

PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY

FACULTY OF AGRICULTURE

DIPLOMA IN AGRICULTURE

STUDY MATERIAL

COURSE NO: DA – 132

PESTS OF CROPS AND THEIR MANAGEMENT

CREDITS: 4 (3+1)



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LECTURE OUTLINE

DA- 132: PESTS OF CROPS AND THEIR MANAGEMENT

CREDITS: 4 (3+1)

Lecture No. 1: Introduction to rice pests

Lecture No. 2-3: Rice: Yellow stem borer, gallmidge, brown planthopper, green leafhopper, hispa, leaf mite, panicle mite, leaf folder, climbing cutworm and IPM practices in rice.

Lecture No. 4-6: Sorghum and Maize: Sorghum shoot fly, stem borer, pink borer, sorghum midge, ear head bug, red hairy caterpillar, deccan wingless grasshopper, aphids, maize shoot bug, flea beetle, blister beetles, ragi cutworm, ragi root aphid, army worm.

Lecture No. 7-9: Pulses: Gram caterpillar, plume moth, pod fly, spotted pod borer, blue butterflies, Blister betteles , Sucking pests like Leafhoppers, aphid, whitefly, cow bug, pod bug and redgram mite.

Lecture No. 10-11: Ground nut: red hairy caterpillar, leaf miner, leafhopper, White grub, thrips, aphid, , tobacco caterpillar, Gram pod borer, jewel beetle, Termites, pod bug,

Lecture No. 12: Sunflower: Helicoverpa and Spodoptera, whitefly, leafhopper, Bihar hairy caterpillar.

Lecture No. 13: Sesamum: Leaf and pod borer, gall fly, sphinx caterpillar.

Lecture No. 14: Castor: Semilooper, shoot and capsule borer, tobacco caterpillar, leafhopper, , whitefly, thrips, castor slug, mite.

Lecture No. 15: Soyabean: Stem fly, Pod fly, leaf miner, tobacco caterpillar, whitefly, Leafhopper, thips and hairy caterpillars.

Lecture No. 16-18: Sugarcane: Early shoot borer, internodal borer, top shoot borer, scales, leafhoppers, white grub, mealy bugs, termites, whiteflies, woolly aphid, yellow mite.

Lecture No. 19: Tobacco: Helicoverpa and Spodopter, whitefly, stem borer, aphid and thrips.

Lecture No. 20-23: Cotton: Spotted bollworm, american bollworm, pink bollworm, tobacco caterpillar, leafhopper, whiteflies, aphid, mites, thrips, red cotton bug, dusky cotton bug, leaf roller, stemweevil, mealybug, IPM in cotton.

Lecture No. 24-25: Chillies: Thrips, , mites, pod borers, aphid, blossom midge

Lecture No. 26: Brinjal: Epilachna beetle, shoot and fruit borer, stem borer, mealy bug, aphid, leafhopper, lacewing bug and red spider mite.

Lecture No. 27: Bhendi: Shoot and fruit borer, leafhopper, whitefl y and Red spider mite

Lecture No. 28: Tomato: Borers, Epilachna beetle, Serpentine leaf miner, fruit borer, whitefly

Lecture No. 29: Cucurbits: Fruitflies, pumpkin beetles, semilooper, serpentine leaf miner, pumpkin leaf eating caterpillar, Epilachna beetle and aphid.

Lecture No. 30-31: Crucifers: Diamond back moth, cabbage head borer, leaf webber, Tobacco caterpillar, mustard sawfly, Cutworms, painted bug, Blister beetles.

Lecture No. 32-34: Mango: Leafhoppers, stem borer, nut weevil, fruitfly, shoot borer, fruit borer, mealy bug, aphids, leaf webber, thrips, red tree ant, leaf gallmidges, red spider mite.

Lecture No. 35-36: Citrus: Butterfly, fruit sucking moths, leaf miner, psylla, rust mite, bark eating caterpillar, blackfly, leaf mite.

Lecture No. 37-38: Grapevine: Flea beetle, thrips, mealy bug, stem girdler, stem borer, leaf eating caterpillars.

Lecture No. 39: Cashew: Tree borer, shoot and blossom webber, tea mosquito bug, thrips, leaf miner

Lecture No. 40: Pomegranate: Butterfly and thrips

Lecture No. 41-42: Coconut: Black headed caterpillar , rhinoceros beetle, red palm weevil, slug, termites, scale, mite.

Lecture No. 43: Banana: Rhizome weevil, Aphid, pseudostem weevil and Nematodes.

Lecture No. 44: Turmeric: Rhizome fly, Lace wing bug Onion: Thrips, Spodoptera exigua

Lecture No. 45: Stored grain: Rice weevil, lesser grain borer, khapra beetle, pulse beetle, groundnut bruchid, flour beetles, saw-toothed beetle, cigarette beetle, angoumois grain moth, rice moth , preventive and curative methods of management.

Lecture No. 46: Birds: Various birds infesting crops and their management Rodents: Rodents and their management

Lecture No. 47 – 48: Nematodes: Nematodes of different crops and their management.

Rice is the most important cereal food crop of the world. It is the staple food for more than half of the world's populations. These crop was affected with different type of pests. The pests are

1. Rice Stem Borer : Scientific Name: *Scirpophaga Incertulas*
Order: Lepidoptera
2. Rice Gall Midge: Scientific Name: *Orseolia Oryzae*
Order: Diptera
3. Brown Planthopper Scientific Name: *Nilaparvata Lugens*
Order: Hemiptera.
4. Rice Green Leafhopper Scientific Name: *Nephotettix Nigropictus, N. Virescens*
Order: Hemiptera
5. Rice Hispa: Scientific Name: *Dicladispa Armigera*
Order: Coleoptera
6. Paddy Leaf Mite / Yellow Mite: Scientific Name: *Oligonychus Oryzae*
Order: Acarina
7. Panicle Mite / Sheath Mite: Scientific Name: *Steneotarsonemus Spinki*
Order: Acarina
8. Rice Leaf Folder: Scientific Name: *Cnaphalocrocis Medinalis*
Order: Lepidoptera
9. Climbing Cutworm: Scientific Name: *Mythimna Separata*
Order: Lepidoptera

Lecture - 2

RICE STEM BORER: Scientific Name: *Scirpophaga incertulas*

Order: Lepidoptera

The pest is widely distributed in all over India. It is a monophagous pest and is a major pest on rice.

Marks of Identification:

- The female moth has bright yellowish brown forewings with a clear single black spot and the anal end having tuft of yellowish hair.
- The male is pale yellow and the spots on the forewings are not conspicuous. Male is smaller than female.
- Newly hatched larvae which are pale white with dark brown head and prothoracic shield.

Nature / Symptoms of Damage:

- After eggs hatching larvae moves downward and wander about on plant surface for 1-2 hours. They hang down by silk thread, get blown off to other clumps or land on water, swim freely and get to the plants. They enter leaf sheath and feed on green tissues for 2-3 days, then bore into the stem near nodal region to feed.
- “Dead-heart” at vegetative stage which turns brownish, curls and dries off
- “White ears” at heading stage with empty, partially filled grains
- Presence of egg masses near the tips of tender leaf blades
- Activity of moths in the vicinity
- Frass at the feeding site

MANAGEMENT:

- Monophagous nature and peculiar boring habits of yellow stem borer make control with insecticides difficult.
- Harvesting of crop close to soil surface, ploughing or flooding the field after harvest to kill hibernating larvae in the stubble.
- Clipping the tips of the seedlings prior to transplantation aids in the elimination of egg masses.
- Seedling root-dip with chlorpyrifos (0.02%) @ 200 ml in 200 litres of water in a plot of 3 m x 3 m for 12-14 hours. If 3 kg urea is added, 3 hours is sufficient. Seedlings thus treated are sufficient to transplant one acre. Seedling root-dip is effective for 30 days in the main field against stem borer, gall midge, BPH and GLH.
- Setting light traps or pheromone traps for monitoring the pest.
- Collection and elimination of egg masses.
- Encouraging natural enemies like *Trichogramma chilonis*

- Need based application of insecticides on ETL basis. Economic threshold levels (ETL) in nursery – one egg mass or one moth per m². In Main crop one egg mass or one moth / m² or 5% dead hearts or 1% white ears.
- Application of carbofuran 3G @ 200 g/cent of nursery in a little water before five days pulling of the nursery.
- Apply Carbofuran 3 g @ 10 kg/acre at main field.
- Foliar sprays with chlorpyrifos 2.5 ml/l or phosphamidon 2.0 ml/l or acephate 1.5 g/l or cartap hydrochloride 2.0 g/l or chlorantraniliprole 0.4 ml/liter of water.

RICE GALL MIDGE: **Scientific Name:** *Orseolia oryzae*

Order: Diptera

The pest is endemic and is distributed in most parts of India. It is a major pest in Telangana, North Coastal region of Andhra Pradesh and mainly a pest of *kharif*.

Marks of Identification:

- Fly is mosquito like and is 3-3.5 mm long. Female has bright orange red abdomen, swifter with a reddish telescopic body.
- Male is darker and smaller.
- Maggot which is pale reddish, apodous.

Nature / Symptoms of Damage:

- After egg hatching larvae moves down to the shoot apex without boring into plant tissue. Throughout its development it feeds at the base of the apical meristem leading to suppression of apical meristem, formation of radial ridges from inner most leaf primordium and elongation of leaf sheath.
- Hollow whitish to pale green cylindrical tube in tillers known as gall / silver shoot/onion shoot.
- Vigorous subsidiary tillering if infested in early growth period.
- The pest infests even nursery but prefers tillering stage. Infested tillers do not bear panicles.
- At panicle initiation stage, the maggot cannot cause damage. Only one larva develops at shoot apex, remains throughout its development inside the gall.

MANAGEMENT:

- Avoid late transplanting in endemic areas. Early planted *kharif* crop escapes pest
- Selection of variety resistant to a biotype of the region.
- Seedling root dip with chlorpyrifos 0.02%.

- The larvae are naturally parasitized by *Platygaster oryzae*, *Polygnotus sp.*, and *Propicroscytus mirificus*
- Application of granules in nursery 5 days before pulling the nursery – phorate 10 G 60 g/cent or carbofuran 3G @ 200 g/cent.
- Application of granules in the main field at 10-15 DAT: phorate 5 kg/ac or carbofuran 10 kg/ac in endemic areas.

BROWN PLANTHOPPER

Scientific Name: *Nilaparvata lugens*

Order: Hemiptera

This is distributed in most of the rice tracts of India.

Marks of Identification:

- Adults are ochraceous – brown dorsally and deep brown ventrally.
- The female is 5 mm long and male 4.5 mm. Female exists in two forms, the fully winged macropterous and the truncated – winged brachypterous.
- Nymphs are brownish in colour.

Nature / Symptoms of Damage:

- Both nymphs and adults suck sap from basal portion of plant clustering at the base of rice clump. They inject toxic saliva while feeding which results in “hopper burn”.
- Premature yellowing of leaves and drying of plants in isolated circular patches.
- Drying of plants spreads in a circular fashion.
- Sooty mould.
- Exuviae at the base of plants.
- Affected stems turn soft and are unfit for use as straw.

MANAGEMENT:

- Avoiding monoculture of susceptible varieties
- Growing resistant varieties like Chaitanya (MTU 2067), Godavari (MTU 1032), Krishnaveni (MTU 2077), Indra (MTU 1061), Vajram (MTU 5249), Vijetha (MTU 1001), Pratibha (MTU 5293), Cottondora Sannalu (MTU 1010), Nandi (MTU 5182), Surya (BPT 4358), Deepti (MTU 4870), Chandan (RNR 74802), Tolakari (MTU 1031), Pushyami (MTU 1075).
- Seedling root dip with chlorpyrifos 0.02%
- Formation of alleys or pathways of 20 cm width for every 2 meters of planting to facilitate aeration, light, basal spraying, monitoring and other farm operations.
- Draining the field during the middle of the season to suppress the pest population.

- Conservation of natural enemies like Spider, Mirid bug, Coccinellids and parasitoids (*Anagrus sp.*, *Oligosita sp.*, and *Haplogonatopus orientalis*).
- Foliar sprays (directing the spray towards base of plants) with any of the following insecticides viz., ethofenprox 2 ml/l; acephate 1.5 g/l; BPMC 2 ml/l; imidacloprid + ethiprole 80 WG 0.25 g/l; monocrotophos 2.2 ml/l; carbofuran 3G 10 kg/ac.

RICE GREEN LEAFHOPPER **Scientific Name:** *Nephotettix nigropictus*, *N.virescens*

Order: Hemiptera

Marks of Identification:

- Adults are small, active wedge shaped leafhoppers, distributed in all rice tracts in India. *N.nigropictus* is about 5 mm long and possesses two black spots in the males which extend up to the black distal portion of the forewings. Males have a black tinge along anterior margin of pronotum and black submarginal band on the crown of the head. Female is generally entirely green without any black tinge on pronotum.
- *N.virescens* can be easily distinguished by the black spots in the male not extending up to black distal portion of forewings and the absence of black tinge on the pronotum and black band on the crown. It causes more damage to rice than *N.nigropictus*.

Nature / Symptoms of Damage:

- Both nymphs and adults suck sap from leaves causing Yellowing, stunting and withering of plants
- Leaves turning brown with small scratch like marks on leaf in severe infestation.
- Uniform yellowing from mid half of leaf.
- Serious damage is inflicted when leafhoppers transmit virus diseases.
- *N.nigropictus* is known to transmit rice dwarf, rice yellow dwarf, rice transitory yellowing and rice tungro, while *N.virescens* transmits rice tungro, rice transitory yellowing and rice yellow dwarf.

MANAGEMENT:

- Early clipping of infested leaf tips to prevent virus transmission
- Removal of left over nursery.
- Removal of alternative hosts during off season such as *Panicum spp.*, *Echinochloa spp.*, *Cyperus spp.*, and other grasses.
- Seedling root dip with chlorpyrifos 0.02%.
- Varieties resistant to green leafhopper IR-20, Vani, Vikramarya.
- Eggs are parasitised by *Oligosita nephotetticum*.
- ETLs: Nursery: 1-2 Hoppers/m².

- Same insecticides recommended for BPH are effective. For immediate knockdown of high population monocrotophos 2 ml/l + dichlorvos 1 ml/l.

RICE HISPA: **Scientific Name:** *Dicladispa armigera*

Order: Coleoptera

Marks of Identification:

- Beetle is a small 4.5 – 5 mm long, square shaped, bluish black and shiny with spines on thorax and elytra.
- Small, yellowish, flattened grubs are Seen.

Nature / Symptoms of Damage:

- Adults scrape green matter on upper surface of leaf blade causing. Whitish leaf tips of young leaves giving dried up appearance.
- White, rectangular streaks parallel to veins on older leaves, which initially appear glistening, membranous, papery white, later turning pale reddish, straw coloured
- Grubs feed on leaf tissue inside the leaf mine causing blister spots towards leaf tip.

MANAGEMENT:

- Clipping of leaf tips of seedlings while transplanting eliminates eggs laid towards the tip.
- Removal of left over nursery.
- Grubs are parasitized by Bracon sp.,
- Foliar sprays with profenophos 2 ml/l or monocrotophos 1.6 ml/l or chlorpyriphos 2.5 ml/l.

Lecture – 3

PADDY LEAF MITE / YELLOW MITE: Scientific Name: *Oligonychus oryzae*

Order: Acarina

Nymphs and adults congregate on lower surface of leaf and suck sap resulting in pale whitish blotches on upper side of leaf which later turn yellow to orange colour. Thin webs are seen on the undersurface of leaves. In heavy incidence mites can be seen on upper side of leaf also.

Foliar sprays of wettable sulphur 3 g/l or dicofol 5 ml/l are found effective.

PANICLE MITE / SHEATH MITE: Scientific Name: *Steneotarsonemus spinki*

Order: Acarina

At vegetative phase, both nymphs and adults colonise midribs of leaves and lacerate tissues up to maximum tillering stage causing brown necrotic patches on midribs. At panicle initiation stage mites move to leaf sheath to feed causing brown necrotic lesions on leaf sheath. Maximum incidence occurs at boot leaf stage. At panicle emergence, mites enter florets, feed on ovaries and stamens causing sterile and discoloured grains in the panicle. Later these grains turn black invaded by saprophytic fungus.

Dicofol 5 ml/l or profenophos 2 ml/l once at maximum tillering stage when brown lesions on midribs appear and second spraying at panicle emergence are recommended in its management.

RICE LEAF FOLDER: Scientific Name: *Cnaphalocrocis medinalis*

Order: Lepidoptera

Marks of Identification:

- Moth is small with a wing span of 15 mm, brownish orange coloured with light brown wings having two distinct dark wavy lines on forewings and one line on hind wings. Both wings have dark brown band on their outer margin.
- Larva is pale yellowish green with having black/ dark brown head measuring 16-20 mm long.

Nature / Symptoms of Damage:

- The larva folds 3-4 leaves of young plants feeding from within.
- In grown up plants, it folds leaf longitudinally from tip downwards bringing together the margins with silken threads, lives in tubes thus formed feeding on chlorophyll.

- Single larva damages several leaves causing whitish membranous folded leaves with typical white streaks.
- Faecal pellets when leaf opened
- Reduced vigour of the plant

MANAGEMENT:

- It is better to manage effectively the first generation of the pest to prevent the build up of the population at boot leaf stage.
- Early clipping of infested, folded leaf tips.
- Removal of alternative hosts *Echinochloa* spp., and *Panicum* spp., and other grasses.
- The ichneumonid, *Xanthopimpla emaculata* is parasitic on the pest larvae.
- Passing a rope 2-3 times over the crop at tillering stage mechanically to dislodge caterpillars.
- Foliar sprays with chlorpyrifos 2.5 ml/l or acephate 1.5 g/l or cartap hydrochloride 2 g/l or granules of cartap hydrochloride 4 G 8 kg/ac.

CLIMBING CUTWORM:

Scientific Name: *Mythimna separata*

Order: Lepidoptera

It appears in swarms at ear head stage in Nov-Dec. Late instars have the characteristic habit of climbing and cutting ear heads in addition to defoliation. The pest becomes serious in certain years of heavy rainfall.

In nature, population is suppressed by natural infections by entomogenous fungus, *Nomuraea rileyi*.

Foliar sprays with chlorpyrifos 2.5 ml or profenophos 2 ml per litre of water in the evening hours following irrigation are effective.

INTEGRATED PEST MANAGEMENT (IPM)

There are many definitions of IPM, but the basic concept is the containment of a pest below economically damaging levels, using a combination of control measures. Following four primary components of IPM are usually recognized.

- Host plant resistance.
- Manipulation of the farming system to minimise pest infestation or damage.
- Enhanced natural control practice.
- Selective use of biorational and synthetic pesticides.

IPM Practices in Rice: Various approaches in the management of pests of rice fit into the above primary components of IPM.

- Harvesting of crop close to soil surface and deep ploughing or flooding after harvest.
- Selection of resistant / tolerant varieties against key pests suitable to local situations.
- Protection of nursery from pests.
- Application of carbofuran 200 g/cent of nursery in a little water 5 days before pulling nursery for protection against stem borer, gall midge, brown planthopper and green leafhopper for 30 days in the main field.
- Clipping tips of leaf blades before transplanting to eliminate eggs of rice stem borer and hispa.
- Early planting in gall midge endemic areas.
- Formation of alleys or path ways of 20 cm width for every 2 metres of planting to facilitate basal spraying and for aeration and light.
- Avoiding of excessive doses of nitrogen.
- Ensuring proper drainage and water management.
- Weed management.
- Monitoring incidence of pests through light traps or pheromone traps for rice stem borer, leaf folder.
- Monitoring pest and natural enemy ratio (2:1).
- Passing a rope over the crop in vegetative phase against leaf folder and caseworm.
- Inundative release of Trichogramma egg parasitoids @ 20,000/ac three times within 30-45 DAT.
- Use of botanical pesticides such as neem seed kernel extract, neem oil etc.
- Application of insecticides on ETL basis.
- Need based application of insecticides.

Lecture – 4

PESTS OF SORGHUM & MAIZE

SORGHUM SHOOTFLY:

Scientific Name: *Atherigona soccata*

Order: Diptera

Marks of Identification:

- Fly is a small 3 mm long, dark grey housefly like with its abdominal segments marked with two rows of six dark spots in female and four dark spots in male.
- Full grown maggot is pale yellowish measuring 10 mm in length.
- Egg is whitish cigar shaped or flattened boat shaped with wing like lateral projection.

Nature / Symptoms of Damage:

- Maggot moves to the dorsal surface of leaf, wriggles down the leaf, reaches base of the seedling and bores into axis destroying growing point. The central succulent core begins to decay, and the maggot feeds on the rotting matter.
- The damage results dead heart which can easily be pulled out giving offensive smell at cut end.
- Production of side/secondary tillers which are in turn attacked.

MANAGEMENT:

- Use of a higher seed rate of 12 kg/ha instead of normal rate of 10 kg/ha and removal of affected and extra plants at the time of thinning four weeks after sowing since shootfly affects only young plants of 4-5 weeks age.
- Timely sowing of *kharif* sorghum before July 15th, however for highly susceptible variety CSH-1, the above measures proves ineffective.
- Some varieties found resistant to shoot fly: IS 1054, IS 1071, IS 2394, IS 5484, SPV 86, SPV 462.
- Application of carbofuran 3 G granules @ 2 g/one metre row length in furrows at sowing time.
- Foliar spray with profenophos 2 ml/l at weekly intervals (7, 14, 21 DAS).

SORGHUM STEM BORER:

Scientific Name: *Chilo partellus*

Order: Lepidoptera

Marks of Identification:

- Moth is medium sized, straw coloured with black specks along caudal margin of forewings.

- The larva is cylindrical, yellowish brown with a brown head and a prothoracic shield and dark spots on the body. It measures about 25 mm long.
- Pupa is oblong, reddish brown with 6 spines at caudal end.

Nature / Symptoms of Damage:

- Larvae bite their way into the stem feeding on the internal tissue and killing the central shoot in young plants.
- The damage results in Shot holes due to biting across leaf spindle.
- Dead heart with no offensive smell at cut end when pulled out.
- Chaffy ear heads in later stages

MANAGEMENT:

- Uprooting and burning affected stubbles after harvest to destroy hibernating larvae.
- Adoption of higher seed rate, pulling and destroying affected plants in the early stages.
- Selection of sorghum varieties resistant to stem borer CSH 7,8; SPV 17, 19, 29,58; ICSV 197, 745, 88013.
- Maize varieties / hybrids Ganga 5, DHM 101, 103, 105 have been found resistant to *C.partellus*.
- Preservation of natural enemies like *Cotesia*, *Xanthopimpla*.
- Placement of carbofuran 3 G granules @ 4 kg/ac at 35-40 DAS in leaf whorls since first instar caterpillars congregate in leaf whorls.
- Foliar spray with chlorantraniliprole 0.4 ml/l at 30 and 45 DAS. Spray should be directed towards leaf whorls.

SORGHUM EARHEAD BUG:

Scientific Name: *Calocoris angustatus*

Order: Hemiptera

Marks of Identification:

- Adults are slender, long legged, yellowish green, about 1 cm long and are active fliers.
- Nymphs with light orange abdomen initially turn green as they grow.

Nature / Symptoms of Damage:

- Both nymphs and adults suck sap from tender grains in milky stage resulting in shrivelled, unfilled, chaffy grains which initially show red spots on feeding sites and later turn black.
- Whole earhead turn black and later dries up.
- Varieties with compact earheads are severely infested.

MANAGEMENT:

- Timely sowing at first monsoon showers.
- Avoiding compact earhead varieties.
- A reduviid bug, *Reduviolus sp.*, and a lygaeid bug, *Geocoris tricolor* are predaceous on the insect.
- Shaking of infested earheads in kerosinated water to destroy nymphs.
- As soon as earheads emerge, dusting them with carbaryl @ 8-10 kg/ac, second dusting a week after if needed or foliar sprays with phosalone 2.5 ml/l.

RED HAIRY CATERPILLAR: **Scientific Name:** *Amsacta albistriga* and *A. moorei*,
Order: **Lepidoptera**

Introduction:

These are distributed all over India. *A.albistriga* is the predominant species in South India while *A.moorei* in North India. In South India it is very serious pest of dry crops especially groundnut in most of the rainfed tracts in *khari*f season. It also infests young sorghum, maize, cotton, castor, cowpea, bajra. Red soils are more suitable.

Marks of Identification:

- Moth is medium sized having white forewings with brownish markings and streaks and white hind wings with black spots.
- There is a yellow band on the head and a yellow streak along costal margin of the forewings in *A.albistriga* while the band on the head and streak along costal margin of the wing are red in *A.moorei*.
- Larvae are reddish brown with a red head and dense large hair and body. On either end of the body, larva has black bands enclosing a red band in between.

Nature / Symptoms of Damage:

- The larvae feed on leaves in large numbers and march from field to field in thousands resulting in heavy defoliation.

