (Chloropidae : Diptera)
 - *Formasina flavipes* (Chloropidae : Diptera)
 - *Celyphus* sp. (Celyphidae : Diptera)
- Weevil, *Hedychrous rufofasciatus* (Curculionidae : Coleoptera)

Turmeric

1. Castor capsule borer, *Dichocrocis punctiferalis* (Pyralidae: Lepidoptera)

Damage

- The caterpillars enter into the aerial stem killing the central shoot
- Results in 'dead heart'.

The life cycle and management has been discussed under insect pests of cardamom.

2. Bihar hairy caterpillar, *Spilarctia (Spilosoma) obliqua* (Arctiidae: Lepidoptera)

Damage

- This pest damages the turmeric plants extensively in Bihar and Bangal states.
- Damage is caused by the caterpillars
- First two stages the tiny caterpillars feed gregariously
- Older larvae disperse widely in search of food.

For identification and life cycle see insect pests of beans

Management:

- Young caterpillars can be controlled by spraying the crop with malathion (0.05%)
- Moths can be trapped in artificial light and killed
- Young gregarious caterpillars can be collected and killed manually in kerosinized water.

Minor pests of turmeric

- **Coccids:** *Aspidiotus hartii* (Diaspididae: Hemiptera)
 - *A. cucumae* (Diaspididae: Hemiptera)
- **Leaf thrips:** *Anaphothrips rudanensis* (Thripidae: Thysanoptera)
 - *Asprothrips indicus* (Thripidae: Thysanoptera)
 - *Panchaetothrips indicus* (Thripidae: Thysanoptera)
- Skipper butterfly, *Udaspes folus* (Hesperidae : Lepidoptera)

- Chrysmellid beetle, *Lema pracusta* (Chrysomelidae : Coleoptera)
- Banana lacewing bug, *Stephanitis typica* (Tingidae: Hemiptera)

Lecture - 28 Insect Pests of Coriander

Lecture - 28

Objectives: Coriander is another important spice crop grown commercially in India. Many insect pests attack this crop. Hence, the main objective of this lecture will be to teach the students about the identification, nature of damage, life cycle and management of different pests attacking this crop.

Cotton whitefly

1. Cotton whitefly, *Bemisia tabaci* (Aleyrodidae: Hemiptera)

- **Distribution:** Throughout the northern and western regions of the Indian sub-continent
- **Hosts:** Cotton, okra, cabbage, cauliflower, melons, potato, egg plant, coriander and several weed plants.

Damage

- Caused by nymphs and adults
- Suck the cell sap from leaves and other tender plant parts
- Vitality of the plant is reduced
- Nymphs also excrete honey dew on which sooty mould grows
- Interferes with photosynthesis
- Also transmit viruses.

Identification

- The eggs are stalked, sub elliptical and light yellow initially and turns brown before hatching
- Nymphs are elliptical
- Adults are small white coloured insects

Life cycle

- Eggs hatch in about 3-5 days
- Nymphs grow through three stages
- Become pupae in about 9-14 days during summer and 17-81 days during winter
- Pupal period is of 2-8 days
- Total life cycle is completed in 14-122 days.

Salient features

- The pest breeds through out the year
- During cold seasons only adults are noticed
- Females lay eggs singly on the under surface of the leaves
- Suck the sap from tender parts of the plant.

Management:

- Use of yellow sticky traps
- Need based spray of phosphamidon (0.04%) or oxy-methyldemeton (0.025%) or dimethoate (0.03%).
- Observe a waiting period of 7 days

Minor pests of coriander

- Aphid, *Hyadophis coriandri* (Aphididae: Hemiptera)
- Bug, *Agonoscelis nubila* (Pentatomidae: Hemiptera)
- Indigo caterpillar, *Spodoptera exigua* (Noctuidae: Lepidoptera)

Cinnamon butterfly

Cinnamon butterfly, *Chilasia clytia* (Papilionidae: Lepidoptera)

- **Distribution:** South India and Srilanka.
- **Hosts:** A number of wild species of cinnamon and other forest trees.

