

THEORY

Distribution, host-range, bionomics, symptoms of damage and management practices for major pests of the following crops.

Cereals and Millets

1. Rice – sucking pests.
2. Rice – internal feeders.
3. Rice – foliage pests.
4. Wheat – sucking pests, internal feeders and foliage pests.
5. Millets – Sorghum.
6. Millets – Corn.
7. Millets – Pearl millet, Finger millet and Tenai.

Pulses

8. Redgram.
9. Greengram, Lab-lab.
10. Cowpea, beans, blackgram and chickpea.

Oil seeds

11. Mustard, Soybean.
12. Groundnut – foliar feeders.
13. Groundnut – subterranean pests.
14. Gingelly and Sunflower
15. Castor.

Fibre crops

16. Cotton – sucking pests.
17. Mid semester examination.
18. Cotton – bollworms.
19. Cotton – foliar feeders.
20. Cotton – stem weevil, surface and leaf weevils.

Sugars

21. Sugarcane – borers.
22. Sugarcane – sucking pests, subterranean pests.
23. Fumigatories and Masticatories – Tobacco
24. Green manure crops.
25. Forage crops.
26. Pests of stored commodities.
27. Scientific methods of storage.

28. Management of storage pests.
29. Locusts – biology, classification and management.
30. Rodents and their management.
31. Non insect pests – birds, crabs, snails.
32. Non insect pests – mites.
33. Integrated pest management case studies – rice, cotton.
34. Integrated pest management – future needs.

Lecture No. 1.

PESTS OF RICE- SUCKING PESTS

1. **Thrips**, *Stenchaetothrips biformis*, Thripidae, Thysanoptera

Symptom of attack: Affected nurseries present a **pale yellow colour with brown tips**.

On passing the wet palm over the top of the seedlings a large number of black adults and yellowish nymphs may be seen striking to the palm. The infestation invariably disappears after sharp showers.

Nature of damage: Both the adults and nymphs lacerate the tender leaves and suck up the plant sap. As a result fine yellowish lines or **silvery streaks** are seen on the leaves. Later, the leaves curl longitudinally and begin to dry from the tip downwards. In severe cases, the **entire nursery may dry up** and fail to produce seedling. Sometimes transplanted crop is also affected in the early stages.

Life stages

Egg: Eggs laid singly in the tissues of the tender leaves on the sides facing the stem.

Eggs are hyaline and turn pale yellow as they mature.

Nymph: Newly hatched nymphs are transparent but turn yellowish white after the first moult and possess darker legs, head and antennae.

Pupa: Pupation takes place inside the rolled leaves and appendages and wings are clearly visible.

Adult: Adult is 1 mm long, dark brown to black in colour with fringed wings. Male is smaller, more slender than female. It reproduces parthenogenetically since males are seldom seen in the population.

2. **Green leafhopper**, *Nephotettix virescens*, Cicadellidae, Hemiptera

Symptoms of attack: Affected plants become pale yellow in colour and get stunted in growth. If the plants are tapped large number of leafhoppers may be seen jumping to water.

Nature of damage: Both nymphs and adults **suck the plant sap** from the leaf and leaf sheath. (It is a phloem feeder. Amino acid content is high in phloem sap than xylem. The xylem and phloem vessels are plugged with their stylet sheath that causes disruption in the transport of food substances in the vessels.) Mild infestation reduces the vigour of the plant and the number of reproductive tillers. Heavy infestation causes withering and complete drying of the crop. Plants are **predisposed to fungal and bacterial infection** through feeding and ovipositional punctures. Nymphs and adults exude sticky, whitish honeydew, which attracts **sooty mould** (that reduces the photosynthetic rate). It also **transmits plant diseases** such as dwarf, transitory yellowing, yellow dwarf and rice tungro virus (Tungro is transmitted during short feeding period).