MANAGEMENT:

- Deep ploughing to expose pupae after harvest.
- Bonfires at night between 7-11 pm within 48 hours after monsoon rains to attract and kill emerging moths.
- Collection and destruction of egg masses and gregarious larvae.
- Growing cowpea or castor as trap crops.

- Placing shoots of *jatropha*, *Ipomoea* on the field bunds to attract and kill migrating larvae.
- Larvae are parasitised by *tachinids*, *Exorista civiloides*, *sturmia inconspicuella* and preyed upon by a pentatomid predator, *Eocanthecona furcellata*.
- Digging treches around the field and dusting them with methyl parathion (Folidol).
- Dusting with methyl parathion or quinalphos @ 10 kg/ac for early instars.
- Foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l for grown up caterpillars.
- Distribution of poison baits (rice bran 10 kg + jaggery 1 kg + quinalphos 1 litre or methomyl 350 ml + water in sufficient quantity for making balls) in the evening hours.

Lecture – 5

SORGHUM MIDGE:

Scientific Name: *Stenodiplosis sorghicola*

Order: Diptera

Marks of Identification:

- Adult fly is a tiny, fragile, mosquito like insect with a bright orange abdomen and a pair of transparent wings.

Nature / Symptoms of Damage:

- The maggots feed on the ovaries and destroy the developing grains causing flattening of florets.
- Red ooze from spikelet when squeezed indicating the presence of maggot.
- Chaffy grains with round holes indicating fly emergence.
- Empty pupal cases protruding from glumes

MANAGEMENT:

- Burning panicle residues and chaff after threshing to destroy diapausing larvae.
- Adoption of uniform date of sowing to make varieties flower at same time.
- Early sowing at monsoon to escape midge damage.
- Selection of resistant varieties ICSV 197, 745, 88013, PJ 890.
- Larvae and pupae are parasitised by *Tetrastichus coimbatorensis*.
- spraying earheads when blooms first appear on panicles with carbaryl 5 g/l or dusting carbaryl on earheads @ 8 kg/ac.

RAGI PINK BORER:

Scientific Name: *Sesamia inferens*

Order: Lepidoptera

Marks of Identification:

- Moth is medium sized, straw coloured with forewings having marginal black streaks. Hindwings and thorax are white.
- The larvae is pale yellow with a purple pink tinge and reddish brown head.

Nature / Symptoms of Damage:

- Caterpillars bore into the stem and kill the central shoot causing dead hearts and chaffy ear heads.
- A single caterpillar can damage number of plants. Oblong and elongate shot holes can be seen on unfolding leaves.

MANAGEMENT:

- Pull out and destroy by burning dead hearts and affected plant parts.
- Placement of granules in central whorls as detailed under sorghum stem borer.
- Foliar spray with chlorantraniliprole 0.4 ml/l

Lecture – 6

SORGHUM APHID / CORN APHID: **Scientific Name:** *Rhopalosiphum maidis*

Order: Hemiptera

- It is confined to unopened leaves of sorghum, maize and other millets.
- Nymphs and adults suck sap from leaves and tender earheads leading to mottled appearance with yellow patches, failure of grains to develop in earhead and formation of sooty mould due to honeydew excretion on the plants.
- It transmits maize dwarf mosaic virus in sorghum leading to death of young seedlings.
- Coccinellids, syrphids and chrysopids suppress the population in nature.
- However, need based treatments with dimethoate 2 ml/l or monocrotophos 1.6 ml/l or acephate 1 g/l are recommended.

MAIZE SHOOT BUG: **Scientific Name:** *Peregrinus maidis*

Order: Hemiptera

-
- It is one of the important sap feeders of millets in South India.
- These bugs are found within leaf whorls or on the leaves.
- Both nymphs and adults suck sap from tender portions of plants causing yellowing of foliage, stunted growth and scorched appearance.
- The ants, *Camponotus compressus*, *Monomorium destructor* are seen attending on the bugs for honeydew on which sooty mould develops.
- It is a vector of stripe disease of sorghum, maize, sugarcane and other millet crops.
-
- If predatory population is not found sufficient, dusts of carbaryl 10 D @ 10 kg/ac or foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l are effective.

SORGHUM GRASSHOPPER/DECCAN WINGLESS GRASSHOPPER:

Scientific Name: *Colemania sphenerioides*

Order: Orthoptera

- It causes appreciable damage to rainfed millets.
- Both nymphs and adults feed on the leaves in early stage of the crop. However, the crop suffers at the ear head stage.
- Grasshoppers devour flowers and ripening ears wholly, sometimes leading to total loss of crop.
-
- Deep ploughing after harvest to expose eggs and dusting all around borders and then entire crop with carbaryl 10 D @ 10 kg/ac are effective measures.

BLISTER BEETLES:

Orange banded blister beetle: *Mylabris pustulata*

Brown blister beetle: *Gnathospastoides rouxi*

Order: Coleoptera

- Blister beetles prefer yellow and red flowers. Beetles attack inflorescence and feed on flower petals, pollen adversely affecting grain set. They can also feed on tender foliage.
- Beetles can be collected by hand nets and destroyed. They are highly phototropic and get attracted to light traps. Dusting earheads with carbaryl @ 10-15 kg/ha is effective.

FLEA BEETLE:

Scientific Name: *Chaetocnema pusaensis*

Longitarsus sp

Order: Coleoptera

- Beetles bite small holes on leaves which affect photosynthetic activity. Leaves or seedlings of various millets such as sorghum, maize and bajra are damaged. Grubs are not destructive and are found in the soil.
-
- Dusting carbaryl @ 10 kg/ac or spraying 2% neem oil is effective.

RAGI CUTWORM/ ARMYWORM:

Scientific Name: *Spodoptera exigua*

Order: Lepidoptera

- It infests among millet crops, ragi, sorghum and bajra. It is widely distributed in India and highly polyphagous.
- The pest is serious in ragi nurseries feeding on leaves causing extensive defoliation.
- The grown up larva coils with slightest touch and drops down.
- The larvae hide during day time in the soil and feed on the foliage at night.
- In nature, larvae are infected by entomopathogenic fungus, *Nomuraea rileyi* and parasitised by Bracon sp.
- Thiodicarb 1 g/l or acephate 1 g/l or chlorpyrifos 2.5 ml/l as foliar sprays are recommended.

Lecture – 7, 8 & 9

PESTS OF PULSES (Red gram, Black gram and Green gram)

GRAM CATERPILLAR

Scientific Name: *Helicoverpa armigera*

Order: Lepidoptera

Introduction:

Redgram in southern states of India suffers heavy losses due to the lepidopterous borers, especially by *H. armigera*, a notorious polyphagous pest with wide distribution. Variation in adult and larval phases is observed due to its polyphagous nature. Damage ranges from 46 to 67 per cent on redgram due to this pest. If one larva per plant infests then the damage caused will be about 34 per cent. *Helicoverpa* readily adjusts with any newly introduced variety. It is observed through out the year on one or the other crops viz., peas, tomato, cotton, maize, tobacco, safflower, groundnut, chillies etc.

Marks of Identification:

- Moth is stout with dark yellow olive grey or brown wings crossed by a dark band near outer margin and a dark spot near costal margin of forewings and hindwings pale with a dark apical border.
- Caterpillar is cylindrical with variable colour, dark green or reddish brown or brownish and marked with a white broken lines and a prominent white line along lower part of sides.

Nature / Symptoms of Damage:

- The young caterpillars feed on the tender foliage and as they grow they bore into the pods and destroy the seeds, while feeding it thrusts its head inside the pod leaving the rest of its body outside. It results in large round on each locule

GREEN POD BORING CATERPILLAR OR LENTIL POD BORER

Scientific Name: *Etiella zinckenella*

Order: Lepidoptera

It occurs on redgram, horsegram and other pulses and green manure crop like sunhemp. The larvae feed on floral parts, newly formed pods and seeds in developing pods. Faecal pellets inside damaged pods and small round holes on redgram pods plugged with excreta can be noticed.

REDGRAM POD FLY**Scientific Name:** *Malanagromyza obtusa***Order:** Diptera**Introduction:**

It is a major pest of redgram, soybean and cowpea. Attack is more in north and central India and Karnataka. In North India 80 per cent damage to crop is reported. The other hosts are sorghum, cowpea, safflower, bhendi *etc.*

Marks of Identification:

- Adult is a black fly with strong legs and ovate abdomen. Its eye are distinct, wings are clear veined, brownish yellow at their bases.
- Maggot is creamy white in colour.

Nature / Symptoms of Damage:

- Small black fly thrusts its minute eggs into the tissues of the tender pod and flower buds.
- Fly pierces pericarp with ovipositor and lay eggs which are seen like needles projecting inwards from the pods.
- Tiny maggots burrow into pods and feed on young seeds.
- In affected pods, no visual symptoms are observed regarding its entrance.
- Initially larva bores into epidermis without rupturing the seed coat.
- In the second and third instar stages, the larva bores into cotyledons and in most instances one seed is sufficient for the maggot to complete its development.
- The final instar larva leaves the seed and prior to pupation, windows the pods and pupates either in the pod cavity or in the pod wall tissue.
- The damaged seeds are unfit for consumption.
- Discolouration of the infested pods visible in green podded varieties.
- At the later stage of infestation, the holes about 1mm in diameter covered with a thin membrane readily seen on the infested pod.
- Exit holes visible after the adult emergence.

SPOTTED POD BORER**Scientific Name:** *Maruca vitrata***Order:** Lepidoptera**Marks of Identification:**

- Moth is with dark brown forewings with white club shaped cross band along anterior margin and white hindwings with dark brown border.
- The caterpillar with short hairs on black warts webs together the flowers and feeds on them.

Nature / Symptoms of Damage:

- Larvae bore into pods at one end and eats up the ripening seeds. Mass excreta can be seen at the entrance of larval burrow.

REDGRAM PLUME MOTH

Scientific Name: *Exelastis atomosa*;

Order: Lepidoptera

Marks of Identification:

- Moth is slender, less than 12 mm long and are grey with long narrow wings. The forewings are divided into two parts and hindwings into three parts and provided with a fringe like border.
- The caterpillar is about 12 mm long greenish brown, and are fringed with short hairs and spines all over the body.
- Pupa looks like larva except for the colour which is brown. Pupa is also fringed with short hairs.

Nature / Symptoms of Damage:

- Tiny caterpillar scrapes the pod surface and cuts a hole and thrusts the head into it and feeds on seed by remaining outside.
- The caterpillars bore into green pods and feed on the developing seeds which are more or less completely devoured or eaten away.
- They also feeds on flower buds.
- This pest is usually found at flowering and known to cause heavy damage to redgram.
- The larva never enters inside the pod and feeds remaining outside the pod.
- The damage results leads to small hole on seeds.
- Dropping of flower buds and flowers in severe cases.
- Completely eaten and devoured seeds.

BLUE BUTTERFLIES

Scientific Name: *Lampides boeticus*,

Order: Lepidoptera

-
- It is seen on redgram, cowpea, lab lab, Niger *etc.*
- The eggs are laid on flower buds. After hatching the tiny caterpillars enter into unopened flower bud and feed inside. Afterwards they may attack another flower or enter a pod and feed on the developing seeds.

Integrated Pest Management for Pod borer complex

A. From initial crop growth to vegetative stage:

1. Deep summer ploughing to expose pupae in soil
2. Crop rotation with less favourable crops like jowar, gingelly, blackgram, horsegram, dry paddy (in redgram)
3. Raising intercrops like greengram, blackgram in 7 rows in *kharif* redgram and jowar in 2 rows in *rabi* redgam
4. Encourage and conserve natural enemies
5. Raising jowar in 4 rows all around redgram crop will serve as guard crop, In bengalgram, mustard, coriander as intercrops
6. Selection of tolerant varieties like ICPL – 332, LRG – 41 and varieties with recuperating ability like LRG – 30.
7. Clipping of a terminal twig upto one foot at 90 – 100 DAS to remove ovipositional niches (depending on moisture availability in soil)
8. Raising of *rabi* redgram to avoid pest.

B. From flowering:

1. Erect pheromone traps @ 10/ha to monitor the pest.
2. Light traps during August –September; November – December.
3. Erect bird perches @ 50/ha to attract predatory birds like Drongo.
4. When eggs and early instar larvae are noticed spray NSKE 5 % or neem based Insecticides.
5. Use of microbial insecticides NPV 200 LE/ha, B.t formulation 400g or 400 ml/ac thrice at weekly interval in evenings in Winter.
6. Mechanical shaking of redgram plants and collection and destruction of dislodged grown up larvae
7. Avoid indiscriminate use of insecticides, synthetic pyrethroids and mixtures. On need basis spray Chlorpyrifos 2.5 ml/l at initiation of flowers, Quinalphos 2 ml/l or acephate 1.5 g/l at flowering and fruiting using 750 – 1000 l of spray fluid with High Volume sprayer.
9. In severe incidence, indoxacarb 1 ml/l or spinosad 0.3 ml/l
10. Adopt community approach



BLISTER BEETLES:

Scientific Name: *Mylabris pustulata*

Order: Coleoptera

- Blister beetles prefer yellow and red flowers. Beetles attack inflorescence and feed on flower petals, pollen adversely affecting grain set. They can also feed on tender foliage.
- Beetles can be collected by hand nets and destroyed. They are highly phototropic and get attracted to light traps. Dusting earheads with carbaryl @ 10-15 kg/ha is effective.

LEAFHOPPER

Scientific Name: *Empoasca kerri*

Order: Hemiptera

- Small greenish yellow nymphs and adults suck sap from leaves resulting in severe case, the leaves turn brown, dry and brittle, a condition called “hopper burn”.
- Attacked leaflets become cup shaped and yellow at edges.
- Heavy attack result in the leaflets turning red-brown with subsequent defoliation and stunting.

BEAN APHIDS

Scientific Name: *Aphis craccivora*

Order: Hemiptera

-
- Both nymphs and adults suck sap from tender leaves and shoots resulting in twisting of leaves, poor pod development, devitalization of plants and sooty mould.
- It acts as a vector of Rosette disease in groundnut and broad bean virus in pea.

REDGRAM COW BUG

Scientific Name: *Oxyrhachis tarandus*

Order: Hemiptera

- Nymphs as well as adults suck sap from green stem at all stages of the plant causing corky tissues and excrete honeydew which attracts ants like *Camponotus compressus*.
- Breeding takes place all the year round the limitation being only the availability of food.
- This species is common all over south India. It is one of the major pests of redgram.

REDGRAM POD BUG

Scientific Name: *Cavigralla gibbosa*,

Order: Hemiptera

- Hundreds of nymphs and adults suck sap from the shoots and pods. Shoots fade, pods shrivel and seeds with dark patch loose germination capacity due to the feeding of bugs.

GREEN PLANT BUG/STINK BUG**Scientific Name:** *Nezara viridula***Order:** Hemiptera

- It is a polyphagous pest. Nymphs and adults suck sap from tender shoots and developing pods in large numbers, due to that shoots fade.

RED GRAM MITE**Scientific Name:** *Aceria cajani***Order:** Acarina

- It infests underside of tender leaves, causing yellowing of leaves and suppression of flowering and fruiting. It transmits pigeonpea sterility mosaic virus.
- A single eriophyid mite is sufficient to transmit disease. Disease can be identified from a distance as patches of bushy, pale green plants without flowers or pods.
- Leaves are small, show a light and dark green mosaic pattern.

Lecture – 10&11

PESTS OF GROUNDNUT

RED HAIRY CATERPILLAR: **Scientific Name:** *Amsacta albistriga* and *A. moorei*,
Order: Lepidoptera

Introduction:

These are distributed all over India. *A.albistriga* is the predominant species in South India while *A.moorei* in North India. In South India it is very serious pest of dry crops especially groundnut in most of the rainfed tracts in *kharif* season. It also infests young sorghum, maize, cotton, castor, cowpea, bajra. Red soils are more suitable.

Marks of Identification:

- Moth is medium sized having white forewings with brownish markings and streaks and white hind wings with black spots.
- There is a yellow band on the head and a yellow streak along costal margin of the forewings in *A.albistriga* while the band on the head and streak along costal margin of the wing are red in *A.moorei*.
- Larvae are reddish brown with a red head and dense large hair and body. On either end of the body, larva has black bands enclosing a red band in between.

Nature / Symptoms of Damage:

- The larvae feed on leaves in large numbers and march from field to field in thousands resulting in heavy defoliation.
- Entire crop looks as though grazed by cattle.

MANAGEMENT:

- Deep ploughing to expose pupae after harvest.
- Bonfires at night between 7-11 pm within 48 hours after monsoon rains to attract and kill emerging moths.
- Collection and destruction of egg masses and gregarious larvae.
- Growing cowpea or castor as trap crops.
- Placing shoots of *jatropha*, *Ipomoea* on the field bunds to attract and kill migrating larvae.
- Larvae are parasitised by *tachinids*, *Exorista civiloides*, *sturmia inconspicuella* and preyed upon by a pentatomid predator, *Eocanthecona furcellata*.
- Digging trenches around the field and dusting them with carbaryl or methyl parathion dust @ 250 g /one meter length.
- Dusting with methyl parathion or quinalphos @ 10 kg/ac for early instars.

- Foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l for grown up caterpillars.
- Distribution of poison baits (rice bran 10 kg + jaggery 1 kg + quinalphos 1 litre or methomyl 350 ml + water in sufficient quantity for making balls) in the evening hours.

GROUNDNUT LEAF MINER:

Scientific Name: *Aproaerema modicella*

Order: Lepidoptera

Introduction:

- This is one of the major pests on groundnut especially in rainfed conditions. Bunchy variety is generally severely infested. This pest appears mostly six weeks after crop germination *i.e.*, during September-October. The other hosts are redgram, soybean *etc.*

Marks of Identification:

- Moth is very small with dark brown wings and small distinct white spot on forewings.
- Caterpillar is greenish with a small dark head

Nature / Symptoms of Damage:

- The newly hatched caterpillar mines into tender leaflets or it webs together adjacent leaflets and feeds on the tissue.
- The leaflets get distorted and due to feeding get dried up in due course of time.
- The damage results in mining of larvae in the upper epidermis of leaves which causes in characteristic blotches and folded leaves.
- Drying of affected leaves and withering of plants.
- Severly infested field looks as if burnt from a distance.

MANAGEMENT:

- Regular monitoring and surveillance.
- Collection and destruction of the larvae and infested plant parts .
- Crop rotation with a non leguminous crop to avoid out breaks of the pest.
- Raising soybean as trap crop.
- Setting of light traps / pheromone traps.
- Foliar sprays with acephate 1 g/l or chlorpyrifos 2.5 ml/l or monocrotophos 1.6 ml/l.
- Dusting or spraying with quinalphos 1.5 D @ 10 – 12 kg /ac or 2 ml /l.

LEAFHOPPER:

Scientific Name: *Empoasca Kerri*

Order: Hemiptera.

- This species, besides groundnut, also attacks brinjal, chillies, cowpea, tomato, castor *etc.*
- Both nymphs and adults suck sap from central surface of leaves, also inject toxin causing whitening of veins and chlorotic patches at tips of leaflets in a typical 'V' – shape.

- There will be hopperburn in severe cases.
- In presence coccinellids @ 2 or more / plant insecticidal sprays can be limited.
- Insecticides found effective are dimethoate 2 ml/l or methyl demeton 2 ml/l or monocrotophos 1.6 ml/l.

WHITE GRUB OR ROOT GRUB: **Scientific Name:** *Holotrichia consanguinea*
H. serrata
Order: Coleoptera

Introduction:

Root grub is a polyphagous pest, feeding on the roots of a wide range of plants like pulses, groundnut, sugarcane, vegetables *etc.* and it is a serious pest on groundnut.

Marks of Identification:

- Full grown grubs are creamy white with a brown head and reach 2” in length and curled up in position.

Nature / Symptoms of Damage:

- Grubs feed on nodules, fine root lets and also girdle the main root ultimately killing the plants.
- In case of severe infestation the patches of dead plants are seen in the infested fields.
- The cut end of the attacked stem of a dead groundnut plant is swollen.

MANAGEMENT:

- Deep ploughing after summer showers would expose the pupae and beetles to hot sun or birds predations.
- Mass collection and destruction of beetles from the branches of neem, subabul, *Acacia*, ber trees immediately after receiving summer showers.
- Spraying surrounding trees with carbaryl 3 g/l at first monsoon showers.
- Flooding the field for 24 hours kills grub population.
- Utilisation of fungal pathogens like *Metarhizium anisopliae*, *Beauveria brongniartii* is now under consideration.
- Seed treatment with chlorpyrifos 6 - 10 ml/kg seed is effective against root grubs.
- Application of phorate 10 G 15 kg/ha at sowing time.

THRIPS

Scientific Name: *Caliothrips indicus*
Scirtothrips dorsalis

Order: Thysanoptera

- Both nymphs and adults suck the sap from the leaf surface.
- Infested leaves show pale white patches and curling of tender leaflets.
- It transmits peanut bud necrosis virus disease.
- Foliar spray with dimethoate 2 ml/l or imidacloprid 0.50ml/l or thiamethoxam @ 0.4g/l or fipronil @ 2ml/l are effective measures.

GROUNDNUT APHID:

Scientific Name: *Aphis craccivora*

Order: Hemiptera

- It is a polyphagous pest.
- The tender shoots of 2 to 2 ½ months old crop of groundnut are sometimes severely infested by this aphid.
- Both nymphs and adults suck sap from tender leaves and shoots of plant causing the leaves to curl and stunted growth.
- Flowers and pods are also affected.
- Excrete honeydew on which sooty mould develops which interferes with photosynthetic activity of plants.
- The groundnut aphid also transmits groundnut rosette virus and sometimes groundnut stunt virus diseases.
- Spraying with tobacco decoction (1 kg tobacco boiled in 10 lit of water of ½ hour and make up to 30 lit + 100 g soap).
- Systemic insecticides like monocrotophos 1.6 ml/l or dimethoate 2 ml/l or or methyl demeton 2 ml/l are effective.

JEWEL BETLE:

Scientific Name: *Sphenoptera perotetti*

Order: Coleoptera

- It is important during rainy and post rainy season. Elongated dorso-ventrally flattened grub with a globular head burrows into the stem close to soil surface causing drying and death of plants.
- When examined grub or pupa can be seen in hollowed stem.
- Application of carbofuran granules in planting row is effective.

GROUNDNUT POD BUG:**Scientific Name:** *Elasmolomus sordidus***Order:** Hemiptera

- Nymphs and adult are dark brown bugs.
- They suck sap from developing seeds of groundnut pods in the field.
- As a result, the seeds get shrivelled and become rancid and give bitter taste.
- The oil content and germination percentage of infested seed is also adversely affected. Besides causing damage in the field, it continues to infest the pods in threshing yard and even in storage.
- Collection of bugs which on rubbish heaps in threshing floors and their destruction,
- Application of carbaryl 10 D @ 10 – 12 kg/ac or foliar spray with malathion 2 ml/l are effective.

Lecture – 12

PESTS OF SUNFLOWER

LEAF EATING CATERPILLARS:

Scientific Name: *Spodoptera litura*

Helicoverpa armigera

Order: Lepidoptera

(These pests detailed under the pests of cotton)

LEAFHOPPER:

Scientific Name: *Amrasca biguttula biguttula*

Order: Hemiptera

- Greenish yellow adults, pale greenish, translucent nymphs suck sap from undersurface of leaves injecting toxins which result in curling of leaves and ultimately hopper burn symptoms. Leaves dry up and drop down.
- Seed treatment with imidacloprid 5 g/kg seed or foliar sprays with monocrotophos 1.6 ml/l or dimethoate 2 ml/l are recommended.

BIHAR HAIRY CATERPILLAR:

Scientific Name: *Spilosoma obliqua*

Order: Lepidoptera

- It is a highly polyphagous pest. Besides sunflower, it infests millets, cotton, jute, sunhemp, castor, cauliflower, cabbage *etc.* It has been reported to feed on 96 plant species in India. The adult is dull yellow with oblique line of black dots on hind wings.
- The dorsal side of the abdomen is red with dull yellow ventral side.
- The larva defoliates the plants and move from one field to another.
- The full grown larva is darkened with yellowish brown abdomen having numerous pale white brown and black hairs and measures about 43 mm.
- It pupates in soil.
- Collection and destruction of egg masses and gregarious larva, application of NSKE 5 % and foliar sprays particularly for grown up larva with chlorpyrifos 2 ml/l or dichlorvos 1 ml/l are effective measures.

THRIPS:

Scientific Name: *Scirtothrips dorsalis*

Order: Thysanoptera

- *S. dorsalis* infests lower surface of leaves which curl as a consequence, while *F. dampfii* damages capitulum and floral parts.
- Seed treatment with imidacloprid 5 g/kg seed is a better option for conservation of natural enemies.

- Foliar sprays with monocrotophos 1.6 ml/l or imidacloprid 4 ml/10l two or three times are effective measures.