Damage

- Early instars feed on the lamina of the freshly emerged leaves
- Later instars feed voraciously on leaves leaving only the mid ribs
- In case of severe infestation the growth of plant is adversely affected

Identification

- Freshly hatched larva is jet black in colour with white patches which later undergo various changes in colour pattern
- The dorsal side of adults moth is rich velvety brown
- Ventral surface of body varies from soft pale brown to rich velvety brown.

Life cycle

- Eggs hatch in 3-5 days
- The larva moults five times
- Larval period is 12-18 days
- Pupal period is completed in 11-13 days.
- Adults live for 3-5 days
- Total life cycle is completed in 24-36 days.

Salient features

- Lay eggs singly on the upper and lower surface of young leaves, petioles and also on tender shoots
- Larvae feed on leaves
- Pupation takes place in rough silken padding on the stem prepared by the larva

Management:

- Pest can be kept under check by collecting the butterflies with the help of net and destroying them
- In case of severe infestation, spray the crop with quinalphos @ 1.5 L/500 L of water/ha.

Minor pests of cinnamon

- Leaf psyllid, *Pauropsylla depressa* (Psyllidae: Hemiptera)
- Leaf miner, *Phyllocnistis chrysoththalina* (Phyllocnistidae: Lepidoptera)
- Tussock caterpillar, *Dasychira mendosa* (Lymantridae: Lepidoptera)

Lecture - 29 Insect Pests of Black Pepper

Lecture - 29

Objectives: Black pepper is an important spice crop grown commercially in south India. Many insect pests become limiting factors for its successful cultivation. Hence, the main objective of this lecture will be to teach the students about the identification, nature of damage, life cycle and management of different pests attacking this crop.

Polu beetle

1. Polu beetle, *Longitarsus nigripennis* (Chrysomelidae: Coleoptera)

Damage:

- Grubs bore and feed on the contents of tender berries making them hollow
- The external indication of infestation is the presence of dark, drying berries possessing characteristic circular hole in the midst of green healthy berries
- A single grub can destroy 3-4 berries
- The extent of damage caused by polu beetle goes up to 40 per cent in certain endemic areas

Identification

- Polu beetle is small, shining and brownish black flea beetle with stout legs
- Grubs are pale yellow

Life cycle

- The adult beetle lays eggs in small shallow depressions made on the rind of tender pepper berries
- A single grub can destroy 3-4 berries.
- Fully grown grubs drop to soil, construct oval shaped earthen cocoons and pupate in them
- Total life cycle of the pest is completed in 40-50 days
- There are four generation between July and January.
- Egg laying stops by December when pepper berries mature.
- Pest is active from July to Jan-Feb but the maximum population is during November
- The high yielding cultivars suffer more heavily
- TMB V and 'Shimoga' were particularly free from pollu beetle infestation.

Management:

- Cultural operations like raking of soil and regulation of shade by standards.
- Tilling the soil at the base of the vine at regular intervals
- Soil application of insecticides is also affective in controlling the grubs falling to ground for pupation.
- Spraying of vines with quinalphos (0.05%) twice a year during July and October control the pest effectively.

2. Top shoot borer, *Cydia (Laspeyresia) hemidoxa* (Eucosmidae: Lepidoptera)

Damage

- The caterpillars damage terminal shoots by boring into them
- Drying of terminal portions of the vines.

Salient features:

- Adults are yellow coloured moths
- The incidence is more during August to December, when tender shoots are available
- Pest takes about a month to complete its life cycle

Management

- Spraying vines with dimethoate or phosphamidon at 0.05% is effective
- Parasitoids like *Apanteles* sp. (Braconidae), *Euderus* sp. (Eulophidae) and *Goniozus* sp. (Bethylidae) have been reported to attack the caterpillars in nature

3. Gall forming thrips, *Liothrips (Gynaikothrips) karnyi* (Thripidae: Thysanoptera)

Salient features:

- It is a persistent pest in almost all the pepper growing areas of India
- The thrips make marginal galls on leaves within which they live in colonies
- Rasp and suck the sap
- Leaf tissue become thick
- Under server infestation whole leaf presents crinkled or mall formed appearance
- Proliferation of cells
- Leaves become brittle

Management

- Spraying of vines with malathion (0.1%) or dimethoate (0.05%) or quinalphos (0.54%) is effective
- An anthocorid bug and some predaceous mites have also been reported

Scales and mealybugs

4. Scales and mealybugs

- *Lepidosaphes piperis* (Coccidae: Hemiptera)
- Mussel scale, *Lecanium marsupiale*
- Hard scales, *Aspidiotus destructor*
 - *Pinnaspis aspidistrae*
 - *P. marchali*
 - *Chionaspis voricosa*
- Mealy bugs, *Ferrisia virgata*

Damage

- Scales and mealy bugs often cause considerable damage to pepper
- They suck the cell sap from plants
- Badly infested vines dry up gradually.