Life stages

Egg: Greenish transparent eggs are deposited in the midrib of leaf blade or sheath of rice or green grass. They are laid in batches of 10 to 15 arranged in a single row.

Nymph: The nymphs are soft bodied, yellow white in colour. Gradually the colour changes to green.

Adult: Adults are 3-5 mm long, bright green with variable black markings, wedge shaped with a characteristic diagonal movement. Male insect has a black spot in middle of the forewings that is absent in females. The insect is active during July to September.

3. **Brown planthopper/ Fulgorid**, *Nilaparvata lugens*, Delphacidae, Hemiptera

Symptom of attack: Symptoms will not be visible from outside in the early stages, but if we enter the field and tap the plants large number of this insect can be seen. They are visible only when the damage has been severe, the plants present a burnt up appearance, **hopper burn**, in circular patches.

Nature of damage: Both the nymphs and adults remain at the ground level and suck the plant sap. It is a typical vascular feeder primarily sucking phloem sap leading to **hopper burn**. At early infestation, circular yellow patches appear which soon turn brownish due to the drying up of the plants. The patches of infestation then may spread out and cover the entire field. The grain setting is also affected to a great extent. During sustained feeding, it excretes a large amount of **honeydew**. It also acts as **vector of the virus diseases** like grassy stunt, wilted stunt and ragged stunt. (Transmission of persistent ragged stunt and grassy stunt virus require more time. Sheath blight and stem rot incidence was high in BPH infested plants.)

Life stages

Egg: Eggs are laid in a group of 2 to 12 in leaf sheath (near the plant base or in the ventral midribs of leaf blades). White, transparent, slender cylindrical and curved eggs are thrust in straight-line in two rows. (They are covered with a dome-shaped egg plug secreted by the female. Only the tips protrude from the plant surface.)

Nymph: Freshly hatched nymph is cottony white, 0.6 mm long and it turns purple-brown, 3.0 mm long in the fifth instar.

Adult: Adult hopper is 4.5-5.0 mm long and has a yellowish brown to dark brown body. The wings are sub hyaline with a dull yellowish tint. It has two characteristic wing morphs: **macropterous** (long winged) and **brachypterous** (short winged). (Wing morphism is influenced by various factors *viz.*, crowding during the nymphal stage and reduction in the quality and quantity of food, short day length and low temperature, which favour macroptery)

4. **Whitebacked planthopper**, *Sogatella furcifera*, Delphacidae, Hemiptera

Symptom of attack: Heavy infestation cause outer leaves of a hill to show burn symptoms. Damage in the form of **hopperburn** appears uniformly in a rice field, whereas it appears as circular patches in the case of BPH.

Nature of damage: WBPH is more abundant during the early stage of the growth of rice crop, especially in nurseries. (It attacks less than four-month old plants in fields with standing water and shows a marked increase with the age of the crop. Rice is more sensitive to attack at the tillering phase than at the boot and heading stages.) Damage is caused through feeding and oviposition. Gravid females cause **ovipositional punctures** in leaf sheaths. Both nymphs and adults suck phloem sap causing reduced vigour, stunting, yellowing of leaves and delayed tillering and grain formation. (Rice crop fails to produce complete grains [seedless glumes] and this condition is known as *red disease* in Malaysia.) Feeding puncture and lacerations caused by ovipositor **predispose the plants to pathogenic** organisms and

honeydew excretion encourages the growth of **sooty mould**. It is **not a vector** of any viral disease.

Egg: Cylindrical eggs are laid in groups when the rice plant is small but in the upper part of the rice plant when the plant is large. (They are laid with the micropylar end protruding from the tissue, the operculum is long and narrow. The eggs in a group are not sealed together by the material secreted by female.)

Nymph: White to a strongly mottled dark grey or black and white in colour and 0.6 mm size when young. Fifth instar nymph with a narrow head and white or creamy white body. Dorsal surface of the thorax and abdomen marked with various amounts of grey and white markings.