Lecture – 13

PESTS OF SESAMUM

GINGELLY LEAF AND POD BORER: **Scientific Name:** *Antigastra catalaunalis*

Order: Lepidoptera

Marks of Identification:

- Adult is a pale brownish small moth with yellowish brown elongated wings.
- Larva is pale green with black head and tubercles having thin hairs on the body. It measures about 20 mm long.

Nature / Symptoms of Damage:

- Infestation starts when the crop is 15 day old, peak activity being in July – September.
- The larvae web together the top leaves or bore into tender shoots and capsules and feed on them.
- Webbed leaves at top with young caterpillars.
- Bored shoots, flower buds and pods.
- In case of severe infestation the yields are drastically reduced.

MANAGEMENT:

- Early sowing of *kharif* crop in first week of July.
- *Rabi* crop or summer crop as ID crop is recommended to escape pest and also for better quality of seed.
- Collection and destruction of webbed leaves, infested pods at initial stages of infestation.
- Foliar spray with dichlorvos 1 ml/l or chlorpyrifos 2 ml/l

GALL FLY:

Scientific Name: *Asphondylia sesami*

Order: Diptera

It is one important pest in south India and also in Rajasthan and a specific pest on gingelly.

Marks of Identification:

- The small mosquito like fly inserts the eggs into the ovaries of flower buds.
- Maggots are small whitish in colour

Nature / Symptoms of Damage:

- The small whitish maggots feed on the ovary which results in malformation of pod without proper setting of seeds.
- Galled buds and flowers fade and dry.

MANAGEMENT:

- Picking of galls, picking and burning shed buds as a prophylactic measure.
- Resistant variety in endemic areas is N 166 – 5.
- Foliar sprays with dimethoate 2 ml/l or monocrotophos 1.6 ml/l.

SPHINX CATERPILLAR/ GINGELLY HAWK MOTH / DEATH'S HEAD MOTH :

Scientific Name: *Acherontia styx*

Order: Lepidoptera

- The moth is very large, brownish with a characteristic skull like marking on thorax and violet and yellow bands on abdomen.
- Dark brown forewings are covered with yellowish, bluish and grey powdery scales. Yellowish hindwings are with two cross lines.
- It is known to suck honey from combs and cause annoyance to bees.
- Stout green caterpillar with yellowish oblique stripes and a conspicuous yellowish curved anal horn feeds on the leaves and acts as a defoliator.
- Foliar spray with carbaryl 3 g/l or malathion 2 ml/l or phosalone 2 ml/l is recommended.

Lecture – 14

PESTS OF CASTOR

CASTOR SEMILOOPER:

Scientific Name: *Achaea janata*

Order: Lepidoptera

Marks of Identification:

- Adult is a pale reddish brown moth, stoutly built with black hindwings having white band medially and three large white spots on the outer margins.
- Caterpillar is a semilooper, long, smooth, greyish brown in colour. The first pair of prolegs is reduced and as such a semilooper.
- Caterpillar possess red or whitish side stripes. Full grown larva has black head, a red spot on the black loop and red anal tubercles and measures 60-70 mm in length.

Nature / Symptoms of Damage:

- The caterpillar feeds sparingly at first and feeds voraciously during later stages leaving only mid rib and veins.
- Defoliated leaves present and in severe cases only mid rib and veins of the leaves

Management:

- The larvae may be handpicked and destroyed.
- *Telenomus* and *Tetrastichus* sp. Parasitize the eggs.
- Braconid parasite, *Micropletis ophiusae* acts as larval parasite whose cocoons may be seen attached to the ventral aspect of the posterior end of the host caterpillar.
- Erection of bird perches @ 10 / ha.
- Application of neem oil 5 ml/l or *B.t* 1 g/l.
- Foliar spray with methyl parathion 2 ml/l or thiodicarb 1g/l or spinosad @ 0.33ml/l.

CASTOR SHOOT AND CAPSULE BORER: **Scientific Name:** *Conogethis punctiferalis*

Order: Lepidoptera

It is a potential pest and occasionally becomes serious. It is active from September to February when crop is in flowering. It also damages ginger, cardamom, turmeric, guava, peaches, cacao, pear, mango inflorescence, sorghum ear heads, soapnut tree *e t c*.

Marks of Identification:

- Moth is medium sized having bright orange yellow coloured wings with numerous black dots or spots.
- Caterpillar is brownish with pinkish tinge and fine hairs arising from warts on the body.
- The head and prothorax are brown.

Nature / Symptoms of Damage:

- Larvae bore into the shoots as well as capsules and destroy them.
- Occasionally the larva is found at the junction of the petiole with the lamina and rarely in thick mid rib.
- Frassy matter present at the bored shoots.
- Webbed seed capsules covered with dark excreta.

Management:

- Collection of infested shoots and capsules and their destruction.
- Sprayings should be commenced from the time of formation of inflorescence and again after 20 days.
- Insecticides like dimethoate 2 ml/l or methyl demeton 2 ml/l or monocrotophos 2 ml/l are recommended.

TOBACCO CATERPILLAR:

Scientific Name: *Spodoptera litura*

Order: Lepidoptera

It is found through out the tropical and sub tropical parts of the world, wide spread in India. Besides tobacco, it feeds on cotton, castor, groundnut, tomato, cabbage and various other cruciferous crops.

Marks of Identification:

- Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings.
- Hind wings are whitish with brown patches along the margin of wing.
- Moths are active at night.
- Caterpillar is velvety, black with yellowish – green dorsal stripes and lateral white bands with incomplete ring – like dark band on anterior and posterior end of the body.
- It measures 35-40 mm in length, when full grown.

Nature / Symptoms of Damage:

- In early stages, the caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance.
- Later they become voracious feeders making irregular holes on the leaves and finally leaving only veins and petioles.
- During flowering and boll formation stage, the caterpillars also feed on the internal contents of bolls causing irregular holes.

Management:

- Collection and destruction of the infested material from the field.
- Plucking of leaves harbouring egg masses / gregarious larvae and destroying.
- Setting up light traps for adults.
- Setting up of pheromone traps @ 12/ha.
- Spraying NPV @ 250LE/ha.
- Release of egg parasitoid *Trichogramma* @ 50,000/ha/week four times.
- Foliar spraying with thiodicarb 2ml/l or quinalphos 2.5ml/l.
- Baiting with rice bran 12kg + jaggery 2.5kg+carbaryl 50WP1kg in 7.5lt water/ha during evening hours to attract and kill the caterpillars.

LEAF HOPPERS:

Scientific Name: *Amrasca biguttula biguttula*

Order: Hemiptera

- Light green or greenish yellow nymphs and adults suck sap from undersurface of leaf.
- As a result, the margins of leaf turn pale initially, later become yellowish and cause hopperburn or drying of leaves and showing brown necrotic patches in severe cases.
- Plants lose vigor and yield is affected. The other hosts are brinjal, mesta, cotton, bottle gourd etc.,
- Seed treatment with imidacloprid 5g/kg seed or thiamethoxam 4g/kg seed, foliar spray with monocrotophos 1.6ml/l or dimethoate 2 ml/l have been found effective .

CASTOR WHITEFLY:

Scientific Name: *Trialeurodes rara, Trialeurodes ricini*

Order: Hemiptera

- The yellowish nymphs with waxy filaments are found in large numbers on leaves.
- Nymphs and adults suck sap causing yellowing and drying of leaves in severe infestations.
- Application of methyl demeton 2ml/l or monocrotophos 2 ml/l or triazophos 2 ml/l

CASTOR THRIPS:**Scientific Name:** *Retithrips syriacus, Scirtothrips dorsalis***Order:** Thysanoptera

- Both the nymphs and adults lacerate and suck oozing out sap from the plant tissues. The plant loses its vitality.
- Terminal leaves turn crinkled and silvery white.
- Spray application of methyl demeton 2 ml/l or dimethoate 2 ml/l.

CASTOR SLUG:**Scientific Name:** *Latoia (Parasa) lepida***Order:** Lepidoptera

- It is a sporadic pest of castor. It also attacks coconut, mango, Palmyra, citrus, wood apple *etc.*
- Larvae feed on the leaves leaving the mid rib and veins.
- Foliar spray with chlorpyrifos 2 ml/l or monocrotophos 2 ml/l

MITE:**Scientific Name:** *Tetranychus telarius***Order:** Acarina

- Nymphs and adults of the red spider mites suck sap from the under surface of leaves by constructing silken galleries.
- In severe infestations white blotches are formed on the upper surface of leaf.
- In severe attack, mites are also seen on upper surface of the leaves.
- Dusting of fine sulphur and spraying with dicofol 5 ml/l or profenophos 2 ml/l are effective.

Lecture – 15

PESTS OF SOYBEAN

STEM FLY:

Scientific Name: *Ophiomyia phaseoli*

Order: Diptera

- It is a major pest of blackgram, greengram and soybean. Incidence is more in rainy season.
- Shiny bluish – black fly deposit eggs in punctures made by fly on young leaves. Young plants (less than 40 days) suffer more.
- Yellowish maggots bore into nearest vein, reach the stem through petiole, bore down the stem and feed on cortical layers and may extend to tap root.
- Distinct tunnel of stem split open.
- Death of plant or branches.
- Pupation is at ground level within the stem.
- Adult fly exits through a thin semi transparent window.
- Seed treatment with imidacloprid 3 g/kg seed gives protection upto 30 days.
- Foliar spray with acephate 1.5g/l or dimethoate 2 ml/l or monocrotophos 1.6ml/l.

LEAF EATING CATERPILLAR:

Scientific Name: *Spodoptera exigua*

Order: Lepidoptera

The caterpillar causes damage by feeding on leaves. (These pests detailed under the pests of cotton and millets)

SOYBEAN LEAFMINER:

Scientific Name: *Aproaerema modicella*

Order: Lepidoptera

- Important pest of soybean also attacks groundnut and some leguminous weeds.
- Brownish grey moth lays white eggs singly on underside of leaves close to mid rib.
- Young larva initially mine into leaflets and feed on mesophyll.
- Later as it grow web the leaflets together and feed.
- Severely infested field presents a symptom as if burnt when viewed from a distance.
- Full grown caterpillar is green with dark head and pupates within the web.
- Foliar spray with acephate 1.5 g/l or chlorpyrifos 2.5 ml/l or quinalphos 2 m l/l were effective measures.

WHITEFLY:

Scientific Name: *Bemisia tabaci*

Order: Hemiptera

(These pests detailed under the pests of cotton)

PESTS OF TOBACCO

TOBACCO CATERPILLAR:

Scientific Name: *Spodoptera litura*

Order: Lepidoptera

(These pests detailed under the pests of cotton)

TOBACCO APHIDS:

Scientific Name: *Myzus persicae*

Order: Hemiptera

- It is highly polyphagous infesting tobacco, cabbage, chilli, brinjal, radish, potato, tomato, tobacco, mustard, sweet potato, *Hibiscus*, sunnhemp *etc.*
- Adult aphid is small to medium sized about 1.25 to 2.5 mm long, usually green with a darker thorax. Antennae 2/3 as long as body.
- Siphunculi clavate, fairly long. They reproduce both sexually and parthenogenetically, the latter is more common.
- Aphids infest the crop late in the season.
- Both nymphs and adults feed on leaves and shoots in large numbers suck sap and devitalizing the plant.
- Sickly appearance of plants
- Leaves curling up and fading and unfit for curing
- Sooty mould develops on honeydew excreted.
- Tobacco ring spot virus and Rosette virus disease are transmitted by this vector
- Natural enemy, *Praon myzophagum* parasitizes the aphid.
- Spraying neem oil 2% or NSKE 5%.
- Spray phosphamidon 2 ml/l, methyl demeton 2ml/l, Malathion 2 ml/l, Dimethoate 2ml/l, acephate 1.5g/l

WHITEFLY:

Scientific Name: *Bemisia tabaci*

Order: Hemiptera

- The pest is generally seen as white minute specks of flies on the underside of the leaf. It attacks both nursery and main field.
- Breedings take place often parthenogenetically. The female lays up to 120 eggs. Egg period lasts for 3-5 days. Nymphal duration is 9-14 days. About 10-12 generations are completed in a year.

- Nymphs and adults suck sap from leaves and devitalise the plant. It transmits the leaf curl virus disease.
- The leaves are twisted, puckered and thickened with prominent veins.
- Stunted growth and reduced yield considerably
- Sooty mould on the leaves due to honeydew excretion.
- Removal and destruction of alternate hosts.
- Avoiding leaf curl infected tobacco seedlings for transplantations.
- Removal of leaf curl infested plants.
- Avoiding growing brinjal and sunflower in the vicinity.
- Setting up of yellow sticky traps coated with castor oil @ 12 traps / ha.
- Spray application of NSKE 5%
- Foliar spray with acephate 1.5 g and other systemic insecticides

TOBACCO STEM BORER:

Scientific Name: *Scrobipalpa heliopa*

Order: Lepidoptera

- Caterpillar mines into the leaf axil and then into stem.
- Bored stem becomes hollow, swollen and forms a gall.
- Destroying crop residues and monitoring the pest in nurseries are recommended.

Lecture 16, 17&18

PESTS OF SUGARCANE

EARLY SHOOT BORER:

Scientific Name: *Chilo infuscatellus*

Order: Lepidoptera

It is a major pest in South India, distributed all over the cane growing regions of India

Marks of Identification:

- Moth is small, slender, greyish brown or straw coloured with labial palpi projected upwards.
- Males are smaller than the females with a wing expanse of 19-26 mm compared to 23-35 mm in females.
- A row of white dots is present along the outer margin of forewings.
- The full grown caterpillar is 20-25 mm in length.
- The caterpillar whitish with five violet stripes dorsally and dorso-laterally on its body with dark brown head.

Nature / Symptoms of Damage:

- The pest attack is usually severe in the early stages of the crop growth during the hot pre monsoon period. The attack of the borer is a continuous process from sprouting stage to cane formation.
- Even after cane formation, it acts as an internodal borer affecting the internodes. Infestation is favoured by poor irrigation, absence of rains, high temperature and low humidity.
- The larvae that hatch out from the eggs get scattered and young larva enters the stem by passing into the space between the leaf sheath and stem.
- The caterpillar bores into the growing stem and kills the young plant causing dead heart, if ignored later becomes internodal borer, which bores the stem at internodes.
- In young tillers, caterpillar bites holes through the stem at the ground level and feeds inside.
- Presence of an entrance hole at the ground level.
- Dead hearts which can be easily pulled out. The dead heart emits offensive smell.
- If infested canes are split opened, the larvae or pupae are seen inside.

Management:

- Systematic collection of egg masses and their destruction.
- Removal of dead hearts and their destruction.
- Trash mulching which not only checks the population but also conserves soil moisture and adds the organic matter to the soil.
- Planting in deep trenches reduces the borer incidence.
- Adjusting the planting dates to avoid the peak oviposition. Minimum incidence is in November and December planting. Maximum incidence is in January and February planting.
- Quick growing varieties escape heavy infestation – Attack will be more in thin varieties than in thick ones.
- Set treatment with 0.1% malathion or chloripyriphos.
- Light earthing up of soil up to 4-6 week old crop to make the stem inaccessible to larvae followed by frequent irrigations.
- Installation of light traps.
- The release of egg parasites, *Trichogramma minutum*; *T. australicum* is reported to have given good control of this pest at many places (Chagallu sugar factory area).
- By spraying profenophos 2 ml / l at 4th, 6th, 9th and 12th week after planting.
- Application of Phorate 10G @ 1.0 kg a.i. /ha at 4th week age of the crop in equal splits to the soil and leaf whorls.

INTERNODAL BORER:**Scientific Name:** *Chilo sacchariphagus indicus***Order:** Lepidoptera

The insect is found throughout India and usually occurs on sugarcane late in its growing phase. Its multiplication is rapid under conditions of low temperature and high humidity and the infestation ranges from 20 to 50%. It is serious on sugarcane in Andhra Pradesh, Karnataka, Kerala, Tamilnadu and Uttar Pradesh.

Marks of Identification:

- Moth is small, straw coloured. Forewings have a marginal dark line and the hind wings are whitish.
- Caterpillar has a white body with dark spots and a brown head.

Nature / Symptoms of Damage:

- The larva usually attacks sugarcane late in its growing phase.

- The caterpillar bores at the nodal region and enters the stem.
- The tissues turn red and the hole is usually plugged with excreta.
- A larva may attack a number of nodes.

Management:

- Collection of egg masses and their destruction.
- Inundative release of the egg parasite *Trichogramma australicum* at 50,000 parasites/ ha/ week.
- The pest can be controlled by spraying profenophos 2 ml / l at fortnightly intervals from 120 days age of the crop.

TOP SHOOT BORER

Scientific Name: *Scirpophaga nivella*

Order: Lepidoptera

It is distributed all over the country, but it is more serious in North India. It is also found in South-East Asia, Japan *etc.* Besides sugarcane, it attacks a number of wild plants belonging to the genus *Saccharum*.

Marks of Identification:

- Moth is medium sized, creamy white, slightly bigger than early shoot borer moth.
- Female has tuft of crimson coloured hairs at the tip of the abdomen.
- In case of certain males, each of the forewings has a black spot.
- Full grown caterpillar is creamy white in colour with yellow head.

Nature / Symptoms of Damage:

- The caterpillar first bores into the stem from top by tunneling into the mid ribs of leaves, leaving markings on the 2nd through 5th leaves.
- The top shoot borer damage starts when the sugarcane is 2 -3 months old.
- Interference with apical growth gives rise to side shoots and bunchy top symptoms.
- From the midrib it tunnels towards the central core of leaves and enters the shoot to feed.
- As a result of biting across the spindle a row of shot holes are formed .
- A number of shot holes on affected leaves due to biting across the spindle
- Reddish brown charred dead heart that can not be easily pulled out.

Management:

- Collection and destruction of egg masses.
- Collection of affected tillers and destruction.

- Release of egg parasitoid *Trichogramma minutum* and larval parasitoid, *Isotima javensis* during November and December in Adsali sugarcane is found successful.

SUGARCANE SCALES:

Scientific Name: *Melanaspis glomerata*

Order: Hemiptera

This armoured scale is of considerable importance in Telangana, Andhra Pradesh, Gujarat, Karnataka, MP and Maharashtra. It is reported that the pest gained entry into Telangana in 1966 into Nizamabad district and from there to East Godavari district in 1968 and from there to West Godavari and Krishna of AP. Now the pest persists in latter three districts and in the former district it is not of much consequence.

Marks of Identification:

- Adults are greyish black in colour, irregularly oval and slightly convex in shape. Female are flat and pyriform shape.
- The males are winged and smaller in size but are rare.
- Freshly hatched crawlers are tiny and light yellowish in colour.

Nature / Symptoms of Damage:

- The nymphs that hatch inside female come out through the genital aperture (crawlers), crawl about some time and settle down after selecting suitable spot, preferably on the internodes.
- The tiny nymphs after settling down insert their mouthparts into the tissue and start sucking the plant sap.
- They remain stationary all through their life if they are females. The formation of the protected covering *i.e.*, scales starts soon after a nymph gets settled and becomes thicker and increases in size.
- Infestation commences with the formation of the internodes and continues to increase as the plant grows. Plant sap is sucked and the plant is devitalised.
- In severe cases, even it infests the leaf sheath and the lamina including the mid rib.
- Varieties having persistent leaf sheaths are attacked to a greater extent and a definite correlation exists between number of stomata in the stem epidermis and the intensity of attack.
- In a highly susceptible variety of sugarcane, the germination was reduced by about 20 per cent, further the weight of canes, juice sucrose content, bulk density and purity reduced by about 13, 47, 28 and 26 per cent respectively.

- Shrivelled canes become with shortened internodes.
- Formation of shiny thick encrustation on the cane, maximum on the bottom and middle of the cane.
- On account of its sedentary habits and minute size, the scale insect escapes the notice of the cane grower.
- It is only after severe damage, its existence is revealed. In Nizamabad (TS), the pest flares up in July and vividly seen in October to November.
- In coastal AP it is seen first in June – July and persists on the crop right up to July.

Management:

- Planting of varieties having a close leaf sheath and are almost self stripped in endemic areas of this pest.
- A variety CO – 7706 has been found moderately tolerant to scales.
- Immersion of setts before planting in dimethoate 2ml/l or malathion 2ml/l solution for at least 15 minutes or drenching the cane setts kept in the furrow with 0.1% dimethoate solution @ 450-500 litres per hectare before covering them with earth.
- When the shoots have atleast 6-8 internodes, detrating the basal 4-5 internodes ensuring that the top most detrated node is free from scale insect (Before end of July).
- Spraying with malathion 2ml/l or dimethoate 1.7 ml/l on the exposed basal nodes twice at an interval of 10-15 days whenever the stage of the crop and its growth permits.
- Application of carbofuran 3G at the base of clumps 5"-6" deep before July.
- Release of predatory coccinellids, *Pharoscyrnus hornii* or *Chilocorus nigritus* in the detrated fields after July.

SUGARCANE LEAFHOPPERS: **Scientific Name:** *Pyrilla perpusilla*

Order: Hemiptera

It is a potential pest occurring in an epidemic form in UP and Punjab. It is also seen in Bihar and Maharastra. It infests wheat, sorghum, rice, mango, oats, barley etc.

Marks of Identification:

Adults are straw coloured with two pairs of wings folded like a roof on the back and the head prominently drawn forward as a sort of rostrum.

Newly hatched nymphs are milky white in color with a pair of characteristic processes or filaments covered by wax. They are very active and are found in very large numbers on sugarcane.

Nature / Symptoms of Damage:

- Both adults and nymphs suck sap usually from the underside of leaves and divitalize the plant.
- In severe cases, the leaves dry up and the plant is stunted.
- Due to feeding the sucrose percentage of juice is adversely affected. Besides sucking the sap, they excrete honey dew that spreads on the leaves on which a black fungus develops adversely affecting photosynthesis and ultimately the yield.
- Affected plants present sickly and blighted appearance.
- Development of sooty mould.
- Swarms of these insects in all stages on the tender foliage. Fading and drying up of the leaves.

Management:

- Cultural practices like prompt destruction of trash after harvest.
- Selection of tolerant varieties.
- Mechanical methods of collecting and destroying egg masses in the initial stage *i.e.*, during April-May.
- *Tetrastichus pyrillae* and lepidopteran parasite, *Epiricania melanoleuca* naturally suppress the population.
- Foliar sprays with malathion 2 ml/l.

SUGARCANE MEALY BUG:**Scientific Name:** *Saccharicoccus sacchari***Order:** Hemiptera**Marks of Identification:**

- Small pinkish oval insect attached to the lower nodes, protected by leaf sheaths and covered by a white waxy powder.
- Adults and nymphs of these bugs are found in large number near the nodes.
- The females are sac like with clearly segmented body. Males are winged but rare.

Nature / Symptoms of Damage:

- Both nymphs and adults persist on plants and suck the cane juice from the growing canes and excrete honey dew on the leaves.
- Sooty mould develops on the infested portion.

Management:

- The infestation can be identified by the presence of mealy bugs at the nodes within the leaf sheath, reduced plant vigour and growth, movement of ants and mould on infested area.
- Destruction of crop residues, immersion of setts in malathion 2 ml/l or dimethoate 1.7 ml/l solution for 15 minutes before planting, selection of pest free sets for planting
- Detrashing and spraying malathion 2 ml/l or dimethoate 1.7 ml/l are effective measures.

TERMITES:

Scientific Name: *Odontotermes obesus*

Order: Isoptera

- Termites or white ants are another destructive pest of sugarcane, omnivorous and omnipresent.
- They live under ground attacking the crop, when the setts are planted in the soil and ravages continue till harvest of the crop with slight slackness during monsoon.
- They are mostly found in light soil. Their attack is severe in red soils and where irrigation facilities are inadequate.
- The termites damage the cut ends and buds of setts affecting their germination.
- Setts are completely eaten away leaving only the outer hard rinds.
- In attacked plants, the outer leaves first show signs of drying and the attacked canes may come out easily, if pulled.
- The damage may range from 40-50%. Its attack results in heavy loss in yield in sugarcane and also reduction in sucrose content.
- Six species of termites have so far been recorded from India, damaging sugarcane viz., *Odontotermes obesus*, *O. assumthi*, *O. taprobenes*, *Microtermes anandi*, *Eremotermes nerapololis*, and *Trinervitermes biformis*. These are morphologically different, but their habits, symptoms of damage etc are all similar.
- Systematic digging up of termite mounds and destruction of queen is a permanent measure of control.
- Dusting methyl parathion 200 g around and leveling, deep ploughing and copious irrigation reduces infestation and drenching with chlorpyrifos 50 EC@ 10ml/l is effective.