Management

- Spraying of malathion (0.1%) or dimethoate (0.05%) is effective in controlling these coccids.

5. Gall midge, *Cecidomyia malabrensis* (Cecidomyiidae: Diptera)

Damage

- The eggs are laid on the spikes
- The maggots get embedded in the pulp of berries and at the attachment of berry to spike
- Full grown maggots fall to the ground and pupate in soil
- Infested berries increase in size in the beginning but appear stunted later
- Cause Swelling on tender stalks and shoots.

Minor pests

- Flea beetles, *Pagria costatipennis*
 - *Neculla pollinaria*
- Weevil, *Eugnathus curvues*
 - *Myllocerus* sp.
- Stem borers, *Pterolophia annulata* (Cerambycidae: Coleoptera)
 - *Diboma procera*

Lecture - 30 Insect Pests of Stored and Processed Vegetables, Ornamental and Spices

Lecture - 30

Objectives: The main objectives of this lecture will be to teach the students about the important pests of vegetables, ornamental and spice crops in storage and after processing. Emphasis will be on the host range, identification, nature of damage, life cycle and ecofriendly management of important pests.

Indian meal moth

4. Indian meal moth, *Plodia interpunctella* (Phycitidae: Lepidoptera)

- **Hosts:** Important pest of dried and stored commodities in the pantry.

Identification

- Basal half of the fore wings is silver white or grayish, outer two third portion is reddish, copper bronze with irregular bands
- Hind wings are also silvery grey with silky fringes.
- Fresh larva is transparent, about 1mm
- Full grown larva is about 13mm in size, dirty white in colour having granular skin and hairs on the body.

Life cycle

- Incubation period varies from 2 to 17 days
- Larval period is 30-35 days but may be prolonged during low temperatures
- Total life cycle is completed in about 27 days but may be prolonged during winter

Salient features

- Each female can lay 40-275 eggs during its life time
- It feeds superficially but may construct more than one silken tunnel
- Best temperature is around 30°C and RH around 75 %
- Below 10°C there is no development

Management of stored pests:

- Sun drying
- Surface treatment
- Fumigation

- Improved storage receptacles

5. Onion maggot/ onion fly, *Delia antiqua*:

- For details please see the insect pests of onion

6. Gladiolus thrips,

- *Taeniothrips simplex* (Thripidae: Thysanoptera) :
- For details please see the insect pests of gladiolus

7. Potato tuber moth, *Phthorimaea operculella*:

- For details please see the insect pests of potato
- 31

Lecture - 31 Pesticide Residues Problems

Lecture - 31

Objectives: Pesticides play an important role in the control of different pests, but, their indiscriminate use result in many environmental hazards. So, in the present lecture discussions will be on the environmental impacts of pesticides with emphasis on pesticide residues.

Pesticides

Pesticides:

- Pesticides are the poisonous substances intentionally used on crops to control, destroy, repel, prevent and mitigate the pests.
- Dissipated with time but at the same time they persist accumulate and contaminate environment.
- Accumulate in the body.
- Transferred from one trophic level to another with magnification at each level (bio-magnification).

Environmental impacts of synthetic pesticides:

1) Insecticide resistance:

- Development of an ability to tolerate a dose of an insecticide which would prove lethal to the majority of the individuals in a population of the same species.
- This ability results due to genetic change in a pest population in response to toxicants
- First documented case of insecticide resistance appeared in 1914 when Sanjose scale was reported resistant against hydrogen cyanide.
- Over 600 species have developed resistance against one or the other insecticide.

2) Insect resurgence:

- Abnormal increase in pest population or damage following insecticide application often far exceeding the EIL.