Adult: The adult hopper is 3.5-4.0 mm long. The forewings are uniformly hyaline with dark veins. There is a prominent white band between the junctures of the wings. **Macropterous** males and females and **brachypterous** females are commonly found in the field.

5. **Mealy bug**, *Brevinnia rehi*, Pseudococcidae, Hemiptera

Symptom of attack: The infestation starts in plants one or two month after transplanting. **Stunted, circular patches** may be seen in the fields. If such plants are pulled out and teased the insects can be seen at the base of the leaves and leaf sheaths.

Nature of damage: Large number of these insects' remains inside the leaf sheaths and suck up the plant sap. The affected tillers remain stunted with yellowish curled leaves. When the attack is severe, it inhibits panicle emergence. This type of disease is called as **Soorai** disease in Tamil Nadu. The damage occurs from September. In severe cases, yield may be reduced even upto 50%.

Egg: The female lays numerous yellowish white eggs/ simply deposits nymphs in outer leaf sheaths.

Nymph: The newly hatched nymphs crowded within the waxy threads for 6-10 h before they disperse to various parts of the same plant. The pale yellowish nymph is active and crawls about the plant for a while and settled itself on the plant/ stem and turns dark yellow after a day. Body gets covered with waxy material on second day.

Adult: Nymphs and adults being wingless look alike. Females are reddish, oval, soft-bodied living in colonies inside the leaf sheath. Males are small, slender, pale-yellow, having single pair of wings and a style like process at the end of the abdomen but lack mouthparts. Males are seldom found in the colonies, so it reproduces parthenogenetically.

6. **Black bug**, *Scotinophara lurida*, Podopidae, Hemiptera

Symptom of attack: Presence of bugs at the base of the stem just above the water level. Plants stunted with reduced number of tillers; leaves turn **reddish brown and dry**.

Nature of damage: The bugs remain and feed the plant sap on the base of the plants causing stunting of plants. Leaves turn reddish brown and grains do not develop. Bugs feed on the panicles in milky stage result in brown spots or empty grains in the panicles. Heavy bug infestation may cause death to the plants and whole field appears burned called **bug burn** similar to hopper burn.

Egg: Eggs are cylindrical, greenish and laid in small groups of ten in two rows on the leaves.

Nymph: Young nymph is brown with yellowish green abdomen and a few black spots.

Adult: Adults are flat, 7-9 mm long, brownish black bugs with a prominent scutellum and pronotum having a spine on either side. It is active on the cloudy days and during night. Adults or late nymphal stage aestivate in cracks in bunds.

7. **Earhead bug/ Gundhi bug**, *Leptocorisa acuta*, Alydidae, Hemiptera

Symptom of attack: Leaves turn yellow and later rusted from tip downwards. Appearance of **numerous brownish spots** at the feeding sites / shrivelling of grains. In the case of heavy infestation, the whole earhead may become devoid of mature grains. Its presence in the field is made out by its strong smell.

Nature of damage: Both adults and nymphs do the damage. The nymphs start feeding 3 to 4 hours after hatching. They feed on the leaf sap near the tip/ on milky sap in developing spikelets at milky stage. Sucking of the milky sap causes ill-filled/ partial filled and **chaffy grains**. Serious infestation can reduce the yield by 50%. The straw gives **off-flavour** that is unattractive to cattle.

Egg: Eggs are circular, brownish seed like, 2 mm long, laid in clusters in two rows along the midrib on the upper surface of the leaf-blade.

Nymph: First instar is small, 2 mm long, pale green in colour, which grows to deepen green through different instars.

Adult: Adults are greenish yellow, long and slender, above ½ inch in length with a characteristic buggy odour.

8. **Earhead stink bug/ Shield bug/Red spotted bug**, *Menida histrio*, Pentatomidae, Hemiptera

Symptom of attack: Small dot like discoloration on the grains.