WHITEFLIES:**Scientific Name:** *Aleurolobus barodensis*, *Neomaskellia bergii***Order:** Hemiptera

- Only these two species have been recorded damaging sugarcane in India.
- Both nymphs and adults suck sap from leaves which dry up and characteristic yellow streaks appear along the length.
- Nymphs are stationary. Severely attacked plants become stunted.
- The sugarcane crop raised in low lying, water logged areas and in semi dry alkaline soils suffers more due to whitefly.
- Infestation is seen from August – October.
- Due to attack by this pest, cane juice becomes more watery and the jaggery (gur) quality is adversely affected.
- A loss of 30-40 per cent in sucrose and 20-25 per cent in total solids was estimated due to its attack.
- It is reported that the loss to be of 15-20 per cent in yield and 1-2 units in sugar recovery due to the pest attack on crop.
- Whiteflies prefer broad leaved succulent varieties.
- Avoid ratooning in low lying areas, prompt clipping and destruction of affected parts, foliar sprays with quinalphos 2 ml/l against young nymphs and fenetrothion 1 ml/l against puparia are effective measures.

WOOLLY APHID:**Scientific Name:** *Ceratovacuna lanigera***Order:** Hemiptera

- Adults colonise on either side of mid rib, covered with white puff material on under side of leaves.
- Nymphs develop white waxy and mealy filamentous material from third instar.
- Nymphs and adults suck sap from undersurface of leaves resulting in white and yellow spot on leaves, drying of leaves, sooty mold on honeydew and activity of ants.
- Earthing up to destroy infested material, weed management, restricting movement of seed material from infested areas, biological control by neuropteran predator, *Chrysoperla carnea*; lepidopteran predator: *Diapha aphidivora* and foliar spray with acepahte 1.5 g/l are effective management practices.

Lecture – 20, 21, 22 & 23

INSECT PESTS OF COTTON

The cotton crop in its early stage of crop growth is generally subjected to the attack of sucking pests. From flowering till harvest, the bollworms cause appreciable damage. The losses in cotton from insect attack affect both yield and quality of the lint.

COTTON LEAFHOPPER: **Scientific Name:** *Amrasca biguttula biguttula*

Order: Hemiptera

They are distributed in all cotton growing regions of India. They are mostly confined to leaf surface infesting okra, potato, brinjal, castor, tomato, hollyhock and *Abutilon indicum* besides cotton.

Marks of Identification:

- It is a small insect, varying from less than 1 mm to about 3 mm. Its adult stage is subjected to seasonal changes in colour. It is reddish in winter and greenish yellow in summer.
- The adult is a wedge shaped insect about 3.5 mm in length.
- There is a black spot on each forewing and two small black spots on the vertex.
- Nymphs are also pale greenish in colour like the adults but are wingless and are found in large numbers on lower surface of leaves.
- Both nymphs and adults move diagonally, when disturbed.

Nature / Symptoms of Damage:

- At the nymphal stages as well as the adult, they inflict the same type of damage.
- They suck the cell sap from the plant tissue.
- During desapping the plant, they also inject a toxin through saliva into the plant tissue, resulting in hopperburn.
- In susceptible varieties, the attack results in mottling accompanied by the curling of the entire lamina with brown necrotic patches.
- Thus, the entire photosynthetic activity of the plant is very seriously interfered with. Hopper burn *i.e.*, the leaf margins turning yellowish initially and subsequently turning reddish and curling up.
- Brown necrotic patches on the leaves.
- Stunted growth of the plant

WHITEFLY:**Scientific Name:** *Bemisia tabaci***Order:** Hemiptera

- It is known to infest about 50 different species of plants but it becomes quite a serious pest of cotton in certain regions of the country. The infestation by this pest adversely affects the physiology of the cotton plant at all its stages of growth. It is distributed in all cotton growing regions of the world. It also infests radish, water melon, cucumber, chillies, brinjal, tomato, potato, tobacco etc.

Marks of Identification:

- Adult is minute insect measuring about 0.5 mm in length having white or greyish wings, a yellowish body and red medially constricted eyes.
- Nymphs are oval shaped, scale like, greenish yellow with marginal bristle like fringes and nymphs remain stationary once they settle down.

Nature / Symptoms of Damage:

- The maximum infestation on cotton occurs during July. High temperature and low humidity are reported to be conducive to the multiplication of this pest.
- Both nymphs and adults suck sap from lower side of leaves resulting in chlorotic spots which later coalesce forming irregular yellowing of leaves which extends from veins to outer edges.
- The vegetative growth retarded and boll formation seriously hampered.
- Shedding of the bolls accentuated and proper opening of the bolls interfered with.
- Low quality lint and low oil content.
- Sooty mould development due to honey dew excretion on infested parts. It is vector of leaf curl virus.

COTTON APHID:**Scientific Name:** *Aphis gossypii***Order:** Hemiptera

It is of worldwide distribution. It is a polyphagous species. However on cotton, often it causes appreciable damage during severe drought conditions. It also infests brinjal, chilies, amaranthus etc.

Marks of Identification:

- Adult is small, soft, yellowish, green or greenish brown in colour. It is found in colonies of hundreds on the tender shoot and the undersurface of tender leaves.

- They are characterized by the presence of two tubes like structures called cornicles, on the abdomen.
- They are wingless normally but winged forms are often found mostly in the beginning and towards the end of season.
- Wings are thin, transparent and are held like a roof over the body.
- Nymphs are light yellowish green or brownish or greenish black in colour. They colonise growing points, lower surface of leaves and tender shoots.

Nature / Symptoms of Damage:

- Both nymphs and adults suck the sap by remaining on the lower surface of the leaves.
- Curled, faded and dried leaves.
- Development of black sooty mould due to honeydew excretion on infested parts.

COTTON THRIPS:

Scientific Name: *Thrips tabaci*, *Scirtothrips dorsalis*

Order: Thysanoptera

- Cotton thrips is a highly cosmopolitan form and is found on all kinds of vegetation like Onion, garlic, amaranthus, guava, solanaceous, cucurbitaceous plants, groundnut, chilies, mango, cabbage, bhendi *etc.*
- Nymphs and adults suck sap from leaves and flower buds.
- Margins of affected leaves get slightly curled up and the leaf blades show uneven surface, when attack occurs in flowering stage, the affected flowers may wither away.
- It is a vector of yellow spot virus and spotted wilt virus.

MITES:

Scientific Name: *Tetranychus telarius*

Order: Acarina

- The mite is a polyphagous and is known to infest on 183 species of plants including cucurbits, brinjal and bhendi on which it is sometimes very serious.

Marks of Identification:

- Adult female body is oval and is variable in colour *i.e.*, red, green, amber or rusty green and with two large pigmented spots on the body.
- Nymph is light brown in colour and has two eye spots and four pairs of legs and quite active.

Nature / Symptoms of Damage:

- Both nymphs and adults cause damage by feeding on the lower surface of the leaf underneath a web.

- On close examination of the lower leaf surface, mites smaller than a pinpoint may be seen.
- The infested leaves rapidly curl up, become hard and crisp and ultimately shed.
- Bolls ripen prematurely and in serious infestation shed.
- Mite infestation begins in the seedling stage and extends to harvest.

MEALYBUG:

Scientific Name: *Phenacoccus solenopsis*
Maconellicoccus hirsutus
Order: Hemiptera

It is a minor pest with isolated incidence. They suck the sap from all aerial parts of the plant. *B.t.* cotton is severely infested with *P. solenopsis*. The pest initially is restricted to a few plants. If the infestation is not checked in a few isolated spots, it spreads to all corners of the field.

RED COTTON BUG:

Scientific Name: *Dysdercus cingulatus*

Order: Hemiptera

- In India, the bug infests cotton in all cotton growing regions. Also infests bhendi, maize, mesta *etc.*, are other host plants.
- The nymphs and adults suck sap from tender leaves, petioles and shoots in early stages and then infest flower buds and immature bolls and bolls that have just opened.
- The plants lose their vigour and bolls open prematurely with stained lint.
- Infested seeds get shriveled, underdeveloped, become unfit for sowing and oil content gets reduced.
- From the spot of injury on the bolls, a bacterium – *Nematospora gossypii* gains entry and spoils the lint. Some times cannibalism exists in this insect.

DUSKY COTTON BUG:

Scientific Name: *Oxycarenus hyalinipennis*

Order: Hemiptera

It is found in all cotton regions in India. Both nymphs and adults suck sap from immature seeds and strain the lint. The seeds do not ripen and get damaged. Seeds get lighter in weight and lose their germination capacity.

COTTON LEAF ROLLER:

Scientific Name: *Sylepta derogata*

Order: Lepidoptera

Besides cotton, bhendi and several other malvaceous plants are infested by this pest. It is primarily a sporadic pest of cotton in India. The larva rolls the leaf and feeds on the green tissue

in the early stage and eats up a large portion of the leaf as it grows. Severe attack results in the presence of a large number of leaf rolls and the plants become stunted ultimately.

IPM FOR SUCKING PESTS

- Growing tolerant / resistant varieties or hybrids against leafhoppers and white flies. Leafhoppers: Many varieties like MCU – 5, LRA 5166, L 604, L 603, Narasimha (NA1325) & hybrids like NHH 44, Saritha, H8, JK Hy – 1, LAHH – 1.
- Whiteflies: glabrous varieties like Kanchana (LPS 141), LK 861, L615, NA 1280 and Supriya.
- Seed treatment with Imidacloprid 70 WS or thiomethaxam 70 WS @ 4 – 5 g per kg seed which protects the crop from sucking pests upto 30DAS.
- Apply recommended dosage of fertilizers.
- Inter cropping of cotton with cowpea/soybean/greengram/blackgram/foxtail/cluster beans in 1:2 ratio to enhance the natural enemy population.
- Stem application with monocrotophos: water in 1:4 ratio or Imidacloprid: water in 1: 20 ratio at 30, 45 and 60 DAS for effective ecofriendly control of jassids, aphids and mealy bugs.
- Spray with NSKE 5% or Neem oil against sucking pests.
- High yielding varieties in two rows with 90 cm spacing, hybrids in three rows with 120 cm spacing.
- In whitefly endemic areas, keeping yellow empty tins smeared with greese as trap. Wipe out trapped whiteflies every day and apply greese again.
- Need based application of insecticides with monocrotophos @ 1.6 ml or Acephate @ 1.5 g or Fipronil @ 2 ml or Flonicamid @ 0.3 g or imidacloprid 0.25 ml per litre of water against sucking pests.
- For mealy bug, dichlorvos 1 ml/l or methyl parathion 1 ml/l or profenophos 2 ml/l.
- For mites, sulphure 3 g/l or dicofol 5 ml/l.

SPOTTED BOLLWORM:

Scientific Name: *Earias vitella* and *Earias insulana*

Order: Lepidoptera

These are serious pests of cotton. These insects are very widely distributed. These pests attack a number of other plants of the family malvaceae viz., bhendi, Hollyhock, *Hibiscus cannabinus*, *Abutilon indicum* and other malvaceous plants.

Marks of Identification:

- Adult of *E. vitella* has pale whitish fore wings with a broad greenish band in the middle while *E. insulana* has completely green forewings.
- The adult body length is about 1 cm while the wing span is about 2.5 cm.
- The caterpillars of both the species have a number of black and brown spots on the body and hence the name spotted boll worm.

Nature / Symptoms of Damage:

- The spotted bollworm appears about 6 weeks after sowing and initially damages the tender shoot by boring into it resulting in “drying of central shoots” which withers and drops down.
- The larvae later bore into the flower buds, squares and bolls.
- The larva inserts its head inside the boll and feeds by filling the boll with excreta.
- A larva may move out and feed on another bud or boll.
- The feeding causes severe shedding of early formed flower buds and bolls.
- The damage results in Presence of wilting, withering and drooping or drying of tender shoots in early stage of crop growth.
- Presence of bored flower buds (squares), bored bolls with larval frass at the entrance holes.
- Premature dropping of affected bolls.
- Premature opening of damaged bolls, which remain on plants.
- Presence of badly damaged tissues including lint and seed in damaged bolls.

Management:

- Destruction of plants, crop residues and alternative weed hosts which harbour pests in off season.
- Collection and destruction of infested shoots, squares and bolls and the fallen material.
- Adopting crop rotation.
- Deep ploughing in summer.
- Intercultivation with sorghum, greengram, cluster bean, jowar etc.
- Setting of pheromone traps @ 12/ha.
- Conservation and use of natural enemies like *Trichogramma evanescens* which parasitises the eggs and *Bracon lefroyi*, *B. greeni*, *B. hebetor*, *B. brevicornis*, *Apanteles* sp and *Elasmus* sp which parasitise the larval stage and *Chelonus* and *Chalcis* species that parasitise pupal stages.

- Release of first instar larvae of *Chrysoperla* sp. @ 1,00,000/ha.
- Foliar spray with *Bacillus thuringiensis* @2g/l of water.
- The parasitoid activity in the field should be carefully assessed before the insecticidal application
- Foliar spray with quinalphos 2.5 ml; chlorpyrifos 2.5 ml; acephate 1.5 g; triazophos 2 ml; thiodicarb 1.5 g and profenphos 2 ml/l.
- The insecticidal application should coincide with the peak of hatching of eggs, so that the just hatched larvae may get the fatal dose before entering the plant tissue.

AMERICAN BOLLWORM:

Scientific Name: *Helicoverpa armigera*

Order: Lepidoptera

American bollworm has a world wide distribution in all the cotton growing regions of the world. It is a polyphagous, infesting gram, lablab, safflower, chillies, groundnut, tobacco, tomato *etc.*

Marks of Identification:

- Moth is stout, medium sized with brownish/greyish forewings with a dark cross band near outer margin and dark spots near costal margins, with a wing expanse of 3.7 cm.
- Caterpillars are of varying colour, initially brown and later turn greenish with darker broken lines along the side of the body.

Nature / Symptoms of Damage:

- Young larva feeds on the leaves for sometime and then attacks squares and bolls.
- Internal tissues are eaten severely and completely hollowed out.
- While feeding, the caterpillar thrust its head inside leaving the rest of the body out side.
- Fed leaves shoot and buds.
- “Flared or open” squares. Bolls are bored at the base of flower buds which are hollowed out, bracts of damaged flower buds spread out and curl down wards.
- Premature boll opening and shedding.

Management:

- Destruction of crop residues.
- Hand picking up of the grown up larvae.
- Encouraging new crop rotation.
- Nipping terminal buds when 16 to 18 sympodias are present in the plant within 80 – 100 days to reduce the egg load.

- Growing intercrops such as cowpea, onion, maize, coriander, urdbean in 1:2 ratio for conservation of natural enemy population.
- Growing sorghum or maize in 4 rows all around cotton crop as guard crop.
- Use of ovipositional trap crops such as marigold @ 100 plants / acre and collection of larvae from flowers.
- Erecting of bird perches for encouraging predatory birds such as king crow, mynah, drongo *etc.*
- Growing early maturing and tolerant varieties such as Abadita, LK 861, LPS 141, NA 1280 and G 27.
- Installing pheromone traps @ 4 / ac (ETL 10 moths/trap/day).
- Releasing of egg parasitoid *Tricogramma chilonis* at weekly interval @ 1.5 lakhs/ ha or release of 2nd instar larvae of *Chrysoperla carnea* @ one lakh/ha at 75 and 90 days after sowing.
- Application of HaNPV @ 200 LE/ac in combination with jaggery 1 kg, sandovit 100 ml or Robin Blue 50 g thrice at 10-15 days interval on observing the eggs or first instar larvae in the evening hours.
- Larval parasitoid such as *Campoletis chloridae* (Ichneumonidae); *Eriborus angenteopilosus*; *Diadegma fenestalis*; *Bracon brevicornis*; *Peribaca orbata etc.*
- ETL 10% of damaged buds (or) 5% of damage bolls or one egg / plant or one larva / 10 plants.
- In severe incidence, sprays with indoxacarb 1 ml/l or spinosad 0.3 ml/l or emamectin benzoate 0.5 g/l after collecting late instars.

PINK BOLLWORM: **Scientific Name:** *Pectinophora gossypiella*

Order: Lepidoptera

The pink bollworm is a very widely distributed and probably the most serious cotton pest on a world basis. The American cottons in India are damaged much more by the pink bollworm than the indigenous varieties. It is distributed in parts of India, Pakistan, America, Africa, Australia and Asia. Besides cotton, bhendi, hollyhock, mesta, *Abutilon indicum*, hibiscus and other malvaceous crops are infested.

Marks of Identification:

- Moth is small about 5-6 mm in length and has wing span of 12.5 mm.
- Body is dark brown in colour with numerous small black spots on the wings.

- The first segment of the antenna bears 5-6 long stiff hairs and the palpi are pointed and curved upwards.
- The moths are active during night.
- The freshly hatched larvae are white and turn pink as they grow older.
- The full grown, uniformly pinkish larvae measures about 8-16 mm with dark brown head and prothoracic shield.

Nature / Symptoms of Damage:

- The larvae do most spectacular damage to practically mature cotton bolls which they enter mostly at such a tiny stage of just hatched larvae that their entry holes get healed and in which they remain, devouring both seed and fiber forming tissues.
- The infestation at times is so severe that up to 10 larvae are found in each boll and 75-100 per cent bolls are found infested.
- The damage results in “**Rosette**” flowers.
- Attacked flowers drop prematurely and the seeds are destroyed in advanced stage.
- The lint development is retarded and is weakened.
- It causes premature opening of the boll leading to invasion of saprophytic fungus.
- Stain the lint both in the gin and in the boll, thus the ginning percentage and quality of lint is greatly reduced.
- Poor germination capacity of seeds in the attacked boll.

Management:

Since eggs are mostly protected by calyx and the newly hatched larva bore into the bolls immediately, it is difficult to manage this pest with insecticides alone. Therefore the following methods are suggested.

- Growing early maturing varieties: bolls mature before heavy population builds up.
- Taking up timely sowings. Avoid staggered sowings.
- Use acid delinted seeds: soak seed in concentrated sulphuric acid (80 – 100 ml / kg seed) for 2 – 3 minutes, wash with water 2 – 3 times followed by washing with lime supernatant, shade dry.
- Use of organic manures, recommended doses of N.
- Keeping the crop free of weeds.
- Monitoring through field scouting and pheromone traps (Gossyplure).

- Destroying PBW in rosette flowers and periodically remove and destroy dropped squares dried flowers and premature bolls.
- Avoiding ratooning and summer cotton.
- After final picking, allowing cattle, sheep and goats to graze upon immature green bolls to prevent carry over of pest to next season.
- Destroying cotton stubbles to prevent carryover.
- Restrict the movement of cotton seed from other areas / states.
- Seed fumigation with methyl bromide @ 0.4 kg / 1000 cu ft. or aluminium phosphide (Quickphos, Phosfume, Phostoxin) @ 50 tablets (each 3 g)/ 1000 cu ft.
- Need based use of insecticides. ETL: 10 % PBW infested rosette flowers. In particular, persistent insecticides like quinalphos 2.5 ml/l; chlorpyrifos 2 ml/l; at 15 days interval.
- In severe incidence cypermethrin 2 ml/l or lamda cyhalothrin 1.5 ml/l or thiodicarb 1.5 g/l on need basis towards the end of crop season.
- Even at ginning mills, burning the stained kapas is suggested.

TOBACCO CATERPILLAR:

Scientific Name: *Spodoptera litura*

Order: Lepidoptera

It is found through out the tropical and sub tropical parts of the world, wide spread in India. Besides tobacco, it feeds on cotton, castor, groundnut, tomato, cabbage and various other cruciferous crops.

Marks of Identification:

- Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings.
- Hind wings are whitish with brown patches along the margin of wing.
- Moths are active at night.
- Caterpillar is velvety, black with yellowish – green dorsal stripes and lateral white bands with incomplete ring – like dark band on anterior and posterior end of the body.
- It measures 35-40 mm in length, when full grown.

Nature / Symptoms of Damage:

- In early stages, the caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance.
- Later they become voracious feeders making irregular holes on the leaves and finally leaving only veins and petioles.

- During flowering and boll formation stage, the caterpillars also feed on the internal contents of bolls causing irregular holes.
- Irregular holes on leaves initially and later skeletonisation leaving only veins and petioles.
- Heavy defoliation.
- Presence of bored bolls.

Management:

- Collection and destruction of the infested material from the field.
- Plucking of leaves harbouring egg masses / gregarious larvae and destroying.
- Setting up light traps for adults.
- Setting up of pheromone traps @ 12/ha.
- Spraying NSKE 5 % against eggs and first instar larva.
- Spraying NPV @ 200LE/ac in combination with jaggery 1 kg, sandovit 100 ml or Robin Blue 50 g thrice at 10-15 days interval on observing the eggs or first instar larvae in the evening hours.
- Release of egg parasitoid *Trichogramma* @ 50,000/ha/week four times.
- Foliar spraying with thiodicarb 1.5 g/l or quinalphos 2.5ml/l. in severe incidence novaluran 1 ml/l or lufenuron 1 ml/l.
- Baiting with rice bran 10kg + jaggery 2 kg+ chlorpyrifos 750 ml or thiodicarb 300g in sufficient quantity of water in form of small balls and broadcasting in evening hours in one acre.

IPM FOR BOLLWORMS

- Deep summer ploughing to expose pupae surviving in the soil
- Crop rotation with non preferred hosts like ragi, maize, rice, cowpea.
- Apply 25% organic manures, 75% chemical fertilizers
- Inter cropping of cotton with cowpea, soybean, greengram, blackgram, in 1:2 ratio (Korra, goruchikkudu) to enhance the natural enemy population
- Sowing of border crop with jowar or maize is recommended to conserve the natural enemies
- Use of trap crops to attract insects like castor for *Spodoptera litura*, Marigold for *Helicoverpa armigera* is recommended. Insects feeding on these crops will be collected and destroyed.
- Selection of short duration varieties to avoid pink boll worm infestation at later stages of crop growth

- Install pheromone traps @ 4/acre for monitoring of American bollworm, spotted bollworms, pink bollworm and tobacco caterpillar. Use specific lures for each insect pest species and change it after every 15 – 20 days. Trapped moths should be removed daily. If moth catches are observed above ETL then spray with recommended insecticides.
- ETL for pink bollworm is 8 moths per days per trap, ETL for American bollworm is 10 moths per day per trap, *Spodoptera litura* 20 moths, spotted boll worm 15 moths if observed consecutively for 3 days.
- Clipping of terminal shoots at 80-100 days after sowing
- Spraying with 5% NSKE to kill eggs and early instar larvae
- Erection of bird perches @ 15-20/acre
- ETL based application of insecticides with quinalphos @ 2.5 ml or Chlorpyrifos @ 3 ml or Acephate @ 1.5 g or Triazophos @ 2 ml or Thiodicarb 1.5 g per liter of water
- Spray with Indoxacarb @1 ml or Spinosad @ 0.3 ml or Emamectin benzoate 0.5 g or Flubendamide 0.3 ml or Chlorantraniliprole 0.3 ml per liter of water if the incidence of *H. armigera* is high spray with 1 ml Novaluron or lufenuron or 1.5 g Thiodicarb per liter of water.
- **Role of B.t Cotton:** Advances in biotechnological approaches facilitated introduction of *B.t* transgenic cotton which offered greatest protection against American bollworm. Oflate *B.t* cotton has dramatically changed the plant protection scenario in cotton worldwide. Growing of *B.t* cotton has been highly successful against bollworms. This is evident in increased area under *B.t* cotton in India from 72,000 acres in 2002 to 10.15 m. ha in 2009 -10. *B.t* cotton varieties with Cry IAc toxin protein (*B.t.* 1) have been targeting American bollworm, Spotted bollworm and Pink bollworm but not tobacco caterpillar. However gene pyramiding of Cry IAc and Cry IIAb (*B.t.* 2) could offer protection against tobacco caterpillar in addition to bollworms.

Lecture 24 & 25

PESTS OF CHILLIES

CHILLI THRIPS:

Scientific Name: *Scirtothrips dorsalis*

Order: Thysanoptera

S. dorsalis is found in almost all chilli growing areas. It is a polyphagous pest. Besides chilli, it also infests brinjal, cotton, groundnut, castor, bottlegourd, guava, tea and grapevine. It is more common on un-irrigated chilli crop than irrigated one.

Marks of Identification:

They are slender, tiny, straw coloured insects with fringed wings.

Nature / Symptoms of Damage:

- Pest infestation is severe in dry weather. The damage ranges between 30 -50%.
- Both nymphs and adults lacerate the leaf tissues and suck the oozing sap, sometimes even the buds and flowers are attacked.
- Generally they attack tender leaves and growing shoots. Rarely the older leaves are attacked.
- The infested leaves curling upward, crumbling and shedding.
- Infested buds turning brittle with petiole becoming brown and dropping down.
- Affected fruits showing light brown scars.

Management:

- Seed treatment with imidacloprid @ 3 -5 g/kg of seed.
- Foliar spraying with carbaryl 3g/l or phosalone 3ml/l or acephate 1 g/l or fipronil 2 ml/l or spinosad 0.3 ml/l or diafenthiuron 1.2 g/l so as to wet the under surface of the leaves.
- Application of fipronil 0.3G 8 kg/acre at 15 and 45 days after transplanting.