3) Secondary pest outbreaks:

- Due to indiscriminate use of pesticides natural enemies suffer badly
- In the absence of natural enemies the minor pests multiply rapidly and attain the status of major pests.

4) Toxicity to non-target organisms:

- Most of the pesticides are biocides basically meant for killing.
- Without discrimination they kill every organism
- Common categories of non target organisms which suffer are
- Natural enemies
- Pollinators
- Soil organisms
- Fishes

5) Human toxicity and health hazards:

Acute toxicity:

- Toxicity resulted due to single dose of a toxicant.

Chronic toxicity

- Toxicity resulted due to the repeated exposure of an organism to sub lethal doses of a toxicant.
- Toxicant gets accumulated (bio-accumulation) in the body which ultimately results in ill effects in the body.
- Ill effects can be carcinogenic, teratogenic, mutagenic, failure of vital body organs, infertility, etc.
- 3 million acute poisoning cases occur world wide every year out of which 2 millions are of suicide and rest are of occupational or accidental poisoning cases.
- 108 people died due to parathion poisoning in Kerala in 1953.
- Bhopal gas tragedy at Union Carbide Plant in Bhopal during 1984 where the vapours of methyl isocyanate, an intermediate for the manufacturing of carbaryl were leaked from the plant.
- In this tragedy at least 5000 people were killed, 50,000 were disabled permanently and in total 2, 00,000 people were affected.
- According to a report by Natural Resource defense council (NRDC) of USA one out of every 3400 children between 1 and 5 years of age could one day get cancer due to pesticides.
- In India cases of blindness, cancer, diseases of liver and nervous system from pesticides have been reported from cotton growing areas of Andhra Pradesh and Maharastra.
- Symptoms like anxiety, sleep disturbance, depression and severe headache have been reported in people regularly involved in spraying of DDT and malathion.

Pesticide residues

6) Pesticide residues:

Terminology:

- **Deposit:** The amount of pesticide initially laid down on the surface of the commodity is called as the deposit.

- **Residue:** pesticide residue means any specified substances in food, agricultural commodities, or animal feed resulting from the use of a pesticide. The term includes any derivative of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance. The term pesticide residue includes residues both from known as well as unknown sources.
 - **Dissipation and persistence:** In nature disappearance of residues takes place in two steps. The first step is initial phase in which the disappearance of residue is fast. This phase is called as dissipation. The second phase, in which there is slow decrease in the amount of residue, is known as persistence. The main difference in the two is that the dissipation follows the law of “first order kinetics”, whereas, the persistence does not follow this law.
 - **Residue half life (RL50):** It is the time in which half of the amount of the initial deposit is eliminated by reaction or dissipation.
 - **Maximum residue limit (MRL) or tolerance:** It is the maximum concentration (in ppm) of pesticide residue that is permitted in or on food at a specified stage of harvesting, transport, marketing or preparation of food up to the final point of consumption.
 - **Acceptable daily intake (ADI):** It is the daily intake, which during an entire lifetime, appears to have no appreciable risk to the health of the consumer on the basis of all the known facts at the time of the evaluation of the chemical. It is expressed in mg of chemical per Kg body weight. ADIs are derived on the basis of long term feeding studies with laboratory animals. A safety factor of 100 is applied to express the non observed adverse effect level in the most sensitive animal studied.
 - **Waiting period:** It is the time interval (days) between final spray and harvest of the crop. It is the time which is required for initial deposits to dissipate below MRL.
 - **LD50:** It is the dose of a chemical expressed in mg/ Kg required to kill 50% of the test organisms. It is also called as median lethal dose.
- Only a small amount (less than 1%) of pesticide applied on a crop reaches the target pests
 - More than 99% enters the environment
 - Major source of human exposure to these pesticides is food, however, drinking water, inhalation and dermal contacts also leads to residues in humans.
 - Due to the ban of pesticides like DDT, HCH, aldrin, dieldrin heptachlor, etc. a decline in the pesticide residues has been observed in recent past
 - Ways and means to minimize pesticide residues:
 - Observe IPM strategies and pesticide should be used only when it absolutely essential (as last alternative)
 - Always use approved pesticides at recommended doses and at appropriate time. Avoid indiscriminate and unwarranted use of pesticides in pest management programmes.
 - Preference should be given to less persistence pesticides and never use banned or restricted pesticides
 - Monitor the crop regularly for pest incidence and use pesticides only when it reaches ETL
 - Use selective, ecofriendly and less persistence pesticides
 - Ripe fruits and vegetables should be plucked before pesticide application and after pesticide application the crop should be harvested only after observing recommended waiting period.