Nature of damage: Both adult and nymph suck the sap/ milk of developing rice grain and cause **pecky rice**. (Grain discoloration is caused by subsequent infections of pathogenic fungi or bacteria on the sucking injuries and such grains are called as pecky rice). Sucking of this pentatomid bug causes comparatively small dot like discolorations on the grain than by *L. acuta*.

Egg: Eggs are laid in masses of 2-6 on leaves.

Nymph: Nymphs are dark brown.

Adult: It is a small brown bug with red and yellow spots.

Minor pests

1. White leafhopper, *Cofana spectra*, Cicadellidae, Hemiptera
2. Nama vandu/ Stripped bug, *Tetroda histeroides*, Pentatomidae, Hemiptera
3. Blue leafhopper, *Empoasca nana* spp., Cicadellidae, Hemiptera
4. Zigzag leafhopper, *Recilia dorsalis*, Cicadellidae, Hemiptera

I. BORERS

1. Paddy stem borer, *Scirpophaga incertulas*, Pyraustidae, Lepidoptera

Symptoms of attack: A number of stem borer moths seen dead and floating on the water in the fields. In the vegetative stage, dead hearts seen in the affected tillers and in the reproductive stage, white ear may be seen.

Nature of damage: The insect may start attacking the plants in the nursery especially long duration varieties. The incidence is mild in the season June to September, but later on gets intensified from October to January and February. The caterpillar enters the stem and feeds on the growing shoot. As a result the central shoot dries up and produces the characteristic **dead heart**. The tillers may get affected at different stages. When they are affected at the time of flowering the earheads become chaffy and are known as **white ear**.

Egg: Eggs are creamy white, flattened, oval and scale like and laid in mass. Each egg mass consists of 15-80 eggs and covered with buff coloured hairs. Before hatching, the eggs darken to a purplish tinge. They are laid mostly near the tip of the leaves.

Larva: The hatched larvae move downward and wander about on the plant for 1 or 2 hours. They may hang down by a silken thread and get to other plants with the help of the wind. They can also swim over the water and reach other tillers. They enter the leaf sheath and feed upon the green tissues of the stem for 2-3 days. Then they bore into the stem near the node. Deposition of silica in the epidermal layer of the stem and leaf sheath acts as an obstacle to the first instar larvae to chew up a hole. Generally only one caterpillar is seen inside a tiller. It may come out and attack fresh tiller. The full-grown caterpillar measures about 20 mm, white or yellowish white in colour with a conspicuous prothoracic shield.

Pupa: Pupation takes place inside the rice stem, straw or stubble. Before pupation it makes an exit hole in the internode and covers it with a thin web for the adult to come out later. The anterior extremity of the cocoon is tubular and attached to the exit hole and to make the cocoon waterproof the larva weaves two horizontal septa in this tubular area.

Adult: They exhibit remarkable sexual dimorphism. The female moth is bright yellowish brown with a black spot at the centre of the forewing and a tuft of yellow hairs at the anal region. The male is small in size and brownish.

2. Paddy gall midge, *Orseolia oryzae*, Cecidomyiidae, Diptera

Symptom of attack: The central shoot instead of producing leaf produces a long tubular structure. When the gall elongates as an external symptom of damage, the insect will be in pupal stage and ready for emergence.

Nature of damage: The maggot bores into the growing point of the tiller and causes abnormal growth of the leaf sheath, which becomes whitish tubular and ends bluntly. It may be pale green, pink or purplish. Further growth of tiller is arrested. This is called **onion shoot**, **silver shoot** or **anaikomban**. The feeding by the maggot and the larval secretion, which contains an active substance called **cecidogen**, is responsible for cell

proliferation of the meristematic cells and gall formation. It is a pest in irrigated and wet season crop. Tillers in 35 to 53 days old crops are preferred.

Egg: The fly lays elongate, cylindrical, shining white or red or pinkish eggs singly or in clusters (2-6) at the base of the leaves.