CHILLI MITES:

Scientific Name: *Polyphagotarsonemus latus*

Order: Acarina

- A minor pest emerged as a major pest in recent past.
- Adults are tiny white transparent
- The infestation starts in the nursery after 40 days of germination.
- Severe infestation is seen in transplanted crop of 2-3 months old.
- The mites are found in large numbers on the undersurface of leaves under fine webs.
- Both nymphs and adults suck sap and devitalize the plant causing 'Murda' disease of chillies. Infestation results in Downward curling of leaves.

- The affected leaves becoming inverted boat shaped.
- The leaves rolling down along the margin with elongation of petioles.
- Affected leaves turning dark green in certain cases.
- Younger leaves at the tip of branch clustering.

Management:

- Foliar spraying of dicofol 5ml/l or wettable sulphur 3g/l.
- Synthetic pyrethroids not to be used.
- If both thrips and mites are noticed, spraying phosalone 3ml/l or diafenthiuron 1.5 g /l or chlorfenapyr 2 ml/ l .

CHILLI BLOSSOM MIDGE:

Scientific Name: *Asphondylia capsici*

Order: Diptera

- Fly is dark reddish brown mosquito like midge that lays eggs in flower buds.
- Maggot is tiny pale orange colored and feeds on the floral parts leading to poor development of fruits.
- The ovary is distorted into gall like structure of varied shape.
- Foliar spray with triazophos 2 ml/l or carbosulfan 2 ml/l followed by chl orpyriphos 2.0 ml/l one week later is found effective.

CHILLI POD BORERS: Scientific Name: *Spodoptera litura*,

Helicoverpa armigera,

Utetheisa pulchella

Order: Lepidoptera

- Their detailed history can be given under pests of cotton.
- Feeding by *S. litura* leads to irregular holes on the leaves and fruits. Affected pods turn whitish and dry up. In fruits, seeds are also eaten.
- Attack of *H.armigera* leads to round hole on fruits.
- In addition to these borers, sometimes *U. pulchella* also feeds on the pericarp leaving the seed intact. Ladder like marks are seen on chilli pod due to *U. pulchella* .

CHILLI APHIDS:**Scientific Name:** *Aphis gossypii*,**Order:** Hemiptera

- They are polyphagous pests. Cloudy weather is very favorable for multiplication of aphids.
- Heavy rains cause reduction in their population. Adults are found in large numbers on the undersurface of leaves and growing shoots of plants.
- Both nymphs and adults suck sap and also excrete honeydew on which black sooty mould develops affecting photosynthetic activity.
- It results in retardation in growth and fruiting capacity of the plant.
- Sooty mould.
- Foliar spray with methyl demeton 1 ml/l or acephate 1.5 g/l is effective.

Lecture 26

PESTS OF BRINJAL

EPILACHNA BEETLE /SPOTTED LEAF BEETLE:

Scientific Name: *Epilachna vigintioctopunctata*

Order: Coleoptera

This is one of the important pests of brinjal. Its incidence starts in July-August. It also infests tomato, bittergourd, *Datura*, *Physalis*.

Marks of Identification:

- Beetle is small round to slightly oblong in shape measuring about 5 mm in length and 3.5 mm in width.
- The underside of the beetle is flat while the upper side is convex.
- It is light brick red or pinkish in colour bearing 12 -28 small black dots on the pronotum and elytra.
- These black dots are symmetrically placed in a crescent manner.
- The freshly hatched grub is yellowish and turns to cream yellow white.
- When full grown, the grub is broad in front and narrows posteriorly and is covered with spiny structures all over.

Nature / Symptoms of Damage:

- The minute grubs on hatching start damaging the plant by feeding on the fresh matter of the leaf surface leaving veins and veinlets.
- The grown up grubs become voracious feeders, found in batches.
- Both the grubs and adults confine their feeding activities generally to the undersurface of leaves.
- The activity of the pest is more on the lower leaves resulting in damaged leaves presenting a lace like appearance as the green matter in between the veins is eaten away (skeletonisation of leaves).
- Affected leaves, depending upon the area damaged, drying up and in severe infestation, presenting sickly appearance.

Management:

- Hand picking will prove effective as the beetles are sluggish during the morning hours.
- If the area is small, collection and destroying the egg masses which can be spotted easily.

- Egg parasitoid *Tetrastichus ovularum*, larval parasitoid *Uga menoni* suppress the population during March – July.
- Organic compounds of plant origin are effective.
- Foliar spray with DDVP 1 ml/l in nursery as well as planted crop or carbaryl 3 g/l or profenofos 2ml/l or quinalphos 2 ml/l.

BRINJAL SHOOT AND FRUIT BORER: **Scientific Name:** *Leucinodes orbonalis*

Order: Lepidoptera

It is one of the serious pests of brinjal throughout the country. It also infests potato, *Solanum nigria*, *S. xanthocarpum*, bittergourd.

Marks of Identification:

- Moths are medium in size with white wings having large brown patches and red markings.
- Wing span measures about $\frac{3}{4}$ of an inch.
- The head and thorax are blackish brown.
- The full grown caterpillar is pinkish with sparingly distributed hairs on warts on the body with a brownish head. It measures 16 -20 mm long.

Nature / Symptoms of Damage:

- If infestation occurs during vegetative phase, caterpillars enter into the petiole, midribs and young shoots. During fruiting stage caterpillars enter into fruits make holes and feed inside.
- Initially, the entry hole is so small that it is not visible. Later, fruits bear large circular holes plugged with excreta.
- The infested fruits are unfit for consumption and marketing.
- The infestation may go as high as 70 per cent on brinjal.
- The pest is active throughout the year except winter.
- In Nursery no damage is observed.
- Transplanted seedlings are attacked.
- Drooping of tender shoots and wilting in vegetative stage.
- Holes on the infested fruits filled with excreta.

Management:

- The damaged portions of the plants should be removed and destroyed.

- Continuous cropping of brinjal and potato in the same area encourages the pest activity and hence proper rotation should be followed.
- Variety Bhag yamathi is tolerant to the pest damage and suitable for coastal Andhra .
- Erecting pheromone traps @4/acre.
- Larval parasitoids, *Pristomerus testaceus*, *Trathala flavoorbitalis*, *Microbracon greeni*, *Pseudoperichaeta* sp suppress the population.
- Three spraying with carbaryl 3 g/l or profenofos 2ml/l or cypermethrin 1 ml/l at 10 day interval from 3 weeks after transplanting.
- Note: Acaricidal spray should be given after two rounds of spray with carbaryl as mites may flare up.

BRINJAL STEM BORER:

Scientific Name: *Euzophera perticella*

Order: Lepidoptera

- Its damage is entirely different from that of *L. orbonalis*.
- It does not attack fruits and leaves. It attacks only stem of more than pencil thickness.
- The entry of the caterpillar is near the ground level of the stem at leaf or branch axil and covers the hole with excreta and frass.
- Its attack is found in older brinjal plants and not on younger plants.
- Branches start wilting after the attack. Plants become stunted in growth.
- Entire plant wilts and dries. Other hosts include chillies, potato and tomato.
- Avoiding ratoon of the brinjal crop, uprooting and burning the infested plants before planting the new crop to avoid carryover of the pest to the next crop are recommended.
- Foliar spray with carbaryl 3 g/l or profenophos 2.0 ml/l is effective.

BRINJAL MEALY BUGS:

Scientific Name: *Centroccoccus insolitus*

Order: Hemiptera

- Adults are brown or pinkish and are oval in shape.
- Body is covered with white waxy material.
- They are generally present on the lower surfaces of the leaves, tender shoots and stem.
- Colonies of nymphs and adults suck sap from leaves and shoots and stem.
- The affected shoots and leaves show discolouration.
- The damage results in stunted growth of plant. Affected branch dries up.
- Removal of affected parts, foliar spray with profenophos 2.0 ml/l or malathion 2 ml/l are effective against mealybugs.

APHIDS:**Scientific Name:** *Aphis gossypii*, *Myzus persicae***Order:** Hemiptera

- They are found in colonies on underside of tender leaves causing leaves crinkle and curled.
- They reproduce parthenogenetically.
- Coccinellids, *Coccinella septumpunctata* and *Menochilus sexmaculata* are predaceous on aphids. *M. persicae* is parasitized by *Aphidius colemani*.
- Insecticidal sprays with dimethoate 2 ml/l or methyl demeton 2 ml/l are effective.

LEAF HOPPERS:**Scientific Name:** *Amrasca biguttula biguttula***Order:** Hemiptera

- Both nymphs and adults suck sap from underside of leaves, resulting in characteristic hopperburn symptom. Leaves curl downwards, crinkled and the plant is stunted .
- Removal of affected parts and foliar spray with dimethoate 2ml/l or methyl demeton 2 ml/l or fipronil 2 ml/l are effective measures.

BRIJAL LACE WING BUG:**Scientific Name:** *Urentius hystricellus***Order:** Hemiptera

- These bugs can be identified by their lace like network of veins on the forewings and lace like embossed pattern on head and prothorax.
- Both species are specific pests of brinjal. Nymphs and adults suck sap mostly from upper surface of leaves and cause yellowing of leaves in patches.
- Such leaves are found covered with excreta. The infested leaves shrivel, dry and drop down. Heavy infested plants dry up completely.
- Foliar spray with methyl demeton 2 ml/l or dimethoate 2 ml/l or dichlorvos 1 ml/l is effective.

RED SPIDER MITE:**Scientific Name:** *Tetranychus telarius***Order:** Acarina

- Red spider mites are found in large colonies on underside of leaves protected by the silk webbing constructed by the female.
- They are polyphagous infesting brinjal, bhendi and bean.
- Leaves present a characteristic blotches which become whitish then brown patches appear.

- Later the entire affected leaf become discoloured and dried up. More infestation occurs. Warm and dry months are congenial.
- Spraying with wettable sulphur 3 -5 gm/l or dicofol 2.7 ml/l or spiromecyferan 3 ml/l or propargite 3 ml/l twice at 10 day interval are effective.

BHENDI SHOOT AND FRUIT BORER / SPOTTED FRUIT BORER:

Scientific Name: *Earias vitella* and *Earias insulana*

Order: Lepidoptera

- It is one of the important pests of bhendi throughout the country. It also infests cotton, mesta, *Abutilon* etc.,

Marks of Identification:

- Adult of *E. vitella* has pale whitish fore wings with a broad greenish band in the middle while *E. insulana* has completely green forewings.
- The adult body length is about 1 cm while the wing span is about 2.5 cm.
- The caterpillars of both the species have a number of black and brown spots on the body and hence the name spotted boll worm.

Nature / Symptoms of Damage:

- In the early stage of the crop, the caterpillars bore into growing shoots of plants.
- When the fruits appear they also bore into the fruits which show holes plugged with excreta. The infested fruits are mostly shed in early stage of fruiting.
- Drooping of tender shoots.
- Holes on the infested fruit and filled with excreta.
- Fruits distorted and rendered unfit for human consumption.

Management:

- Avoiding bhendi or cotton during off season which will serve as alternate hosts.
- Removal and destruction of affected shoots, fruits in early season help in keeping the pest under check.
- Natural enemies (enumerated under the same species in cotton) suppress the pest population.
- Foliar spray with thiodicarb 1 g/l during vegetative and at fruiting stages or carbaryl 3g/l or quinalphos 2 ml/l or profenophos 2 ml/l twice at 10 day interval after harvest of fruits.

LEAF HOPPERS:**Scientific Name:** *Amrasca biguttula biguttula***Order:** Hemiptera

- It is distributed throughout the country.
- Both nymphs and adults suck the sap from underside of leaves injecting toxic saliva.
- The damage results in characteristic hopperburn symptom.
- Infested leaves crinkle and show characteristic browning.
- Attacked plants stunted, fail to bear fruits.

Management:

- Removal of affected parts.
- A spider *Distina albina* and a chrysopid, *Chrysopa cymbela* are predaceous on leafhoppers. *Lymaenon empoascae* parasitizes the eggs.
- Foliar sprays with dimethoate 2ml/l or methyl demeton 2 ml/l or fipronil 2 ml/l are effective.

WHITEFLY:**Scientific Name:** *Bemesia tabaci***Order:** Hemiptera

- Both nymphs and adults suck the sap from underside of leaves. As a result, the plant loses its luster.
- The adult acts as a vector for yellow vein mosaic virus disease.
- Removal of affected plants, erecting yellow sticky traps, spraying with acetamiprid 0.4 g/l or thiamethoxam 0.4g/l or profenophos 2ml/l were found effective.

RED SPIDER MITE:**Scientific Name:** *Tetranychus telarius***Order:** Acarina

- Red spider mites are found in large colonies on underside of leaves protected by the silk webbing constructed by the female.
- They are polyphagous infesting brinjal, bhendi and bean.
- Leaves present a characteristic blotches which become whitish then brown patches appear.
- Later the entire affected leaf become discoloured and dried up. More infestation occurs. Warm and dry months are congenial.
- Spraying with wettable sulphur 3 -5 gm/l or dicofol 2.7 ml/l or spiromecyferan 3 ml/l or propargite 3 ml/l twice at 10 day interval are effective.

Lecture 28

PESTS OF TOMATO

SERPENTINE LEAF MINER:

Scientific Name: *Liriomyza trifolii*

Order: Diptera

It has been introduced into India through chrysanthemum cuttings.

Marks of Identification:

- It is a pale yellowish fly, measuring 1.5 mm in length.
- Minute orange yellow, apodous maggot is present.

Nature / Symptoms of Damage:

- Maggot feeds on chlorophyll mining in between epidermal layers.
- Leaves with serpentine mines.
- Drying dropping of leaves in severe cases.

Management:

- Neem oil 5 ml/l or profenophos 2 ml/l or carbaryl 3 g/l as foliar sprays is recommended, if situation warrants.

TOMATO FRUIT BORERS:

Scientific Name: *Helicoverpa armigera*

Spodoptera litura

Order: Lepidoptera

(These pests detailed under the pests of cotton)

WHITEFLY:

Scientific Name: *Bemesia tabaci*

Order: Hemiptera

- Both nymphs and adults suck sap from leaves causing chlorotic spots on leaves, yellowing and drying of leaves.
- It has been reported as a vector of tomato leaf curl disease.
- Plucking and burning leaf curl virus affected plants and spraying with systemic insecticides like dimethoate 2 ml/l or methyl demeton 2 ml/l are effective measures.

EPILOCHNA BEETLE /SPOTTED LEAF BEETLE:

Scientific Name: *Epilachna vigintioctopunctata*

Order: Coleoptera

(These pest detailed under the pests of brinjal)

Lecture 29

PESTS OF CUCURBITS

CUCURBIT FRUITFLY:

Scientific Name: *Bactrocera cucurbitae* (Big size)

B. dorsalis (Medium size)

B. ciliatus (Cosmopolitan)

Order: Diptera

It is one of the important pests on gourds like bittergourd, snakegourd, melons, coccinia etc., throughout the country

Marks of Identification:

- Fly is reddish brown with lemon yellow markings on thorax with spotted wings.
- The maggots are apodus, acephalous, dirty white, wriggling creatures, thicker at posterior end and tapering at the other to a point.

Nature / Symptoms of Damage:

- The damage is more in monsoon season.
- Only maggots cause damage by feeding near ripe fruits, riddling them and polluting pulp.
- Maggots bore in to the fruit and feed on pulp forming lesions.
- Fruits decay due to secondary bacterial infection.
- Damage is more serious in melons.
- Fruits at early stage also are attacked.
- Such fruits do not develop.
- Infestation results in premature drop of fruits and decaying of fruits due to secondary bacterial infection

Management:

- Early maturing varieties are less affected than later ones.
- Changing of sowing dates.
- “Arka Tinda” among round gourd and “Arka Suryamukhi” among pumpkin are resistant to *B. cucurbitae*.
- Affected fruits collected and destroyed.
- Harvesting of fruits before ripening.
- Slight ploughing and raking of soil after the harvest to expose pupae from the soil.

- “CUE LURE” is an effective attractant being used to trap cucurbit fruit fly.
- Poison baiting with malathion 100 ml + sugar/jaggery 100 g as saturated solution + water 1 litre distributed in earthen lids.
- Foliar sprays with malathion 2ml/l or carbaryl 3g/l, 3 -5 rounds at fortnightly intervals.
- Foliar sprays with carbaryl 3g/l for flies resting on undersurface of leaves.
- Before each spraying the fruits should be harvested.

PUMPKIN BEETLES:

Scientific Name: *Raphidopalpa foveicollis*

Aulacophora cincta

Aulacophora intermedia

Order: Coleoptera

They infest bittergourd, snakegourd, melons, pumpkin, coccinia *etc.*

Marks of Identification:

- *R. foveicollis* has reddish brown elytra, *A. intermedia* blue black elytra and *A. cincta* grey with black border elytra.
- Grubs are creamy white with darker oval shield at back.

Nature / Symptoms of Damage:

- Beetles are more destructive.
- They bite holes on leaves and also feed on flowers.
- Beetles injure the foliage, flowers and cotyledons by biting holes into them.
- Early sown cucurbits are severely damaged necessitating re-sowing.
- Beetle damage results in numerous of holes on leaves.
- Grubs after hatching, feed on roots of plants below soil surface. Grubs bore into vines, feed on fruits that come in contact with the soil.

Management:

- Deep summer ploughing exposes the grubs and pupae.
- Collection and destruction of adults.
- Dusting the plants with ash temporarily repel the beetles.
- Dusting the soil and foliage with carbaryl 10D.
- Foliar spray with carbaryl 3g/l/ or methyl parathion 2 ml/l or dimethoate at 2 ml/l or malathion 2 ml/l and drenching the soil at root zone so as to kill the grubs.
- Synthetic pyrethroids show phytotoxic symptoms resulting in whitening of foliage.

SNAKEGOURD SEMILOOPER:**Scientific Name:** *Anadevidia peponis***Order:** Lepidoptera

It is a specific pest of snake gourd found throughout South India causing appreciable damage to snakegourd.

Marks of Identification:

- Moth is dark with a body length of 12 -16 mm and wing expanse of 32 mm.
- Forewings have irregular light markings.
- Hind wing is of lighter colour and is darker towards the edges than towards base.
- A sprinkling of golden sheen is discernible in close examination.
- The semilooper is green with tubercles on the body from which arise thin hairs and its anal segment is humped.
- Only three pairs of prolegs are present.

Nature / Symptoms of Damage:

- They feed on leaves causing defoliation.
- The caterpillar is often found on underside of the leaf which may also be lightly folded.

Management:

- Hand picking and destruction of grown up larvae and pupae.
- Larva is parasitized by *Apanteles plusiae*.
- Foliar spray with quinalphos 2 ml/l or malathion 2 ml/l.

SERPENTINE LEAF MINER:**Scientific Name:** *Liriomyza trifolii***Order:** Diptera

Serpentine leaf miner is polyphagous pest, native of Florida and believed to be accidentally introduced into India. It is widely distributed in Telangana, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra causing damage to fibre crops, pulses, ornamentals, vegetables, fodder etc . It is a serious pest on tomato, cotton, ridge gourd, brinjal, cucumber, potato. It has been introduced into India through chrysanthemum cuttings.

Marks of Identification:

- It is a pale yellowish fly, measuring 1.5 mm in length.
- Minute orange yellow, apodous maggot is present.

Nature / Symptoms of Damage:

- Maggot feeds on chlorophyll mining in between epidermal layers.
- Leaves with serpentine mines.
- Drying dropping of leaves in severe cases.

Management:

- Neem oil 5 ml/l or profenophos 2 ml/l or carbaryl 3 g/l as foliar sprays are recommended, if situation warrants.

PUMPKIN LEAF CATERPILLAR: **Scientific Name:** *Diaphania indica*

Order: Lepidoptera

- Moth is medium with whitish wings, transparent with brown marginal patches.
- Elongate bright green caterpillar is seen with two narrow longitudinal white stripes dorsally.
- It folds the leaves and scrapes the green matter. As a result the leaves get dried up.
- It can also feed on ovaries of flower, sometimes bore into young developing fruits.
- Hand picking grown up larvae and killing, foliar sprays with quinalphos 2 ml/l are effective.

APHIDS: **Scientific Name:** *Aphis gossypii*

Aphis malvae

Order: Hemiptera

- *Aphis gossypii* infests different cucurbits while *A. malvae* infests bittergourd in south India.
- Both nymphs and adults suck sap from tender leaves and shoots causing the leaves to curl and growth to be stunted.
- Flowers and pods are also affected.
- Excretion of honey dew leads to sooty mould which interferes with photosynthetic activity of plants.
- Spraying with tobacco decoction (1 kg tobacco boiled in 10 lit of water of 30 minutes and making up to 30 lit + 100 g soap), or systemic insecticides like dimethoate 2 ml/l or methyl demeton 2ml/l have been promising.

Lecture 30 & 31

PESTS OF CRUCIFEROUS CROPS

DIAMOND BACK MOTH:

Scientific Name: *Plutella xylostella*

Order: Lepidoptera

- It is distributed worldwide infesting cruciferous plants of *Brassica* sp. cauliflower, *Brassica oleracea* var. *capitata*, turnip *Brassica rapa* etc.

Marks of Identification:

- The moth is greyish brown with narrow wings having pale white triangular markings on inner margin of each forewing which form three diamond shaped white patches dorsally when wings are folded over back at rest.
- Hence the name, diamond back moth.
- Larva is greenish with short thin hairs on the body. Full grown caterpillar measures 1-1.5 cm and its body tapers towards both ends.

Nature / Symptoms of Damage:

- Caterpillars feed on undersurface of leaves and bite holes in leaves and cause serious damage causing holes on leaves.
- Withered appearance of affected leaves.
- Skeletonised leaves.

Management:

- Removal and destruction of plant remnants, stubbles, debris after harvest and ploughing the field
- Transplanting 2 rows of mustard as a trap crop for every 25 rows of cabbage to attract moths to mustard.
- Larval parasites *Apanteles ruficrus*, *A. plutellae* and pupal parasite *Brachymeria excarinata* suppress population.
- Foliar spray with 5% NSKE for killing the eggs. To obtain 5% neem seed extract, take extract from 5 Kg kernel powder in 100 litres of water. About 12.5 Kg kernel powder is needed to cover 1 ha with 250 litres in high volume sprays for crops like chickpea.
- Foliar sprays on 30, 45 DAT with *B. t.* formulations 1g/l.
- Foliar spray with spinosad 0.3 ml/l. (Last spray should be 15 days before harvesting).
- Under severe infestation, fenvalerate 1ml/l or cypermethrin 1ml/l or deltamethrin 1ml/l is recommended.

CABBAGE BORER**Scientific Name:** *Hellula undalis***Order:** Lepidoptera

It infests cabbage, cauliflower, knolkhol and beetroot.

Marks of Identification:

- Adult is pale yellowish-brown moth having grey wavy lines on the forewing.
- Larvae is greyish yellow with seven purplish brown longitudinal stripes on the body

Nature / Symptoms of Damage:

- Larvae bore into the cabbage head also making it unfit for consumption.
- The damage results in webbed leaves and holes in cabbage head with faecal matter.
- Caterpillars web the leaves and bore into stem, stalk or leaf veins.

CABBAGE LEAF WEBBER:**Scientific Name:** *Crocidolomia pavonana***Order:** Lepidoptera

It infests cabbage, radish, mustard and other cruciferous plants.

Marks of Identification:

- Adult is small with light brownish forewings.
- Caterpillar bears red head with brown longitudinal stripes and rows of tubercles on the body.

Nature / Symptoms of Damage:

- Caterpillar webs together the foliage and feeds on leaves.
- It also feeds on flowers and pods in the case of mustard and flower heads in cabbage and cauliflower.
- The damage results in webbed leaves with faecal matter and skeletonised leaves

CABBAGE APHIDS:**Scientific Name:** *Brevicoryne brassicae***Order:** Homptera

- The aphids are yellowish green (*B. brassicae*) and multiply parthenogenetically.
- This pest infests crucifers in cold season. Both the nymphs and adults suck sap from plant causing loss of vigour and formation of sooty mould due to excretion of honeydew reducing the photosynthesis.
- Foliar spray with malathion or dimethoate or methyl demeton each at 2.0 ml/l is effective.

PAINTED BUG:**Scientific Name:** *Bagrada cruciferarum***Order:** Hemiptera

- Adult is yellow with black markings.
- Nymphs are reddish in colour.
- It is a serious pest of cruciferous crops and widely distributed.
- Both nymphs and adults suck sap from leaves, shoots and pods resulting in wilting and loss of vigour of the plant. It feeds on cabbage, caluliflower, radish *etc.*
- Foliar spray with malathion or dimethoate or methyl demeton each at 2.0 ml/l is effective.

TOBACCO CATERPILLAR:**Scientific Name:** *Spodoptera litura***Order:** Lepidoptera

- Caterpillars feed on leaves and fresh growth, active at night and cause extensive damage.
- The young caterpillars are gregarious in nature and skeletonise the tender leaves.
- Later on the broad leaves are completely eaten.