- Pesticide residues on food commodities can be reduced by processing like washing, peeling and cooking.
- Farmers should develop a habit to read and follow the instructions given on pesticide container/ leaflet which are use full in using the pesticide effectively and safely.
- Farmers should develop a habit to maintain spray diary containing time of application, dose and type of pesticide applied.

MRL values of some common insecticides on some vegetables

| Insecticide | Commodity | MRL (mg/Kg) |
|------------------|---------------------------|-------------|
| Carbaryl | Okra and leafy vegetables | 10 |
| | Other vegetables | 5 |
| Diazinon | Vegetables | 0.5 |
| Dichlorvos | Vegetables | 0.15 |
| Dicofol | Fruits and Vegetables | 5.0 |
| | Chillies | 1.0 |
| Dimethoate | Fruits and Vegetables | 2.0 |
| | Chillies | 0.5 |
| Endosulfan | Fruits and Vegetables | 2.0 |
| | Chillies | 1.0 |
| Malathion | Vegetables | 3.0 |
| Lindane | Fruits and Vegetables | 1.0 |
| Methyl parathion | Vegetables | 1.0 |
| Chlorfenvinphos | Vegetables | 0.05 |
| Chlorpyrifos | Potato and onion | 0.01 |
| | Cauliflower and cabbage | 0.01 |
| | Other vegetables | 0.2 |
| Ethion | Cucumber and squash | 0.2 |

| | | |
|---------------|-----------------------|------|
| Formathion | Vegetables | 2.0 |
| | Peppers and tomato | 1.0 |
| Phosalon | Potato | 0.1 |
| | Other vegetables | 1.0 |
| Trichlorfon | Fruits and Vegetables | 0.1 |
| Thiometon | Potato | 0.05 |
| | Other vegetables | 2.5 |
| Carbofuran | Fruits and Vegetables | 0.1 |
| Cypermethrin | Egg plant | 0.2 |
| | Cabbage | 2.0 |
| | Okra | 0.2 |
| Fenvalerate | Cauliflower | 2.0 |
| | Egg plant | 2.0 |
| | Okra | 2.0 |
| Phorate | Tomato | 0.1 |
| | Other vegetables | 0.05 |
| Permethrin | Cucumber | 0.5 |
| | Soybean | 0.5 |
| Quinalphos | Cardamom | 0.01 |
| Triazophos | Chillies | 0.2 |
| Fenpyroximate | Vegetables | 0.02 |
| Spiromesifen | Tomato | 0.45 |
| | Cucurbits | 0.1 |

Dicofol

Fruits and Vegetables

5.0 (PFA)

Lecture - 32 Crop Losses Caused by Pests and Their Assessment

Before studying the losses caused by insect pests to crops and methods to assess them, it is important to understand the terms pertaining to the topic. Some of the terms are discussed as under.