Maggot: Maggot is 1 mm long after hatching with pointed anterior end. It creeps down the sheath and enters the growing bud. An oval chamber is formed round the site of feeding.

Pupa: At the time of emergence the pupa wriggles up the tube with the help of antennal horn to the tip of the silver shoot and projects half way out.

Adult: The adult fly is yellowish brown and mosquito like. The male is ash grey in colour. Adults feed on dewdrops.

Lecture No. 3.

RICE DEFOLIATORS

1. **Swarming caterpillar:** *Spodoptera mauritia*: Noctuidae: Lepidoptera

Symptom of attack: Nurseries found completely eaten away by the caterpillars' overnight.

Nature of damage: Caterpillars march in large numbers in the evening hours and feed on the leaves of paddy seedlings till the morning and hide during daytime. They feed gregariously and after feeding the plants in one field march onto the next field. Under severe infestation crop gives the appearance of **grazed plants**. Attacked plants are reduced to stumps. Nurseries situated in ill-drained marshy areas attacked are earlier than dry ground. Damage is severe during July to September.

Egg: Eggs are spherical and creamy in colour, which are laid in a group covered over with grey hairs.

Larva: The caterpillars are light green with yellowish white lateral and dorsal stripes in the early stages and later become dark brown or grayish green in colour with a crescent (semi-circular) shaped black spot on the side of each segment.

Pupa: They pupate inside the soil in earthen cocoons. Pupa is dark brown and measures 16-17 mm long.

Adult: The adult moth is medium sized, stout built dark brown with a conspicuous triangular black spot on the forewings. Hind wings are brownish white with thin black margins.

2. **Rice case worm:** *Nymphula depunctalis*: Pyraustidae: Lepidoptera

Symptom of attack: Plants stunted, caterpillars hanging on the leaf edges in a **tubular case**.

Nature of damage: The caterpillar cuts a piece of leaf, rolls it longitudinally into a tubular structure and remains inside. It feeds by scraping the green tissue of the leaf. The cases often float in the water. Its damage can be distinguished from damage by other pests in two ways, firstly the **ladder like appearance** of the removed leaf tissue resulting from the back and forth motion of the head during feeding and secondly the **damage pattern is not uniform** through out the field because the floating cases are often carried in the run off water to low lying fields where the damage is more concentrated.

Egg: Eggs are light yellow, disc like, smooth and irregular in shape. They are laid on the under side of the leaves floating on the water.

Larva: They hatch into green caterpillars with orange brownish head. Each caterpillar lives inside a tubular case and hang down the leaves. The tubular cases are open at one end. The inside of the case is lined with silk to hold a thin film of water, which is essential for respiration and preventing desiccation of the larvae. The cases are replaced with each moult. It moves up and down with the protruded legs and scrapes the green matter. It drops in the water when disturbed. It is semi aquatic and can breathe by filamental gills at the sides. Full-grown caterpillars measure upto 15 mm length.

Pupa: It pupates inside the leaf case. Fresh pupae are milky white, which gradually turn to light yellow.

Adult: The adult is a small delicate moth having white wings speckled with pale brown wavy markings. Females are larger than males. Egg laying takes place in the night.

3. **Rice skipper**: *Pelopidas mathias*: Hesperidae: Lepidoptera

Symptom of attack: Leaves folded longitudinally and **scrapped patches** in such places.

Nature of damage: The caterpillar folds the leaves and feeds from inside. It feeds on the parenchyma and leaf gets reduced to skeleton. Occurs in the nursery and planted crop. Not a serious pest.

Egg: Eggs are laid on the leaves.

Larva: The caterpillar is elongate, yellowish green with four white dorsal stripes, smooth and with a constructed neck and red 'V' mark on the head, which is distinct.

Pupa: Pale green pupa has white longitudinal lines on it and is attached to the leaf blade by a silk girdle.

Adult: The adult is a dark brown skipper butterfly with two white spots on the wings.