(These pest detailed under the pests of cotton)

CABBAGE BUTTERFLY:**Scientific Name:** *Pieris brassicae*,*Pieris rapae***Order:** Lepidoptera

- Adult is a butterfly with its forewings snow white having black distal margins.
- Hindwings pure white with black apical spots.
- The caterpillar is velvety green and measures about 4.2 cm in length.
- The caterpillars are gregarious initially but disperse as they grow.
- They skeletonise leaves and bore into heads of cabbage and cauliflower.
- Pupation is in damaged leaves.
- Two sprays at fortnightly interval with carbaryl 3g/l are effective.

MUSTARD SAWFLY:**Scientific Name:** *Athalia lugens proxima***Order:** Hymenoptera

This is one of the very few hymenopterous insects to infest crops in India. It is also a pest on raddish and other crucifers.

Marks of Identification:

- Adult is small orange yellow with black markings on the body, smoky wings with black veins.

- The female possesses a saw - like ovipositor.
- Larva is cylindrical and dark grey with three pairs of thoracic legs and seven to eight pairs of abdominal legs and five black stripes on the abdomen. It measures about 15-20 mm.
- On slightest touch, larva falls to ground feigning death.

Nature / Symptoms of Damage:

- The larva feeds on the leaves nibbling leaves initially, biting holes later causing skeletonisation of leaves.
- Heavy defoliation

Management:

- Collection and destruction of the larvae.
- Foliar spray with methyl parathion 2ml/l or carbaryl 3 g/l.

Lecture – 32, 33 &34

PESTS OF MANGO

MANGO HOPPERS:

Scientific Name: *Amritodus atkinsoni* (largest)

Idioscopus clypealis (smallest)

I. niveosparsus (medium)

Order: Hemiptera

These insects are monophagous on mango and occur as regular pests.

Marks of Identification:

- They are wedge shaped measuring 3 to 7 mm in length and move diagonally.
- Among these *A. atkinsoni* is the largest and light brown having two black spots on scutellum, the anterior margin of pronotum and vertex.
- *I. clypealis* is the smallest and lighter in colour with two spots on the scutellum dark spots on the vertex. Clypeus is entirely black.
- *I. niveosparsus* is slightly smaller with three spots on the scutellum and prominent white bar crossing its dusky wings. It is the most injurious species in South India.
- Nymphs are smaller than the adults.

Nature / Symptoms of Damage:

- During flowering, the hoppers develop enormously in number, suck juice from the inflorescence and other tender plant parts reducing the vigour of the plant leading to reduction in fruit set and even premature fruit fall.
- The infestation also leads to development of sooty mould on the honeydew excreted by the insects.
- Egg laying also inflicts injury to the inflorescence.
- The infestation ranges from 25 to 50 per cent and in severe case it may lead to total loss of crop.
- The June-August generation hoppers are seen on mango tree trunks while February-April generation is confined to the foliage and causes severe loss.
- Adult hoppers spend winter in the cracks in the barks of the tree.
- Hoppers prefer shady and damp places.
- Affected flowers wither and drop down.
- Presence of black sooty mould on floral and other tender plant parts.

Management:

- Keeping orchard clean.
- Avoiding overcrowding and waterlogging.
- Proper pruning of the tree after harvesting to facilitate proper sunlight and air that minimises hopper population.
- Spray schedule is recommended as follows
 - At flower bud initiation carbaryl 3 g/l

 - At emergence of inflorescence stalks and before flower opening (anthesis), dimethoate 2 ml/l or thiamethoxam 0.3 g/l or imidacloprid 0.3 ml/l

 - During anthesis and pollination, insecticides should not be sprayed.
 - When fruits are of pea size, phosphamidon 1ml/l or dimethoate 2ml/l or acephate 1g/l
- Adding sulphur 3.5g/l to the insecticide based on need to check mites and sooty mould, *Capnodium mangiferum*
- Directing the spray first to stem/ trunk, then branches, twigs, leaves and finally inflorescence is a recommended method.

MANGO STEM BORER:**Scientific Name:** *Batocera rufomaculata***Order:** Coleoptera

Mango stem borer is common pest in India. It is a polyphagous pest, infesting besides mango, apple, fig, mulberry, Eucalyptus, jack fruit, papaya *etc.*

Marks of Identification:

- Adult is a well built, conspicuously long, brownish grey beetle measure wing about 4.5 to 5.5 cm.
- It has two pink dots and lateral spines on thorax and has hard elytra and is long horned.
- Full grown grub is yellowish white, fleshy and about 10 cm long with dark brown head having strong jaws.

Nature / Symptoms of Damage:

- The grub bores and tunnels through the bark of branches and stem feeding on the inner contents.
- As a result of feeding, the affected branches start drying up. In severe cases of attack the whole tree dies.
- The symptoms are masses of frass and sap exuding from the bore holes.
- Leaves of damaged branches dry and fall.
- Branches collapse, tree succumbs in severe cases

Management:

- The affected portions with grubs and pupae removed and destroyed, if branches are affected.
- Methyl parathion 1 ml/l poured in to the hole or tablet of aluminium phosphide inserted into the hole to kill the grub.
- When burrows are superficial, extract the grubs with stiff hooked wire and paint bordeaux paste.

MANGO NUT WEEVIL OR STONE WEEVIL: Scientific Name: *Sternochetus mangiferae*

Order: Coleoptera

It is a major pest in South India. It is widely distributed in tropics. Sweet variety fruits are more liked by stone weevil. It is monophagous and is considered most serious pest of mango. The pest is sensitive to temperature and low humidity and is more confined to humid areas. Due to this pest, Maryland of the USA does not allow mango imports from India.

Marks of Identification:

- Adult weevil is about 6-8 mm in length, greyish brown in colour and stoutly built.
- Antennae are 10 segmented and elytra are convex.
- Grub is white, thick, fleshy and legless.

Nature / Symptoms of Damage:

- The newly hatched grub immediately tunnels in a zig- zag manner through pulp, endocarp and seed coat until it reaches cotyledons and the seed coat hardens afterwards.
- Inside the stone it feeds on the cotyledon, moults 5 times in about 5 weeks and pupates inside the stone.
- As a fruit develops, the tunnel gets healed up.
- The damage results in ovipositional injuries and eggs on marble sized fruits.
- Tunneled cotyledons.
- Fruit dropp at marble stage.

Management:

- Collection and destruction of infested fruits.
- Ploughing orchard after fruit harvest to expose hibernating adults.
- Killing adults before fruiting season by treating bark with spray of monocrotophos 1.6 ml or carbaryl 3 g or fenitrothion 1.0 ml/l at fruit set and one month after fruit set.

- Hot water treatment of fruit for specified period at 60°C kills the weevil inside the stone, but not fruit fly maggot which is within the pulp.

MANGO FRUIT FLY:

Scientific Name: *Bactrocera dorsalis*

Order: Diptera

It is one of the major pests of mango in India. It also infests guava, peach, citrus, ber, banana, papaya etc.

Marks of Identification:

- Adult fly is a brown or dark brown with hyaline wings and yellow legs.
- Maggots are creamy white and legless.

Nature / Symptoms of Damage:

- Damage to semi ripe fruits is caused by both maggot and the adult.
- The oviposition punctures made by the female serves as entry for fermenting organisms.
- Maggots feed on the pulp and convert the pulp into bad smelling discolored semi liquid mass, unfit for use.
- The fruits develop brown rotten patches on them and fall to the ground eventually. The symptoms of attack are semiripe fruits with decayed spots.
- Dropping of fruits

Management:

- Collection and destruction of fallen, rotten fruits.
- Raking under the trees to expose the pupae.
- Mixing of carbaryl 10D in soil @ 50-100 g/tree.
- Hanging from tree branches plastic containers with bait made of methyl eugenol 2 ml + carbofuran 3G 3 g + water one litre (200ml of bait/plastic container) to attract and kill flies.
- Foliar spray with malathion 2 ml/l or acephate 1.5 g/l.

Post-Harvest Control (Heat treatment techniques):

- Hot water treatment: Submerging fruits in hot water at 43 to 46.7°C for 35- 90 min.
- Double dip method: Immersion of mango fruits in water at 40°C for 20 minutes, followed by 10 minutes at 46°C to get 100 per cent mortality of *Bactrocera dorsalis* eggs.

MANGO SHOOT BORER:**Scientific Name:** *Chlumetia transversa***Order:** Lepidoptera

- This pest is active from August to October.
- Eggs are laid on tender leaves. Freshly hatched caterpillars bore into midribs of tender leaves and come out after a couple of days to bore into tender shoots near the growing point tunnelling downwards, throwing out the excreta out of the entry hole.
- Damage results in withering and drying of new terminal shoots.
- When the caterpillar is full grown, it come out of the shoot and pupates on dried leaves, bark, soil *etc.*
- Clipping off and destruction of affected shoots, foliar spray with carbaryl 3 g/l or quinalphos 2 ml/l at the time new flush.

MANGO FRUIT BORER:**Scientific Name:** *Deanolis albizonalis***Order:** Lepidoptera

Castor shoot and capsule borer *Conogethes punctiferalis* is also known to bore into fruits when two fruits are seen attached together.

Marks of Identification:

- Adults are brownish.
- Caterpillar is brick red with white intersegmental streaks.

Nature / Symptoms of Damage:

- A single caterpillar can damage many fruits.
- Caterpillar bores into fruits at beak region, feeds inside reaching kernel causing secondary infection, which renders the fruit unsuitable for market or consumption.
- Bore holes are seen plugged with excreta.

Management:

- After fruit harvest, removal of dead wood and bark and burning, collection of damaged fruits on the tree and the ground and burning.
- Erecting light traps, fires.
- Spraying with NSKE 5 % at 10 days interval from fruit setting (marble size) until 15 days before harvest are recommended.
- Foliar sprays in the evening with dichlorvos 1.5ml/l or chlorpyrifos 1ml/l or carbaryl 3g/l or neem oil 3ml/l + chlorpyrifos 1ml/l.

- Avoid growing of castor in mango orchards to eliminate *C. punctiferalis* which comes as a fruit borer is recommended.

MEALY BUG:

Scientific Name: *Drosicha mangiferae*

Order: Hemiptera

- This giant mealybug is a serious problem in North and Central India.
- Female lays eggs in clusters within ovisacs in soil under the trees 5-15 cm deep during April and May.
- The adult female crawls down the tree in April-May and enter the soil for laying eggs which hibernates till November.
- The eggs hatch during November-December.
- The nymphs ascend the trees and settle on inflorescence.
- Nymphs and adults suck sap from inflorescence, fruit stalks, fruits *etc.* leading to flower drop, pre mature fruit drop *etc.*
- They also excrete honey dew on which sooty mould develops and the fruit development is hampered.
- Both nymph and adults suck sap from other tender plant parts thus reducing the plant vigour.
- Deep summer ploughing up to base of the tree trunks, after harvesting to expose eggs of mealy bugs.
- Dusting methyl parathion 2D around tree and incorporating in to the soil.
- Spraying with dichlorvos 1 ml or imidachloprid 0.3 ml/l or phosphamidon 1ml/l when severe mealybug infestation noticed on the twigs.
- Wrapping 25 cm wide, 400 guage polythene sheet on the tree trunk 30 cm above ground level
- Pasting greeze over it to prevent migration of freshly hatched first instar nymphs during winter (Nov-Dec) from soil to trees, one week before their emergence.
- Crawlers collecting beneath the polythene sheet may be scraped with a knife.

APHID:

Scientific Name: *Toxoptera odinae*

Order: Hemiptera

- It is a brownish species infesting tender shoots and leaves by sucking sap in South India.
- Systemic insecticide like dimethoate 2 ml/l is effective.

MANGO LEAF WEBBER:**Scientific Name:** *Orthaga exvinacea***Order:** Lepidoptera

- Caterpillar webs terminal leaves and feeds by scraping green portion.
- Leaves are skeletonized, wither and drop away.
- Dry top shoots are conspicuous and flower stalk formation is affected.
- Spraying of quinalphos 2m/l or carbaryl 3 g/l or monocrotophos 1.5 ml/l during July - August is effective.

TERMITES:**Scientific Name:** *Odontotermes obesus***Order:** Isoptera

- Colonies of workers feed on bark by constructing galleries and eventually tree may collapse and die.
- Applying in the pit at planting time neem cake or methyl parathion 2D 100g/pit.
- Digging termite mounds and destroying queen, drenching chlorpyrifos 10ml/l on dug termite mounds.
- Spraying chlorpyrifos 4ml/l on tree after clearing mud galleries.
- Applying Bordeaux paste up to 2-3 feet from base after rains cease.

THRIPS:**Scientific Name:** *Thrips hawaiiensis***Order:** Thysanoptera

- Thrips mainly infest flowers and tender fruits. They lacerate the tissues of tender fruits and suck oozing out sap.
- Damage causes scab on fruits which lose their marketability.
- Foliar sprays with acephate 1.5g/l or fipronil 2ml/l. when thrips are found along with mango hoppers, thiamethoxam 0.3g/l are recommended.

MANGO RED TREE ANT:**Scientific Name:** *Oecophylla smaragdina***Order:** Hymenoptera

- Ants construct the nest by webbing the leaves together.
- Though they do not cause any direct damage, they act as carriers for scale insects, mealy bugs and also cause nuisance to the workers in the orchards.
- They are ferocious and workers are badly bitten.

- Removal and destruction of nests mechanically and spraying chlorpyrifos 2ml/l or methyl parathion 2ml/l after disturbing the nests have been found effective.

LEAF GALL MIDGES:

Scientific Name: *Amradiplosis echinogalliperda*

Procontarinia matteiana

Order: Diptera

- Flies are mosquito like; maggots are small, yellow and apodous.
- Areas of ovipositional punctures on leaf develop into galls.
- Maggots feed within the galls.
- Spraying NSKE 5% at new flush is effective.

RED SPIDER MITE:

Scientific Name: *Oligonychus mangiferus*

Order: Acarina

- Tiny mites suck sap from older leaves, turning them brittle.
- They live under silken webs on undersurface of leaves which turn yellow.
- In severe infestation, leaves are shed. Foliar spray with diafenthiuran 1 g/l is recommended.

Lecture – 35 & 36

PESTS OF CITRUS

CITRUS BUTTERFLY:

Scientific Name: *Papilio demoleus*

Papilio polytes

Papilio helenus

Order: Lepidoptera

These are most destructive pests of citrus seedlings. This pest is widely distributed in Burma, Bangladesh, Sri Lanka, India and Pakistan. It infests almost all citrus varieties though Malta (*Citrus sinensis*) is its preferred host. It can feed and breed on all varieties of cultivated or wild citrus and various other species of family Rutaceae. Besides citrus, it also attacks ber, wood apple, curry leaf.

Marks of Identification:

- *P. demoleus* is a big beautiful butterfly with yellow and black markings on all the four wings, having wing expanse of about 50-60 mm. Its hind wings have a brick red oval patch near the anal margin and there is no tail like extension behind though common in Papilionidae.
- *P. polytes* males are black and females vary in form.
- *P. helenus* has black wings with three white distal spots.
- Freshly hatched caterpillars are dark brown and soon develop irregular white markings on their body resembling bird's drop.
- The full grown caterpillar is deep green and cylindrical in form and measures about 40-50 mm in length with a hump in front and has a horn like structure on the dorsal side of the last body segment. When the caterpillar is disturbed, it pushes out from the top of its prothorax a bifid, purple structure called osmeterium which emits a distinct smell.

Nature / Symptoms of Damage:

- The caterpillars feed voraciously on tender leaves right up to the mid ribs and defoliate the entire seedlings or the tree leaving behind the only midribs.
- Leaves fed up to midribs

Management:

- In small orchards and nurseries with mild infestation, hand picking and destruction of various stages of the pest.
- Natural enemies enumerated below suppress the pest population.

- Egg parasitoids: *Trichogramma evanescens*; *Telenomus* sp..
- Larval parasitoid: *Distatrixpapilionis*; *Brachymeria* sp.
- Pupal parasitoid: *Pterolus* sp.
- Spraying of monocrotophos 1.6 ml/l or dichlorvos 1 ml/l or methyl parathion 2 ml/l when the caterpillars are small. *B. t.* formulation HALT at 9 g/l is also recommended.

CITRUS FRUIT SUCKING MOTHS: **Scientific Name:** *Eudocima materna*
Eudocima fullonica
Eudocima ancilla

Order: Lepidoptera

This pest is distributed in Australia, China, Japan, Korea, Philippines, Hawaii, Thailand etc. Besides citrus, it also attacks grapes, apple, castor, ber, pomegranate, guava etc.

Marks of Identification:

- *E. materna*: The moth has brownish black forewings with a white stripe and yellowish hind wings with a circular black spot in the middle.
- *E. fullonica* : The moth has brownish forewings and yellowish black hind wings with a half moon or kidney shaped black spot.
- *E. ancilla* : The forewings of this moth are dark brown with a green band in the middle; hind wings are yellowish with a kidney shaped black spot.
- Caterpillar is a semilooper.

Nature / Symptoms of Damage:

- This is the only group where the adult moths are harmful and damage the citrus fruits.
- Moth pierces the ripe fruit with its strong proboscis and sucks the sweet juice.
- The feeding injury opens way for invasion of bacteria, which makes the fruit rot around the punctures and drop prematurely.
- *Achaea janata* moth also sucks the juice from the unripe fruits.
- Premature dropping of fruits.
- Rotting at the site of feeding injury.
- Larvae of *Eudocima* sp feed on foliage of other weed hosts of the family Menispermaceae.

Management:

- Destruction of weeds found around orchards.
- Collection and destruction of rotten and dropped fruits.
- Adults are highly phototropic. One fluorescent light/ha one month before fruit maturation between 7.00 PM to 6.00 AM below which poison baits with sugar solution 1% + fruit pulp + Malathion 1 ml should be placed.
- Bagging of fruits with polythene or paper covers, though effective is rather expensive and not practicable on large scale.
- Creating smokes in the orchards after sunset to keep the pest away which is also rather laborious.
- Arranging poison baits during Sep – Nov and Mar – May at fruiting under lights with a solution of malathion 1ml + fruit juice with 1% sugar to attract and kill adult moths.

CITRUS LEAF MINER:**Scientific Name:** *Phyllocnistis citrella***Order:** Lepidoptera

It is widely distributed from Australia to Africa. It attacks all species of citrus but prefers sweet oranges. It also infests Ponagamia, jasmine etc. The pest is active all-round the year, except during severe winter (December – February). Maximum damage is caused during May-June and also during August-October, if the temperature is high enough.

Marks of Identification:

- Adult is a silvery white small moth with brown striped forewings having a prominent black spot near the tip and white hindwings.
- Both pairs of wings are fringed with hairs.
- The adult moth measures 6 mm in wing span.
- Early larva tiny red, apodous.
- The full grown caterpillar is slender, yellowish green with brownish mandibles.

Nature / Symptoms of Damage:

- Larva mines in between the epidermal layers of the leaf in a zigzag manner and feeds on chlorophyll which results in distortion of the leaf lamina.
- The tunnel appears silvery white. New and tender leaves are preferred.

- Sometimes, the larva mines the outer layer of young green twigs. Serious infestation causes retardation in growth.
- The infestation predisposes the leaves to canker growth.
- Characteristic silvery white zigzag galleries below the epidermis of tender leaves.

Management:

- Pruning of affected parts during winter and burning.
- Spraying of Neem cake solution 5% or neem oil 5% or monocrotophos 1.6 ml/l or dimethoate 2 ml/l or imidachloprid 0.5 ml/l twice at 10 days interval at every new flush time i.e. during June – July, Sep – Oct, Dec – Jan.

CITRUS PSYLLA:

Scientific Name: *Diaphorina citri*

Order: Hemiptera

This is widely distributed in India and is considered as a major pest in Punjab. In these regions the pest is active from February to November and has 16 generations per year.

Marks of Identification:

- Adults are reddish with jumping legs.
- Nymphs looklike adults but without wings.

Nature / Symptoms of Damage:

- The damage is caused by the nymphs which crowd on the terminal shoots and buds and suck up the juice.
- Curling and cupping of leaves.
- Defoliation and death of young shoot in severe infestation and the fruits turning undersized and juice content reduced.

Management:

- Spraying of methyl demeton 2 ml/l or dimethoate 2 ml/l or imidacloprid 0.5 ml/l at seedling stage on fresh foliage twice at 10 days interval.

CITRUS RUST MITE:

Scientific Name: *Phyllocoptruta oleivora*

Order: Acarina

- Citrus rust mite damage epidermal cells of plant leaves, fruit, and green twigs of all citrus varieties and can be found any time during the year with peak populations usually occurring during June and July in south India.
- Minute worm like mites are found on the under surface of leaves and fruits.
- The infestation may cause browning of leaves.

- Pale brown and sickly fruits.
- The affected fruit becomes pinkish, brown red and brittle and is locally called as “mangu” disease.
- Rust mite is known to avoid most sun exposed portion of the fruit.
- Foliar sprays with wettable sulphur 3g/l or dicofol 2.7ml/l or propargite 1ml/l once in a month in Sep, Oct and Nov.

BARK EATING CATERPILLARS: **Scientific Name:** *Indarbela tetraonis*

I. quadrinotata

Order: Lepidoptera

- Occasionally these pests in large numbers cause severe damage especially to old trees.
- The freshly hatched larvae feed on the surface of tree trunks.
- When strong enough, they bore inside the trunks and move about inside the concealed silken gallery and feed on the bark by scraping which interrupts the translocation of cell sap adversely affecting growth and fruit setting capacity of the tree.
- Ribbon like or pipe like webbings on the stem near forks or angles of branches and the tree trunk is the clear indication of its damage.
- Only one caterpillar is seen in a gallery.
- Cleaning the tree trunks by removing all the webs and placing cotton wool soaked in chloroform, kerosene, petrol and, carbon disulphide and sealing the same with mud.
- Injecting into the hole with monocrotophos 1.6 ml/l or of dichlorvos 2 ml/l is effective.

CITRUS BLACKFLY: **Scientific Name:** *Aleurocanthus wogluni*

Order: Hemiptera

- It is found mainly in North India. It infests during post rainy season and disappears in summer. It also infests coffee.
- Adults are tiny, moth like slaty black with white markings at the edge of wings. Both the nymphs and adults suck sap resulting in loss of plant vigour and formation of sooty mould due to excretion of honey dew.
- Predators like *Brumus* sp., *Scymnus* sp. And *Chrysoperla* sp suppress the pest population.
- Spraying profenophos 2.0 ml /l or chlorpyriphos 2 ml/l or imidacloprid 0.5 ml/l or acephate 1.5 g/l are effective.

CITRUS RED MITE / LEAF MITE:

Scientific Name: *Panonychus citri*

Order: Acarina

- Citrus red mites feed on leaves, green twigs, and fruit.
- Visible injury is characterized by light colored, scratched areas which give the upper leaf surface a silvery appearance.
- Avoiding water stress and spraying of wettable sulphur 3 g/l or dicofol 2.7 ml/l or propargite 1ml/litre of water during Sept-Nov months.

PESTS OF GRAPEVINE

GRAPEVINE FLEA BEETLE:

Scientific Name: *Scelodonta strigicollis*

Order: Coleoptera

It is the most destructive pest of grapevine all over India.

Marks of Identification:

- Adult is a shiny flea beetle with a metallic bronze colour and six black patches on the elytra and is 4.5 mm long.
- Grub is small, dirty white grubs.
- Adults have characteristic habit of falling down and feigning death when disturbed.

Nature / Symptoms of Damage:

- The adults are very destructive during Sep - Nov particularly when the vines put forth new flush after pruning.
- The beetles feed on the sprouting buds and eat them completely without allowing them to develop.
- They feed on mature leaves cutting elongated holes on the leaf lamina like shot holes.
- Complete fed sprouting buds are present.
- Shot holes (rectangular cuttings) on mature leaves are present.
- Grubs burrow into the soil and feed on the cortical layer of roots not causing any appreciable damage.

Management:

- Adult beetles may be collected and killed.
- Removal of loose bark in rainy season after pruning to expose and eliminate eggs and adults found underneath.
- First spraying when buds swell in early morning or evening hours to kill beetles and second spray after 10 days with monocrotophos 1.6 ml/l or carbaryl 3.0 g/l or imidachloprid 0.3 ml/l or quinalphos 2ml/l.

GRAPEVINE THRIPS:

Scientific Name: *Rhipiphorothrips cruentatus*

Order: Thysanoptera

Most destructive pest of grapevine India. It also feeds on rose, jasmine, cashew and other fruit trees.

Marks of Identification:

- Adults are minute, pale, blackish brown, found on the underside of leaves.

Nature / Symptoms of Damage:

- Young nymphs on hatching feed on the undersurface of leaves.
- Both the nymphs and adults lacerate tender foliage and suck the oozing sap.
- The attacked leaves appear silvery initially and later turn brown and give withered appearance, curl up and drop off the plants.
- Severely affected vines do not bear fruits.
- If fruits are attacked, they develop corky layer on the fruits and turn brown. Infestation results in silvery patches on the affected leaves.
- Brown corky patches on fruits (scab)
- Reproduction is either with or without fertilization. Fertilized eggs give rise to female and unfertilized ones to male.