- **Yield:** Yield is a measurable produce of economic importance from a crop. The yield may be evaluated in terms of quantity and/or quality. The distinction between total yield and marketable yield is important if marketability and /or value of the crop is determined by its quality i.e. commercial class or grade.
- **Production:** It is the total amount harvested in a country or in a region in a year.
- **Theoretical yield:** It is the yield obtained from a crop grown under most favourable conditions. There is no factor limiting the yield potential of the crop, only genetic factor are limiting.
- **Attainable yield:** It is the site specific maximum yield that can be obtained under the geographic and ecological conditions at a location using best production techniques to avoid biotic stress. It is determined by factors like climate, latitude, and variety grown.
- **Actual yield:** It is the site specific yield obtained when the crop is grown using available cultivation and plant protection practices at a particular place.
- **Crop loss:** A crop loss is any reduction in quantity and/or quality of yield and is the equivalent of 'damage' Crop loss is measured as the difference between actual yield and attainable yield due to the effect of one or more pests. The term yield loss should be restricted to describe the reduction in yield caused by a single pest.
- **Direct losses:** These relate to the decrease in productivity (quantitative) or intrinsic value/ acceptability of the produce (qualitative). Direct losses include killing of flowers, buds, fruits, twigs or whole plant due to the attack of insect-pests. The examples of indirect qualitative losses include light infestation of fruits by scales, puncturing of fruits.
- **Indirect losses:** These are primarily of economic interest i.e. decreased purchasing power of farmers due to reduced production. These will lead to decrease in related activities, reduced productivity of agro based industries and forced acceptance of less desirable substitute products.
- **Actual losses:** These include the sum total of both direct as well as indirect losses.
- **Potential losses:** These refer to the losses likely to be sustained without the adoption of the plant protection measures.
- **Avoidable losses:** It is that proportion of the losses that can be saved by adopting proper crop protection measures.
- **Unavoidable losses:** It is that proportion of the crop losses that cannot be prevented by using the available crop protection technology.
- **Efficiency of crop protection:** It is defined as the percentage of avoidable losses which are actually prevented by the use of crop protection measures.

Efficiency of crop protection = $100 \frac{\text{Actual yield} - \text{yield without crop protection}}{\text{Attainable yield} - \text{yield without crop protection}}$

Methods of estimating the crop losses:

Estimation of crop losses caused by the pests is very important in pest management programmes. Estimation of pest damage is use ful in pest management in following ways:

- To determine the economic status of a given pest species.
- For establishing the economic threshold levels and economic injury levels of the pest.
- To estimate the effectiveness of control measures.
- For evaluating the crop or a variety for its reaction to the pests.
- Helping in deciding the allocations for research and extension in plant protection.
- Helping in assigning the priorities on the bases of relative importance of different pests.

A brief account of the techniques adopted for the assessment of crop losses caused by insect-pests has been given below:

Mechanical protection: The crop is grown in enclosures under protected conditions by using anti-insect nets or cotton cloths in order to keep the pests away. The yield obtained under theses enclosures is compared with that obtained from infested crop grown under similar conditions. This technique has been used with various modifications for estimating the crop losses caused by jassids and whiteflies. The limitation with this method is that the plants generally become week and pale in enclosures due to changes in micro-environment. Further, this technique can not be used on a large scale because it is time consuming and impracticable under field conditions.

Chemical protection: In this case the crop is protected from pest damage by applying chemical pesticides. The yield of treated plot is compared with that of untreated which is exposed to natural infestation. This technique has been extensively used and can be employed on a larger area. Here care should be taken that the treated and untreated plots should be as identical as possible in respect of soil type, variety grown, fertilization and other cultural practices. The major drawback in this method is that the crop treated with chemicals may be physiologically affected and hence may vary in yield to some extent.

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

Comparison of yield of individual plants: In this case the yield of individual plants in the same field is measured and the average yield of healthy plants is compared with the plants showing different degree of infestation and the loss in yield is estimated. The data so obtained can also be used to work out the correlation between yield and infestation level on the bases of the yield of individual plants. This technique has been used with different modifications for the estimation of crop losses in different crops. In this case the soil heterogeneity is greatly reduced, however, plant to plant variation in infestation level may be there.

Damage caused by individual insect: Preliminary information is obtained from studies on the biology of the pest. The details regarding the amount of damage caused by different stages of pest are worked out and the amount of loss is calculated. This technique is quite convenient in

case of leaf feeding insects. However, it is difficult to use this technique over a large area because it is time consuming.

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

Simulation of damage: In this method the pest injury is simulated by removing or injuring the plant parts. The simulated damage may, however, not always be equivalent to the damage caused by an insect. Insects may inject toxins in to the plant rather than producing injury instantly. Feeding on margins of the leaf may not be equivalent to the tissue removed from the centre of the leaf. Insect feeding is usually extended over a period of time and is rather difficult to incorporate the concept of rate of injury in simulating studies. Furthermore the period of leaf removed may be important, as for example the age, quality and position of the leaf on the plant. In addition the time of simulating damage with respect to the stage of growth is also critical. Simulated studies have been done on spotted boll worm in cotton in India.