4. **Leaf folder/ roller**: *Cnaphalocrocis medinalis*: Pyralidae: Lepidoptera

Symptom of attack: Leaves folded longitudinally or transversely with silk and scrapped patches in such places.

Nature of damage: Larvae remain inside the fold and scrapping off green portion of the leaves leaving white patches.

Egg: Flat oval yellowish eggs laid singly or in pairs on the undersurface of tender leaves.

Larva: Larva is yellowish green in colour and translucent about 16-20 mm long.

Pupa: It pupates inside the fold.

Adult: Adult is small yellow coloured moth with dark wavy lines on both pairs of wings.

5. **Rice horned caterpillar**: *Melanitis ismene*: Nymphalidae: Lepidoptera

Symptom of attack: Defoliated leaves. It is a minor pest.

Nature of damage: The larva feed on the paddy leaves at night, remaining inactive during daytime.

Egg: Eggs are white, round laid singly on the paddy leaves.

Larva: Larva is green in colour with roughened skin, flattened dorsally and has a dark brown head with a pair of red horn like processes and two yellow processes in the anal end. It feeds on the leaves.

Pupa: Dark green chrysalis hangs from the leaf and is attached to the leaf blade by its anal extremity.

Adult: The butterfly is dark brown with large wings having a few black and yellow eye-like markings one on each of the forewings and six ocellar spots on hindwings.

6. **Yellow hairy caterpillar**: *Psalis pennatula*: Lymantriidae: Lepidoptera

Symptom of attack: Defoliated leaves. It is a minor pest.

Egg: Eggs are laid in batches on the leaves covered with yellow hairs.

Larva: The caterpillar is yellow with red stripes and an orange head. Tufts of hairs are found all over, of which two in the anterior region and one in the posterior region are prominent.

Pupa: Pupation is in a yellowish cocoon of hairs on the leaves.

Adult: Moth is light yellow with bipectinate antenna.

7. **Grass hoppers** : *Hieroglyphus banian* (Large grasshopper)

Oxya nitidula (Small grasshopper) : Acrididae: Orthoptera

Symptom of attack: The nymphs and adults nibble leaves and also earheads in the early stages.

Nature of damage: Both the adults and nymphs feed on the leaf and in severe cases the entire leaf may be eaten away. It is capable of causing severe damage. In the earhead stage the adults nibble at the tender florets or grain or into the base of the stalks causing white ears.

Life stages *H. banian* has only one brood in a year. *O. nitidula* breeds throughout the year. Egg: It lays eggs in the wet sandy soil during October to November at a depth of about 2" especially in the side of bunds. The eggs are laid in batches of 30-40, hatch only in June to July on receipt of the monsoon rains. Eggs are yellowish and covered with gummy substrate that hardens into a waterproof coating.

Nymphs: The nymphs feed on the grasses or paddy

Adult: They grow into adults by August to September. *H. banian* measures about 1½ inches long. There are three transverse dark lines on the prothorax, which is helpful for identifying the pest. *O. nitidula* is about one inch long and has a longitudinal brown streak on either side of the thorax.

8. **Spiny beetle/ Rice hispa**: *Dicladispa armigera*: Chrysomelidae: Coleoptera

Symptom of attack: The mining of the grubs will be clearly seen on the leaves. White parallel line will be clear on the leaves.

Nature of damage: The grub mines into the leaf blade and feed on the green tissue between the veins. Adults also feed in the green tissue; they scrape the green matter of the tender leaves. Generally the plants are affected in the young stage.

Egg: Eggs are laid inside minute slits on the tender leaves generally toward the tip.

Grub: The grub is whitish yellow and flattened. It feeds inside the leaf tissue by mining. It pupates inside.

Adult: The adult beetle is somewhat square shaped about 1/6 to 1/8" in length and width. Dark blue or blackish in colour with spines all over the body.