Management:

- Removal of weeds in and around garden.
- Cutting of infested branches and burning.
- Spraying dimethoate 2ml/l or methyl demeton 2.0 ml/l or thiamethoxam 0.25 g/l.

GRAPEVINE MEALY BUG:**Scientific Name:** *Maconellicoccus hirsutus***Order:** Hemiptera

- It is a serious pest on grapevine varieties having compact fruit bunches like Thompson seedless. Anab – e – shahi with loose bunches is less infested.
- Clusters of mealy bugs with white mealy mass suck the sap from fruits making berries or fruits unfit for consumption.
- They also feed on stems and foliage resulting sooty mould development that affects photosynthesis and final yield.
- Malformation of growing shoots and leaves and sooty mould are the common.
- Clearing mealy bug clusters on stem using gunny cloth.
- Releasing 8-10 *Cryptolaemus montrouzieri* (Australian lady bird beetle)/each tree
- Removal of loose bark and paste mixture of carbaryl 6 g + Copper oxy chloride 10 g + neem oil 1ml+ gum 1ml on the stem and branches.
- Spraying of dichlorvos 2.0 ml/l or methomyl 1.0 g/l have been found effective.
- Applying sticky bands like greeze or sticky tapes around stem, stalks of branches to prevent crawlers from reaching young shoots.

- Dipping grape bunches in a solution of DDVP 1.5ml + soap 2.5g + water 1 litre for 30 seconds is also suggested.

GRAPEVINE STEM GIRDLER:

Scientific Name: *Sthenias grisator*

Order: Coleoptera

- Besides grapevine, this insect also infests apple, citrus, mango.
- It is a medium sized, stout beetle which girdles (ringing) the vine as a pre – ovipositional operation resulting in drying up of regions beyond the cut.
- Eggs are inserted under the bark in cuts made by the beetle on the girdled vines.
- 1-4 eggs are laid at one place.
- Egg period is 8 days.
- The grub tunnels in to the wood and completes its life cycle within the stem.
- Pupation takes place within the tunnel.
- Cutting attached branches below girdling point and burning.
- Applying dichlorvos in the holes or placing half a tablet of aluminium phosphide in to the hole and closing it with mud.

GRAPEVINE STEM BORER:

Scientific Name: *Coelosterna scabrator*

Order: Coleoptera

- The insect is a borer, the grub of which bores in to stem and branches and causes drying and withering of affected branches.
- Initially reddish sap oozes from wounds, chewed particles of wood are seen on the ground just below the site of damage.
- Removal of loose bark in pre monsoon period, later painting bark with lindane suspension is recommended.
- Applying dichlorvos in the holes and closing it with mud or placing half tablet of aluminium phosphide in to the hole and closing it.

LEAF EATING CATERPILLARS: Scientific Name: *Spodoptera litura Spodoptea exigua*

Helicoverpa armigera

Order: Lepidoptera

Their incidence is sporadic. Caterpillars feed on grapevine leaves voraciously.

(These pest detailed under the pests of cotton)

PESTS OF CASHEW

CASHEW TREE BORER

Scientific Name: *Plocaederus ferrugineus*

Order: Coleoptera

It is one of the major pests and normally found in old plantations of more than 7 years age where sanitation is poor. It is a serious pest of cashew tree in Kerala, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu and Maharashtra.

Marks of Identification:

- Adult is a medium sized, dark brown longicorn beetle.
- Grub is creamy white, robust and fleshy.

Nature / Symptoms of Damage:

- Grubs bore into the bark in their early stage and into the wood in their late stages making extensive tunnels within.
- Both young and old plants are affected.
- The young plants are killed immediately whereas the older plants gradually become weak and succumb.
- Infestation results in yellowing and shedding of leaves and drying of twigs.
- Chewed up fibre, excreta and gummy secretions seen protruding from the bore holes.

Management:

- For trees over seven years age , spraying or swabbing on tree trunks up to 3 feet from ground and exposed roots with 5%neem oil once in 4 months *i.e.* 3 times a year as a prophylactic measure.
- Removal of dried branches, dead trees and burn them.
- Removal of grubs, pupae and adults from damaged portion by physically chisteling and destroying them.
- Chistled trunks and roots treated with carbaryl 4 g/l.
- Removing the soil around the base of tree up to 1 foot depth and applying 300 -500 g of carbaryl dust per tree and covering it with fresh soil.
- Cleaning the bore holes to insert 1-2 table ts of aluminium phosphide in each hole and plugging the holes.

CASHEW SHOOT AND BLOSSOM WEBBER **Scientific Name:** *Lamida monocusalis*

Order: Lepidoptera.

It is a major and regular pest and occurs all through the year.

Marks of Identification:

- Adult is a dark brown moth with a wing expanse of 24-26 mm.
- Newly hatched caterpillar is pale white and feeds on the leaves by webbing.
- Full grown larva is reddish brown with yellow lateral longitudinal bands and pinkish dorsal lines and measures up to 26 mm in length.

Nature / Symptoms of Damage:

- Larva webs inflorescence at the time of flowering and feeds on the floral parts.
- Apples and nuts are also covered with webs with the caterpillar scraping the upper green layer of tender apples and nuts.
- It results in cracking of tissue and retardation in nut development.
- The pest incidence is severe at the time of new flush.
- Webbed leaves, inflorescence, apples and nuts are present.

Management:

- Three species of *Apanteles* (Braconidae) were observed during January and February parasitizing the larval population.
- Spraying of carbaryl 3g/l or monocrotophos 1.6 m/l after disturbing the webs.

TEA MOSQUITO BUG:

Scientific Name: *Helopeltis antonii*

Order: Hemiptera

Major pest of cashew in Kerala, Karnataka, Goa, Maharashtra and Tamil Nadu. Besides cashew, it infests grapevine, guava, neem *etc.*

Marks of Identification:

- Adult is a reddish brown bug with black head, red thorax and black and white abdomen; a knobbed process arises mid -dorsally on the thorax.

Nature / Symptoms of Damage:

- Nymphs and adults feed on petiole, tender shoots and leaf veins.
- Brownish black necrotic patches on foliage and elongate streaks and patches on shoots.
- Resins exuding from the feeding punctures.

- Blossom blight and die back symptoms .

Management:

- First spray coinciding with new flush in Oct – Nov with Profenophos 2ml/l.
- Second spray during emergence of inflorescence in Dec – Jan with monocrotophos 1.6ml/l or dimethoate 2 ml/l.
- If damage still persists another spray at the time of fruit set in Feb with Profenophos 2ml/l.

CASHEW LEAF MINER:

Scientific Name: *Acrocercops syngamma*

Order: Lepidoptera

- This pest regularly occurs at the time of new flush generally during June -July and Jan-Feb.
- The caterpillar mines into the leaves, as a result the thin epidermal layers of the leaf swells up in the mined area and appears as whitish patches on the leaf surface of tender leaves.
- In older leaves big holes are formed due to the drying and crumbling of the mined areas.
- Generally young plants are more affected by this pest.
- Spraying of carbaryl 2 g/l or monocrotophos 1.6 ml/l or profenophos 2 ml/l is effective .

CASHEW THRIPS:

Scientific Name: *Rhipiphorothrips cruentatus*

Rhynchothrips raoensis

Order: Thysanoptera

- Incidence is severe in March- May.
- Both nymphs and adults appear in colonies on the lower side of the leaf. They scrape the leaf surface and suck sap. Affected leaves turn pale green, later to pale brown with dark brown spots. Ultimately the affected leaves shrivel and drop off.
- During flowering *Rhynchothrips raoensis* incidence is severe during December and January.
- Both nymphs and adults suck sap from flowers, flower stalks, apples and green nuts.
- This results in flower and fruit drop and development of scab on apple and green nut.
- Spraying chlorpyriphos 2 .5 ml/l or profenophos 1ml/l.

PESTS OF POMEGRANATE

POMEGRANATE BUTTERFLY / ANAR BUTTERFLY

Scientific Name: *Virachola (Deudorix) isocrates*

Order: Lepidoptera

It is the most important and destructive pest of pomegranate and distributed throughout the country, also infesting guava, annona, apple, ber, citrus, litchi, tamarind, wood apple, soap nut, *etc.*

Marks of Identification:

- Butterfly is bluish brown with an orange spot on each of the forewings and black spots on the hindwings with a tail like extension at the lower margin of hindwings.
- It is active in bright sun.
- Caterpillar is stoutly built dirty brown in colour, with light patches, a few short hairs and measures about 16-20 mm long.

Nature / Symptoms of Damage:

- Larva after hatching bores into the fruit and feeds on the seeds.
- Entry hole heals up.
- The fruit appears healthy but the caterpillar inside feeds on pulp and seeds just below the rind.
- It is only when the grown up caterpillar comes out, a round hole is seen through which juices come out.
- A single fruit may harbor half a dozen caterpillars. Feeding injury also cause rotting of the fruits.
- Up to 50% fruit damage is observed.
- The conspicuous symptoms are offensive smell and excreta of caterpillar at the entry hole.
- The affected fruits ultimately falling down.

Management:

- Destruction of fallen infested fruits checks the spread.
- Removal of flowering weeds especially of compositae family.

- Though expensive, bagging of fruits with polythene or paper bags or cloth bags soon after the fruit set prevents the pest attack.
- During flowering and flower bud stage, Profenophos 2ml/l is recommended.
- After 15 – 20 days, spray application of dichlorvos @ 1 ml. /L or carbaryl 3g /l.

POMEGRANATE THRIPS

Scientific Name: *Rhipiphorothrips cruentatus*

Order: Thysanoptera

- These are found throughout country. *A. oligochaetus* infests flower stalks, sepals, petals and fruits with their rasping sucking type of feeding.
- As a result, flowers are shed and fruits show scab like rough surface.
- *R. cruentatus* and *S. dorsalis* lacerate the leaves and suck oozing out sap causing curling of leaves.
- At flower bud initiation, foliar spray with dimethoate 2ml/l or fipronil 2ml/l is effective.

PESTS OF COCONUT

COCONUT BLACK HEADED CATERPILLAR: **Scientific Name:** *Opisina arenosella*

Order: Lepidoptera

It is the most important lepidopterous pests of coconut in India and Sri Lanka. It occurs more commonly along the west and east coast regions. It has been observed infesting coconut in some inland regions of Karnataka and Tamil Nadu also.

Marks of Identification:

- Adult is a greyish white moth measuring 10-15 mm long and 20-25 mm in wing span across outstretched wings.
- The moth is straw to ash grey in colour, medium sized with uniform pale whitish upper wings.
- Caterpillar is light green with red brown stripes and black head and grown up larva is about 15 mm long.

Nature / Symptoms of Damage:

- Larvae feed gregariously on the surface tissues of the leaflets scraped out from their lower surface.
- The leaflets are reduced to papery tissues.
- The larva constructs a gallery of silk and frass and lives and feeds under it.
- The attacked leaflets turn brown in colour and dry up.
- The production of nuts gets adversely affected as photosynthetic activity of the palm is much reduced.
- The fronds become unsuitable for thatching and other purposes.
- The damage is more during hot months (April-June) and less during rainy season.
- The folded leaflets with silken galleries and frass.
- Large scale drying of leaflets.
- In case of severe attack the whole plantation presenting a burnt up appearance from a distance.

Management:

- Due to hidden nature of the caterpillars and height of the plants chemical control measures are often inadequate.

- Clipping and destroying the infested portions.
- A host of parasites attack different stages of the pest. For obtaining effective control, schedule release of a combination of these parasites should be adopted four times depending on the stage of the pest.

1st release immediately when the infestation is observed.

2nd – a fortnight after the first.

3rd – a month after the second.

4th – a fortnight after the third.

- The parasites and their hosts are listed below.

Egg parasite	<i>Trichogramma chilonis</i>
Early larval	<i>Cotesia taragamae</i>
Mid larval	<i>Bracon brevicornis</i>
Late larval	<i>Goniozus nephantidis</i>
Pre pupal	<i>Elamus nephantidis</i>
Pupal	<i>Stomatoceros sulcatiscutellum</i> <i>Trichospilus pupivora</i> <i>Brachymeria nephantidis</i> <i>Tetrastichus israeli</i>

- Bacteria like *Serratia marcescens* and *Bacillus thuringiensis* cause disease in larvae.
- Predatory carabid beetle *Parena laticincta*.
- **Root feeding technique:** A dark brown coloured root is selected for root administration of monocrotophos to the trees. The root is given a slant cut. The cut end of the root is kept in polythene bag containing 10 ml of monocrotophos mixed in 10 ml of water for plants having 15 feet height. Allow the root to absorb the chemical for 24-48 hours. If the root does not absorb the chemical change the root.
- **Note:** Before administering the chemical the mature nuts should be harvested. After root administration there should be a gap of at least 45 days for harvest of nuts.

RHINOCEROS BEETLE:**Scientific Name:** *Oryctes rhinoceros***Order:** Coleoptera

It has a wide distribution in Asia, Australia and Pacific Islands and is reported from all regions where coconut is grown. It also attacks coconut, oil palm, date palm, sugarcane, banana, sisal, pineapple, papaya *etc.*

Marks of Identification:

- Adult is a stout beetle measuring 35-50 mm in length, shiny and black above and reddish brown and hairy ventrally. On the face, beetle has a pointed horn and hence the name, rhinoceros beetle.
- The cephalic horn is longer in males than in females.
- Full grown grub is 9-10 cm long, stout, fleshy, dirty white, curved (C- shaped) with brownish head. Tail end dark, body segments wrinkled.

Nature / Symptoms of Damage:

- The beetle injures the trees by boring into the central shoots, spathes and petioles.
- The boring beetle chews the internal tissues and after ingesting the juicy part throws out the fibrous part which is indicative of the presence of the beetle in the crowns.
- The injury by the beetle is clearly.
- A series of holes on the fronds when leaf opens out and fan like cutting.
- Typical 'V' shaped clipping/ cuts on mature leaves, in partly damaged crowns.
- Death of the central growing primordium of both young and old plants in severe attack.
- Damaged palms often becoming infected by fungal rots.
- The damage caused by the beetle is more serious in young trees.

Management:

- Periodical examination of the breeding places and destruction of eggs, grubs and pupae by raking and turning up of the manure pits.
- Treating breeding places with carbaryl 50 WP 3g/l or carbaryl c10D at least once in three months *i.e.* January, April, July, August.
- Crownless trees and dead trees should be cut and dried to avoid breeding of the pest.
- Extraction of the beetle with a barbed iron hook or wire and filling up the holes with sand + lindane dust in equal proportions to prevent further attack or filling up holes with sevidol 8G 25g.
- Providing poisoned breeding traps made out of rotting mustard or castor cake or dung mixed with lindane to attract and kill beetles.

- The histerid beetle, *Santalus parallelus* is predaceous on the eggs and all stages of the grub while its grub is predaceous on the egg and first instar grub *Agrypnus sp.* predate on the grubs.
- The green muscardine fungus *Metarrhizium anisopliae* infects all stages except eggs.
- The bacteria *Serratia marcescens*, and *Pseudomonas sp.* attack the third instar grubs.
- Nematode, DD 136 or *Neoaplectana carpocapsae* and the associated bacterium *Achromobacter nematophilus* parasitize the grub.
- Release of Baculovirus infected adults.

RED PALM WEEVIL:

Scientific Name: *Rhynchophorus ferrugineus*

Order: Coleoptera

It is distributed in Pakistan, India, Sri Lanka, S.E. Asia to China, Taiwan and the Solomon islands. In India it occurs in all coconut growing tracts. It also infests oil palm, date, sago and other species of Palmae.

Marks of Identification:

- Adult is a brown weevil about 35 mm long. It has six dark spots on thorax and in the males the long snout has a tuft of hairs.
- The full grown grub is stout, fleshy, apodous.

Nature / Symptoms of Damage:

- The grubs hatched from the eggs laid in crown enter in to the growing point of the crown and cause damage.
- Yellowing and wilting leaves of inner and middle whorls.
- Presence of circular holes on the stem with brownish black viscous fluid oozing out from the holes.
- Longitudinal splitting of leaf bases and presence of cocoons or adult weevil or chewed up fibres in leaf axis or at the base of the palm.
- The sound of feeding by the grub can be heard by keeping the ear on the trunk of the tree.

Management:

- Disposal of felled trunks, tree stumps, dying and dead palms, dead plants due to lightning or bud rot.
- Avoiding wounds, mechanical injuries and stripping of leaves.
- Avoiding damage to roots and stem during cultural operation.
- Removal of rhinoceros beetle from the hole using an arrow headed rod and filling the hole with neem cake 100 g + 150 g sand to prevent weevil attack on young plants.

- Arranging bucket traps (Pheromone traps) at 1-1.5 m height on tree trunk to attract the pest and the weevils collected in the buckets destroyed or killed using poison baiting.
- The affected plant parts scraped off and swabbed with coal tar or Japan black.
- Release of sterile males to compete with the normal males to reduce the progeny.
- Chipping out the affected portions and filling with concrete mixture so that the plant can withstand strong winds.
- Earwig, *Cheliosoches moris* feeds on eggs and grubs
- Root feeding with monocrotophos 10 ml mixed with water 10 ml. (Do not harvest the nuts for the next 45 days).

SLUG CATERPILLARS:

Scientific Name: *Macroplectra nararia*

Order: Lepidoptera

- It is a sporadic pest.
- Mango, castor, cashew, pomegranate are other hosts.
- The caterpillar feeds on leaves, buds, flower shoots and developing fruits.
- Caterpillar is fleshy, slug like with series of tufts of spines highly irritating to touch, hence called “nettle grub”. Pupation takes place in hard shell like grayish cocoon.
- Clipping the affected leaves along with the larvae.
- Natural parasitisation occurs with larval and pupal parasites.
- Bacterial and fungal infections on larvae and pupae are common in rainy season.
- Spray application of carbaryl 3 g/l or root feeding with monocrotophos is effective.

TERMITE:

Scientific Name: *Odontotermes obesus*

Order: Isoptera

- Termites damage the seedlings in the nursery and transplanted seedlings.
- Wilting of central shoot is a symptom of the attack.
- Up to 20% of the seedlings are destroyed by the termites in the laterite soils.
- Base of trunk is seen plastered with runways made of soil and fibre.
- Locating termite mounds in or near the coconut nursery or garden, digging out the termitarium and destroying the queen, drenching the soil with chlorpyrifos 10 ml/l of water are effective measures.

COCONUT SCALE:

Scientific Name: *Aspidiotus destructor*

Order: Hemiptera

- Large number of scales sucks sap from undersurface of leaflets which turn yellowish, finally wither and dry up, thus reducing vitality of plant.

- Root feeding with monocrotophos after harvest of nuts, spraying with carbaryl 3g/l or dimethoate 2ml/l are effective.

COCONUT ERIOPHYID MITE:

Scientific Name: *Eriophyes guerreronis*

Order: Acarina

- It became a threat to coconut in south India causing economic losses. The microscopic wormlike eriophyid mites are seen in thousands under inner bracts of the perianth.
- They also feed in colonies on lower leaf surface causing yellow speckling and chlorosis.
- Triangular pale or yellow patches close to perianth initially at the level of perianth which turn into brown patches with longitudinal fissures and splits on the husk (warting).
- Shedding of buttons.
- Oozing of the gummy exudation from the affected surface.
- Reduced nut size and copra content.
- Malformed nuts with cracks and hardened husk.
- Application of urea 1.3 kg., super phosphate 2.0 kg and murate of potash 3.5 kg./ palm / year.
- Application of neem cake 5 kg and organic manure 50 kg / palm / year.
- Grow intercrops, banana, cacao, turmeric, vegetables in rich soils and shelter belt with casuarina all around the coconut garden to minimize the pest.
- Spraying twice at weekly interval on buttons and developing nuts on bunches with wettable sulphur 6g/l or prophanophos 5ml/l or methyl demeton 6ml/l or triazophos 5ml/l.
- Spraying azadirachtin 10000 ppm 5ml/l on fruit bunches or root feeding thrice a year with azadirachtin 10000ppm 10ml + 10 ml of water /tree.

PESTS OF BANANA

BANANA RHIZOME WEEVIL:

Scientific Name: *Cosmopolites sordidus*

Order: Coleoptera

It is distributed throughout India and is a serious pest of banana. This pest is also recorded on cacao.

Marks of Identification:

- Adult is medium sized, 10-13 mm long, stout, brown initially but turns almost black after a few days.
- Longitudinal ridges are seen on elytra and abdomen is not covered fully.
- Grub is dwarf, stumpy, legless creamy white with a red head and wrinkled body.

Nature / Symptoms of Damage:

- Grubs tunnel the rhizome, which is roughly circular and increases in size with the growth of the grubs.
- The rhizome becomes riddled with tunnels.
- The leaves turn yellow and dry.
- The tissue at the edge of the tunnel turns brown and rots.
- The grub also bores into the pseudo stem even up to 2-3' up.
- Due to the damage, the banana plants may break down when there is strong wind.
- Blackened mass of rotten tissue in which case the grub deserts the rhizome.
- The plants may show premature withering, the leaves become scarce, and the fruits become under sized.
- Very few suckers emerge from the affected plant.
- The adults also tunnel within the stem feeding on internal tissues during night.

Management:

- Obtaining suckers from healthy fields for planting.
- Clean cultivation and sanitation in the orchard.
- Dipping the suckers in methyl demeton 0.1% solution before planting.
- Avoiding ratooning and changing the field every year.
- Dusting the pits with carbaryl 10D 50g/ pit or 250 g neem cake/ pit before planting.

- Uprooting and destroying the affected pseudo stem and rhizome in which grubs are present.
- Applying contact insecticide during July - September at fortnightly intervals to prevent attack.
- Give temporary support to the plant.
- Application of phorate 10 G 10 g/ plant.
- Spraying the pseudostem and drenching around the base of the tree with chlorpyrifos 2ml /l and after a week spraying and drenching with malathion 2 ml/ l.

BANANA APHID:

Scientific Name: *Pentalonia nigronervosa*

Order: Hemiptera.

- Adult aphid is brownish with black veins on the wings.
- It lives in colonies within the leaf axils or tender leaves or at the base of the culm.
- A single female produces 35-50 nymphs during its life span of 27-37 days.
- There are four instars and each instar is completed in 2-3 days. 30-40 overlapping generations are seen in a year.
- High humidity and moderate temperature are conducive for the population increase.
- The nymphs and adults suck sap from the plant parts and in case of severe infestation progressive leaf dwarfing, leaf curling is seen.
- Fruit bunches become small and the fruits are distorted.
- These aphids also act as persistent vectors of Bunchy top of banana.
- Musa AAB variety of banana is resistant to aphids and thus resistant to Bunchy top.
- Spray application of methyl demeton 2 ml/ l or dimethoate 2 ml/l or monocrotophos 1.6 ml/ l is effective.

BANANA PSEUDO STEM WEEVIL:

Scientific Name: *Odoiporus longicollis*

Order: Coleoptera

- It is a serious pest of banana in North East India.
- Weevil is a robust reddish brown and black weevil.
- Adult feeds on tissues of leaf sheath from its inner surface and also on decaying tissues.
- Eggs are thrust singly in to the leaf sheath through oviposition slits made by rostrum.
- Egg period is 3-5 days in summer and 5-8 days in winter.
- The larva bores into the pseudostem making tunnels within and cutting holes on the outer surface.
- The tunnelled part decomposes and pseudostem becomes weak and easily breaks in wind.

- Grub is apodous, has five larval instars.
- Larval period is 26 to 68 days in summer and winter, respectively.
- Pupation occurs in stem tunnel and pupal period is 20-29 days in summer and 37-44 days in winter.
- Field sanitation, uprooting and burning infested plants.
- Foliar spray with chlorpyrifos 2.5 ml/l two to three times at three weekly intervals.
- Injection of dichlorvos 1ml/l into the bore hole are effective measures.

Nematodes: (These pest detailed under the Nematodes lecture)

PESTS OF TURMERIC

RHIZOME FLY:

Scientific Name: *Mimegralla coeruleifrons*

Order: Diptera

It is reported from Telangana, Andhra Pradesh, Kerala and Maharashtra. It also infests ginger. Flies are noticed in the field during August - September.

Marks of Identification:

- Adult flies are dark blackish. Wings are transparent with three light ashy bands. Tarsi of forelegs are white in colour.
- Maggot is creamy white, apodous and 9 mm long.

Nature / Symptoms of Damage:

- Maggots bore into the shoot causing dead hearts.
- Finally they reach rhizomes and feed on them.
- In association with *Pythium* they cause rotting of the rhizomes.
- Dead hearts due to primary injury.
- Wilting and drying of aerial plants.

Management:

- Removal of dead hearts and rotting rhizomes along with maggots after harvest.
- Treating seed material in dimethoate 2ml/l solution before planting.
- Spraying monocrotophos 1.6 ml/l or fenitrothion 2 ml/l two sprays.
- Avoiding waterlogging in the field.
- The puparia are parasitized by *Trichopria* sp.
- As soon as rotting of rhizome is noticed, application of neem cake 100 Kg/ac or carbofuran 3G 10 Kg/ac + equal quantity of sand.