9. **Whorl maggot**: *Hydrellia sasakii*: Ephydriidae: Diptera

Symptoms of attack: Presence of feeding lesions in the lines and the infested plants become stunted.

Nature of damage: The maggots are found to feed on the unopened leaves and to nibble the inner margins of the leaves, which showed conspicuous feeding lesions in the lines. Damaged leaves became distorted and broke-off in the wind. Infested plants are stunted. It cause damage to the boot leaf and developing panicles, which resulted in

producing only partially filled/ half filled grains. Small puncture appear in the middle of the flag leaf and its margin get discolored.

Egg: White, cigar shaped egg laid singly on either side of the leaves.

Grub: Newly hatched larva is transparent to very light cream in colour but later become yellow. The larvae move down the leaf into the whorl on a film of dew and feed within developing whorls. The larvae mostly remain outside the leaves and feed on the mesophyll tissue of the foliage. When leaves emerge from the whorl damage can be seen as pinholes in the leaves and white and yellowish lesions on the leaf edge.

Pupa: Pupation takes place in between the leaf sheath where the pupa is loosely attached to the stem. The puparium is light to dark brown ovoid and sub-cylindrical in shape.

Adult: Adult dark grey flies, 1.8-2.3 mm in size.

10. **Blue beetle**: *Halticia cyanea*: Chrysomelidae: Coleoptera

I. BORERS

1. **Shoot fly:** *Atherigona varia soccata*: Anthomyiidae: Diptera.

Symptom of attack: Dead hearts or drying of central shoots or production of profuse side tillers in main plants.

Nature of damage: The maggots bore into the shoot of young plants, a week after germination to about one month and as a result the central shoot dries up. If the plants are attacked at the initial stages the mother plant may produce profuse side tillers, but the tillers also may be attacked. The infestation often goes as high as 60%. The high yielding hybrid varieties are severely attacked. In South India, crop is damaged during October to December as also in summer.

Egg: Whitish eggs are laid singly on the under surface of the leaves which are about one week old.

Maggot: The maggots are yellow in colour migrate to the dorsal surface of the leaf, enter the space between the leaf sheath and the axis and make a clear cut through the tightly rolled sheaths and damages growing point. The growing points of the plant die and decay on which the maggots feed.

Pupa: Pupation takes place inside the stem itself.

Adult: The adult is a small dark fly. Female fly has whitish grey head and thorax, while the abdomen is yellowish with paired brown patches. Male is darker in colour.

2. **Stem borer:** *Chilo partellus*: Crambidae: Lepidoptera

Symptoms of attack: Presence of circular holes on the unfolded leaves and dead hearts in the early stages are the main symptoms. The boreholes may be visible in contrast to the dead heart caused by the stem borer. When grown up plants are attacked the symptoms will not be quite visible.

Nature of damage: The caterpillar bores into the stem and feeds on the central shoot. There may be more than one caterpillar in a single plant. In early stages, the caterpillars make circular holes on unfolded leaves and later central shoot dries up producing dead heart. Later it acts as an internode borer and is found till the time of harvest. Young cobs may also be attacked. Yield is affected much and the quality of the fodder is also reduced. The damage caused to the crop by this pest was estimated to range between 70 - 80%. Egg: Eggs are yellowish in colour, flat and oval, laid on the underside of the leaves, near the midrib.

Larva: The larva is pale white with black dots and brown head. The newly hatched caterpillars migrate to the top of the plant and enter the stem or it mines in the midrib or bores into the stem near the node and feeds upwards. The larvae remain dormant in winter and hibernate. A caterpillar is dirty white with a brown head and thorax. There are four longitudinal stripes on its dorsal surface.

Pupa: Pupation takes place inside the stem.

Adult: Moth is medium sized and straw coloured. Male has pale brown forewings provided with dark brown scales forming a dark area along the coastal margin. Hind

wings are light straw light straw in colour. Female possesses forewing of a lighter colour and nearly white hind wings.