TURMERIC LACEWING BUG:

Scientific Name: *Stephanitis typicus*

Order: Hemiptera

- It also infests banana, coconut, turmeric, cardamom.
- Bugs measure about 4 mm long with transparent, shiny reticulated wings and black body.
- Nymphs and adults suck sap from leaf surface causing yellowing of leaves in patches which dry and drop off.
- Black resinous excretion in tiny spots are seen between the damaged areas.

- Foliar spray with malathion 2ml/l or methyl demeton 2ml/l, or dimethoate 2 ml/l is effective.

PESTS OF ONION

ONION THRIPS:

Scientific Name: *Thrips tabaci*

Order: Thysanoptera

It infests cotton, crucifers, tobacco, tomato besides onion and garlic.

Marks of Identification:

- They are minute delicate, less than 1 mm long with fringed wings.
- Nymphs are slender and yellowish.

Nature / Symptoms of Damage:

- Both nymphs and adults suck sap from leaves.
- Silvery white blotches on leaves giving whitish appearance to the whole crop which become brownish and get distorted from tips downwards.
- Wilting and drying of crop

Management:

- Variety “Spanish White” is tolerant to thrips.
- Foliar sprays with dimethoate 2ml/l or fipronil 2ml/l + mancozeb 3g/l two or three times at 10 day interval.

RAGI CUT WORM/ LEAF EATING CATERPILLARS:

Scientific Name: *Spodoptera exigua*

Order: Lepidoptera

- It damages by defoliation. Its life history is detailed under pests of millets.
- In its management foliar sprays with carbaryl 3g/l or profenophos 2ml/l are recommended.

PESTS OF STORED GRAIN

Grain in storage is subject to depredations of insects, mites, rodents, birds and moulds of which insects account for huge losses. In India losses during post harvest handling and storage estimated at 15 % annually. FAO estimate of total world losses in storage is 10% annually. Out of total storage in India 65 to 70 % being stored at farmers level and 30 to 35 % by traders and Government agencies. Pests of stored grain causes different types of losses, namely, weight loss, food loss, quantity loss, monetary loss, loss of good will and seed loss.

Insects that damage stored grain can broadly be placed in two groups as follows Hard bodied beetles

1. Internal feeders

- Grain weevil
- Lesser grain borer
- Khapra beetle
- Pulse beetle
- Groundnut bruchid
- Grain moth

2. External feeders

- Red flour beetle
- Saw toothed beetle
- Cigarette beetle
- Rice moth

GRAIN WEEVILS:

Scientific Name of Rice weevil: *Sitophilus oryzae*

Maize weevil: *S. zeamais*
Granary weevil: *S. granarius*

Order : Coleoptea

- They are distributed worldwide and throughout India.
- All the three species are similar in appearance and found together on rice, wheat, maize and jowar.
- Among these *S. oryzae* is commonest and widely distributed and also found in paddy fields.
- Beetles are small reddish brown, dark brown or black with long slender snout. Wings have four light reddish or yellowish spots.
- Damage symptoms are hollowed out grains, kernels reduced to powder and Heating of produce.

LESSER GRAIN BORER:**Scientific Name:** *Rhizopertha dominica***Order:** Coleoptera

- This pest is original inhabitant of India, now spread to rest of world.
- It is a pest of unhusked paddy. It also causes damage to wheat, maize, sorghum, barley, dried potato, millets, tamarind, pumpkin seed, biscuits as well as broken pulses.
- Brown to blackish beetles.
- The head is deflexed downwards to such an extent that it is almost hidden in a dorsal view.
- There is a prominent constriction between prothorax and elytra. These are good fliers and migratory, spoiling more than they eat.
- Flour produced serves as feed for young grubs till they enter the grain. Antenna has a large loose three segmented club.
- Adults come out from the grain after some days leaving irregular hole. Males live for longer periods.
- After hatching, grubs feed on flour produced by the adults. Later burrows in to the slightly damaged grain. Both grubs and adults are destructive, feeding inside the grains. The free living larvae normally enter the grain after 3rd instar for pupation.
- Infestation is indicated by irregular messy waste flour spots in bagged storage, heating.
- Kernels reduced to mere shells
- The damaged kernels remain engulfed in a film of waste flour.

KHAPRA BEETLE:**Scientific Name:** *Trogoderma granarium***Order:** Coleoptera

- It is a native of India.
- It is more confined to extreme dry climate as in Punjab, Haryana, U.P., M.P. and Rajasthan.
- It is less common in coastal areas.
- It is highly destructive to wheat, also infesting maize, jowar, rice, pulses, dried fruits, oil seeds and their cakes
- Small, dark brown beetles are 2 – 3 mm long.
- There is distinct division of head, thorax and abdomen.
- Body is convex, oval in shape.
- Males are smaller, darker and incapable of flying. Adults do not cause damage.
- Being a primary pest, grub alone is destructive to grain starting with germ portion, surface scratching and devouring the grain.

- It reduces grain into frass. Excessive moulting creates public discrimination, loss of market appeal due to insanitation caused by the cast skins, frass, and hair.
- Crowding of larvae leads to unhygienic conditions in warehouses.
- Damage is confined to peripheral layers of bags or 30-45 cm in bulk storage.
- Infestation is indicated by presence of cast skins, frAss and hair on bags.
- Full grown grub is yellowish brown, with brown head, clothed with long hairs of 40 mm
- Hiding habits in cracks and crevices are most distinctive.

PULSE BEETLE:

Scientific Name: *Callosobruchus maculatus*

Order: Coleoptera

- It is a pest of gram, mung, peas, lentil, redgram, cotton seed, sorghum and maize.
- Brownish grey beetle with characteristic elevated ivory like spots near the middle of the dorsum of the body. Abdomen is conspicuously swollen. Elytra do not cover the abdomen completely.
- Every grain is infested.
- Symptoms indicative of its infestation are damaged grains present they are unfit for consumption.
- Damaged grain converted to flour by traders give off flavour.

GROUNDNUT BRUCHID:

Scientific Name: *Caryedon serratus*

Order: Coleoptera

It is of Asian origin, but has become distributed to many tropical and subtropical regions of the world. It is a large robust bruchid which is associated with groundnut when stored in their shells; it is also a pest of tamarind pods.

- The beetle has a reddish-brown cuticle densely clothed with grey-brown setae and with dark irregular markings on the elytra. The pygidium in the female is fully visible from above.
- Infestation of groundnut by the beetle is revealed by larval exit holes and presence of cocoons outside the pods.
- Damage to the seeds seen when pods are split open.

FLOUR BEETLES: **Scientific Name:** Rust red flour beetle: *Tribolium castaneum*
Confused flour beetle: *Tribolium confusum*
Order: Coleoptera

They are of worldwide distribution, commonest in wheat flour. They also feed on broken grains, milled products, dry fruits, pulses, corn flakes.

- Beetles are small, reddish brown or brick red beetles, smooth and 3.5 mm long.
- *T. castaneum*: More common with functional wings, antennae gradually thickened, 3 segmented.
- *T. confusum*: Without functional wings antennae suddenly bulged
- Both adults and larvae are incapable of feeding on sound grain. They damage milled products. Flour beetles are secondary pests of all grains and primary pests of flour and other milled products.
- In grains, embryo or germ portion is preferred.
- Flour greyish and mouldy giving disagreeable odour.

SAW TOOTHED BEETLE: **Scientific Name:** *Oryzaephilus surinamensis*
Oryzaephilus mercator
Order: Coleoptera

- The beetles are narrow, flattened measuring 2.5 to 3.0 mm long with the rax with six teeth like serrations on each side.
- Adults and larvae cause roughening of grain surface producing off odour and heating of grain.
- Grains with higher percentage of brokens and foreign matter attract heavy infestation, which leads to heating of grain. Full grown larva makes protective cocoon like covering with sticky secretion.
- Multiplication is quick in rainy season and in coastal areas.

CIGARETTE BEETLE: **Scientific Name:** *Lasioderma serricornis*
Order: Coleoptera

- It is cosmopolitan pest, also feeds on seeds, dried plant products, such as black and red pepper.
- It is a round beetle, light brown in colour.
- Head and prothorax bent down to give humped nature.
- Eggs are laid in and about the substance on which it feeds.
- Both grubs and adults bore holes into tobacco products like cigarettes, cheroots (cigars) and chewing tobacco. It also damages stuffing furniture.

- Grubs are yellowish with light brown head. Pupation is in silken cocoon covered with bits of food.

GRAIN MOTH / ANGOUMOIS GRAIN MOTH:

Scientific Name: *Sitotroga cerealella*

Order: Lepidoptera

It is distributed worldwide as a pest of paddy, maize, jowar, barley, wheat. It does not attack milled rice and other cereal products.

- Adult is buff, brown or straw coloured with narrow pointed wings, fringed with long hairs which are prominent along posterior margin.
- Small, whitish eggs are laid singly or in batches on or near grain which later turn reddish.
- Larva bores into grain, feeds inside up to 30 – 50 percent seed is damaged.
- Sometimes whole grain is damaged.
- Infestation confined to upper 30 cm depth.
- Damaged grain give out unpleasant smell.

RICE MOTH:

Scientific Name: *Corcyra cephalonica*

Order: Lepidoptera

It is distributed in Asia, N. America and Europe, pest on rice, gram, sorghum, maize, groundnut, cotton seed.

- Moth is pale buff brown coloured. Wing expanse is 25 mm, forewings with dark veins. It is bigger than other grain moths. Adult longevity is one week.
- Caterpillar alone is responsible for damage. It prefers partially damaged grains and feed. It pollutes food grains with frass, moults and dense webbing.
- In case of whole grains, kernels are bound into lumps up to 2 kg with the following grain converted to webbed mass.
- Damaged grain / flour with bad odour unfit for consumption.

MANAGEMENT OF STORED GRAIN PESTS

Preventive / prophylactic measures: Near mature crops treated with safer insecticide like malathion to prevent the transport of infestation (eggs) from field to stores.

- Threshing yards clean and away from stores.
- Gunny bags new and insect free.
- Grain dried to have less than 10% moisture, before filling in bags.
- Transport carriers free of infestation.
- Stores moisture free and rat proof.

- Before storing, cracks and crevices on walls, floor closed.
- Dirt, rubbish, sweepings removed and white washed.
- Disinfestation of stores by treating walls, dunnage, ceilings of empty godown with malathion 50 EC 1: 100 or DDVP 100EC 1: 300 @ 3 litres / 100m²(DDVP is a constant and fumigant).
- Maintenance of good storage conditions by providing dunnage, leaving gangway or alleyway of 0.75 – 1.0 mt all around for aeration, inspection and operation.
- Air charging or treating alley ways with malathion 1: 100 or DDVP 1: 300 @ 1 litre of spray fluid per 270 m³.
- Stack spraying over the bags with malathion 50 EC 1: 100 @ 3 litres/ 100m².
- Do not spray directly on food grains
- Prophylactic treatment of seeds or grains for small scale storage
 - If for seed purpose, mix 1 Kg of activated Kaoline or Lindane 1.3 D or malathion 5 D for every 100 Kg of seed, store in gunny or polythene lined bags
 - If for grain purpose, mix 1 Kg of activated Kaoline for every 100 Kg of grain and store
 - To protect pulse grains, activated kaoline or any edible oil @ 1Kg/100 kg of grain.
 - Mix neem seed kernel 1 kg for every 100 kg of cereals or pulses and store never mix synthetic insecticides with grains meant for consumption. This is legal offence.

Curative measures: Most useful and practical curative method is fumigation and fumigants. Process of applying toxins in fumes or gases to infested grains for certain period in reasonably airtight chamber or room is called fumigation. Depending upon the need, fumigation may be

- Shed fumigation
- Cover fumigation
- Fumigation in air tight containers (Choose the fumigant and work out the requirements based on the recommendation.)

Aluminium phosphide:

- For cover fumigation or air tight containers - 3 tablets of 3g each/ tonnes of grain.
- In case of cover fumigation, mud plastering and sand snakes to be used for preventing leakage of toxic gas.
- For shed fumigation – 21 tablets each weighing 3g / 28 m³
- Period of fumigation – 5 days (Other fumigants earlier used are EDB, EDB + EDCT. MBr are now banned and no longer permitted.)

- Insert required number of aluminium phosphide tablets in between bags in different layers all around stack and above the stack..
- Cover the bags immediately with fumigation cover.
- Seal it with mud or sand snakes.
- Keep the bags for 5-7 days under fumigation.
- After fumigation period, lift covers in a corner to allow residual gas to escape.
- Aerate the stocks.
- Follow similar steps to ensure leak proof conditions in shed or container fumigation.
- Fumigants have no residual effect on new immigrants, so sample periodically and fumigate stored grain based on need.
- Handle fumigants with utmost care as per specifications.
- Phosphine is a deadly poison. 3g tablets should be supplied through Govt. agencies only under close monitoring of technical personnel.
- Mechanical methods: Light traps against *Ephestia*, *Lasioderma* for monitoring and mass trapping
- Use of centrifugal force: subjecting infested commodities at a speed of 2000 – 3000 rpm kills insects.
- A device ENTOLETOR for milled products is effective.

RODENTS:

Rodents are vertebrate pests which belong to class Mammalia and have an external covering of hairs. Its order Rodentia includes a large number of animals ranging in size from the smallest mice to as large as porcupine, squirrel and beaver *etc.* Rodents are easily distinguished from other mammals by the characteristic arrangement and form of their teeth. They have only one pair of chisel shaped incisors in both the lower and upper jaws and no canines. The rodent incisors grow continuously throughout the life @ 12.5 cms/year. About 2.5% losses are caused due to rodents in storage annually. Rodents not only feed on grains but also contaminate 20 times more than what they consume with their droppings, urine, hair and even some times with their own dead bodies. Some of the important rodents species found in field and storage are discussed in this section.

- Different type of rodents in storage:
 1. House mouse
 2. House rat / common rat
 3. Larger Bandicoot / Bandicoot rat
 4. Brown rat / Norway rat / sewer rat

- Different type of rodents in storage:
 1. Indian mole rat / lesser bandicoot
 2. Soft furred field rat / grass rat
 3. Indian gerbil rat / antelope rat
 4. Indian field mouse
 5. Brown spiny mouse
 6. Coconut rat

Management of field rodents

Three basic components of IPM as in any other pest are

1. Prevention
2. Observatrion
3. Intervention

Prevention: Food and habitat manipulation is the key in preventing rodents in the field to pose any threat to field crops

- Summer ploughing
- Keep the field bunds free from weeds
- Trimming the field bunds and reducing the number of bunds as far as possible.
- Selecting uniform maturing varieties
- Uniform planting, avoiding staggered sowings / plantings
- Monitoring rodent population build up particularly after floods / natural calamities.
- Avoiding hay stacks near fileld to eliminate harbourages.
- Encouraging natural enemies (snakes, birds *etc.*,)
- Identifying species can be made by Visual observation of species Their burrowing pattern.
- Assessment of rodent population by burrow count is handy because single adult whether male or female, inhabits a burrow.
- ETLs 2% tiller damage (Rice) 15 % affected hills

Intervention:

- Setting of indegenous traps : Bow traps @ 20 – 25 / ha
- Smoking burrows with burrow fumigator (originally designed at APRII, Maruteru, AP)
- Baiting on a community approach over a large area. The baits are used like Zinc phosphide, bromadiolone.
- Fumigation with aluminium phosphide after enumeration of burrows @ 2 pellets (1.2 g) / burrow.

MANAGEMENT OF RODENTS IN STORES

- Killing by sticks
- Using traps
 - Snap neck trap
 - Live catch trap
 - Wonder trap
- Encouraging predators like cats, dogs, owls and hawks.
- Use of chronic anti coagulants like Rodafarin 'C' (solid bait) and Rodafarin 'S' (liquid bait).
- Death of rats is observed after 2.5 day of continuous feeding.
- Bromadiolone (ROBAN, MOOSH MOOSH): Single dose anticoagulant new generation rodenticide.
- Coumatetralyl (RACUMIN): new group of anticoagulant is available as loose bait or tracking powder.

BIRDS

Birds belong to the class Aves. Their body is covered with feathers. They have a unique characteristic of forelimbs modified as wings. Mouth is continued to form a beak and are homoethermous and grainivorous. About 0.85% losses are caused due to birds in storage. The damage done by birds to food grains in fields and stores is appreciable both quantitatively and qualitatively. Average consumption by birds ranges from 8 to 25 gm per day. Besides eating grain in the fields and godowns, they are also responsible for spoilage, contamination with excreta, feathers and dead bodies. Some of them are responsible for spreading diseases. They also create nuisance and unhygienic conditions in warehouses.

Some of the important birds of agricultural importance are described here below.

S.No	Common name	Scientific name	
1	Common pigeon, Blue rock –pigeon	<i>Columba livia</i>	Grainivorous, eat foodgrains in grain mandies, godowns
2	House Sparrow	<i>Passer domesticus</i>	Principally grainivorous; lives or enters house and warehouses, eat grains in open / bag storage
3	House Crow	<i>Corvus splendens</i>	Omnivorous feeding on kitchen waste to dead animals and hence considered as the best scavenger.
4	Rose ringed parakeet	<i>Psittacula krameri</i>	Normally frugivorous, attacks ripening cereal crops and foodgrains in open storage.
5	Common mynah	<i>Acridotheres tristis</i>	Damages food grains in fields and mandies but seldom enters ware-houses.
6	Baya/Weever bird	<i>Ploceus philippinus</i>	Pest of paddy grains
7	Spotted Munia	<i>Lonchura punctuata</i>	Feed on ripening paddy grains, other grass seed.

MANAGEMENT

- Habitat manipulation: trimming trees, removal of shrubs on borders reduces roosting place where birds perch/settle/sleep.
- Netting: arrangement of traps and nets for catching the birds.
- Scaring by
 - Beating empty drums
 - Mechanical bird scarers
 - Metallic ribbons
 - Pyrotechniques (art of making fire works)
 - Bioacoustics - making distress calls
 - Firing blanks with gun Throwing missiles
 - Catapulting (to shoot from a hurl)
- Destruction of eggs and nests
- Use of non toxic and sticky material like “ Lassa”
- Growing bird resistant varieties like
 - Ganga 3 in maize
 - Red sorghum
- Use of repellents like cupric oxide, methiocarb.
- Use of chemosterilants like mestranol, ornitrol, avitrol.
- Fumigation of holes
- Use of stupefying substances, immobilizers, narcotizers (Alfachloralose 1 – 2 % in bait.)

NEMATODES

Nematodes are minute worm – like animals without true body cavity and with unsegmented, bilaterally symmetrical and externally cuticularised body. In plants, they are either endoparasites or ectoparasites.

Economically important plant parasitic nematodes, their damages and management are explained in this section.

WHITE TIP NEMATODE OF RICE/ SPRING DWARF NEMATODE:

Scientific Name: *Aphelenchoides besseyi*

It is widely distributed in Tamil Nadu. Remain alive as pre adult, beneath the hull of paddy seed for two years. When seed are sown, immature forms become active and move up the plant along a thin film of moisture and feed on foliage as ectoparasites. Adults lay eggs on foliage. Larvae move to panicle when it is formed and enter grains. The symptoms are

- Leaf tips (2-5 cm) turn yellow, brown and finally turn white, dry up and hang down.
- Tips of developing leaves become twisted and crinkled.
- Kernels distorted and in severe cases it becomes chaffy.

MANAGEMENT:

- Treatment of paddy seeds with hot water at 52 – 55°C for 15 minutes.
- Seed treatment with N – 244 @ 3 ml a.i. for every litre gives 100 % control

WHEAT GALL NEMATODE/ EAR COCKLE NEMATODE:

Scientific Name: *Anguina tritici*

It is a problematic pest in all wheat growing areas of world. Second instar larva inside seed gall gets activated when sown under favourable moisture conditions and come out of the seed. Larva crawls up the plant through a thin film of moisture. It feeds on tender foliage as ectoparasite. It enters young green grain and converting it into a gall, grow and reproduce in the gall. Each female inside the gall lays hundreds of eggs, hatched out larvae remain in seed and will be viable in dry seeds for years. When those seeds are sown the cycle is repeated. The following symptoms can be seen.

- Affected plant stunted with wrinkled and twisted leaves.
- Infested grains ripen slowly, smaller in size with irregular contour.
- Whole or part of the grain converted into galls, cockles or pepper galls

Nematode infestation is associated with “Tundu disease” or “yellow slime” disease caused by a bacterium, *Corynebacterium tritici* causing rotting of spikelet with oozing of yellow slime (yellow slime disease).

This results in

- Twisting of leaves
- Distortion of ear heads
- Rotting of spikelets with profuse oozing of yellow slimy liquid.

MANAGEMENT:

- Seeds for sowing should be immersed in salt solution by dissolving 10 kg of common salt in 60 litres of water. The floating seeds should be rejected.
(or)
- Seeds pre soaked in water about 2 h and after rejecting seeds that float, (light and chaffy seeds) the remaining seeds are kept in hot water at 50° C for 2 h. Seeds treated by either of the above methods should be shade dried by spreading on floor in a thin layer
- Resistant variety is Kanred (USA).

WHEAT CYST NEMATODE:

Scientific Name: *Heterodera avenae*

It infests wheat and oats. Female encysted with tough resistant leathery wall is called is called a cyst. This encysted female is resistant to chemicals, adverse environmental conditions and will remain alive in soil even in the absence of host for years. Second stage larva enters root near tip and feeds on tissues resulting in

- Shallow root system.
- Stunted plants with chlorotic leaves.

MANAGEMENT

- Soil fumigation with DD @ 500 l / ha
- Application of carbofuran 3G @ 4 kg a.i./ha

ROOT KNOT NEMATODE:

Scientific Name: *Meloidogyne* spp.

M. incognita and *M. javanica* infest all vegetables, other crops like cotton, sugarcane, chillies, wheat, barley, tea. *M. incognita* infests brinjal, chillies, tomato and bhendi while *M. arenaria* infests chillies and tomato. Infections by this nematode lead to the invasion of pathogens like *Fusarium*, *Rhizoctonia*

Female lays 200-500 eggs in a gelatinous sac surrounding the posterior tip of female. Egg mass is seen protruding out of the galled roots. Second stage larva is slender, long and

cylindrical. After entering the roots, female larva swells up at each moult. Adult female is spherical, flask shaped. Males are slender. As a result of feeding by nematode, infested roots show

- Knot-like galls on roots.
- Stunted plants with chlorotic leaves.

MANAGEMENT

- Fallowing field in summer after 2 or 3 deep ploughings and drying
- Keeping the field in flooded condition for a few days, wherever possible.
- Ploughing nursery area and spreading paddy husk uniformly @ 20 kg/m² (about 15 cm thickness), burning it and ploughing back facilitates production of nematode free seedlings.
- Crop rotation with mustard
- Application of chopped leaves of Pongamia and Crotalaria reduces disease severity.
- Preplant soil fumigation with DD mixture.
- Nursery treatment with carbofuran 3G @ 65 g/m² and in main field carbofuran 3G @ 4 kg a.i./ha is effective.
- Resistant varieties in tomato are nematox, neared, SL 120, Ronita, NTR – 1 and Pelican.

CITRUS NEMATODE:

Scientific Name: *Tylenchulus semipenetrans*

It infests many species of citrus and related genera, in all citrus growing areas. Females are swollen, sac like, remain attached to roots with head region buried in tissues.

Damage results in

- Drying of apical leaves, buds, twigs downward- known as die back.
- Trees show reduced vigour, gradual reduction in yield.

MANAGEMENT

- Selection of planting material from nematode free nurseries.
- Application of neem or castor cake @ 15 kg / tree
- Application of carbofuran 3G @ 50 g / tree and watering.
- Avoiding brinjal, tomato and tobacco as intercrops in citrus gardens which are nematode prone.
- Preplant soil fumigation with DD mixture and using clean nurse stocks.
- In infested orchards, soil drenching with DBCP (Dibromo chloro propane) is found to be effective.

BANANA BURROWING NEMATODE:

Scientific Name: *Radopholus similis*

It infests banana, coconut, rice, sweet potato, tomato, citrus, coffee, pepper, grasses and weeds.

Nematode enters root at any point, feeds on cell contents, and migrates through root tissues. Females leave numerous eggs in their trail. Cell walls dissolved and destroyed and roots are severed from plant. It is an endoparasite responsible for panama wilt of banana caused by *Fusarium oxysporum*, *F. cubens*. Nematode infections give way to pathogenic fungi, bacteria, which hasten destruction of infested root tissues. Infestation results in

- Characteristic reddish brown lesions throughout cortex.
- Reduced root system with few short stubs.
- Affected plants getting toppled.

MANAGEMENT

- Crop rotation
- Deep summer ploughing
- Selection of suckers from nematode free areas.
- Planting suckers only after trimming all the roots.
- In endemic areas, trimming rhizome and dipping in clay slurry and applying 40 g carbofuran 3G on clay slurry before planting gives effective protection.
- Application of carbofuran 3G @ 20 – 40 g/plant at the base at a depth and covering it with soil and water.