3. **Pink Stem borer** : *Sesamia inferens*: Noctuidae: Lepidoptera

Symptom of damage: Presence of dead heart.

Nature of damage: The young larvae after hatching, congregate inside the leaf whorls and feed on folded central leaves causing typical 'pin hole' symptoms. Severe feeding results in killing of the central shoot and consequent dead heart formation. Usually the second instar larvae migrate to neighbouring plants by coming out from the whorls and suspending themselves from the plants by silken threads, these are then easily blown off by wind to other plants. These larvae penetrate in the stem and cause tunneling resulting in stunting, infested plants become weak and bear very small earheads. The weakened stems, especially of tall local varieties, break easily during heavy rains or with high velocity winds.

Egg: Creamy white spherical eggs are laid in batches in between leaf sheaths and stem of a plant.

Larva: The larvae penetrate the stems directly and may kill the young plants. The fully developed caterpillar is cylindrical, pinkish dorsally and whitish ventrally. Larvae can migrate from plant to plant.

Pupa: Pupation occurs inside the stem, pupae are robust and light brown in colour.

Adult: Adults are stout, straw coloured and are nocturnal in habit.

II. LEAF FEEDERS

5. **Slug caterpillar**: *Thosea apierens*: Cochlididae: Lepidoptera

Symptom of attack: Defoliation.

Nature of damage: They feed on the leaves and defoliate. Apart from this they cause lot of irritation on the people who work in the field. Harvest is made difficult and it is reported the even cattle do not relish the fodder.

Life stages: Slug is found to appear in a severe form in Coimbatore.

6. **Leaf roller**: *Marasmia trapezalis* : Pyralidae: Lepidoptera

Symptom of attack: Rolled up leaves in which the larvae are found feeding and longitudinal patches on leaves whose tips dry are the clear symptoms.

Nature of damage: The leaf roller becomes quite serious on young crops and feeds on the leaf epidermis. It causes longitudinal patches on the leaves and the tips of the leaves dry up. It is only a minor pest and rarely becomes serious. The varieties with broad leaves are attacked more severely.

Egg: Eggs are laid on young leaves.

Larva: A caterpillar is greenish yellow and is provided with setae over its body. Head and thoracic shield are brownish in colour. When full grown the caterpillar measures about 20 mm.

Pupa: Pupation takes place within the rolled leaf.

Adult: Adults are grayish with shining coloured patterns. Anal margins are darker in colour.

7. **Flea beetle:** *Cryptocephalus schestedti* : Chrysomelidae: Coleoptera

Monolepta signata: Chrysomelidae: Coleoptera

Symptom of attack: Shot holes.

Nature of damage: The pest occurs in small number is feeding on the leaves. It nibbles small holes on the leaves.

Life stages: *C. schestedti*: This is an yellow beetle with long black streak. *M. signata*: Adult is a black beetle with four yellow spots.

III. SAP FEEDERS

8. **Shoot bug :** *Peregrinus maidis* : Delphacidae: Hemiptera

Symptom of attack: The leaves turn yellow due to sucking; plants become weak and the yield goes down. The mid rib of the leaves become red due to egg laying and may dry up subsequently.

Nature of damage: Both adults and nymphs suck the plant sap from the leaves and cause the shoot to dry. They feed gregariously within the leaf sheaths. It is not a serious pest, but sometimes causes appreciable damage.

Life stages: It is a small active, grayish brown bug. Colonies of this bug (both adults and nymphs) live within the whorl of the central leaf or in the root region. This pest is very common in Coimbatore during summer. The large black ant attends these insects.

9. **Plant lice:** *Rhopalosiphum maidis*, *Longinuis sacchari* : Aphididae: Hemiptera

Nature of damage: Nymphs and adults suck plant sap from the leaf, leaf sheath and inflorescence. They occur in cluster and may cause severe damage to inflorescence by hampering pollination. The aphid colony secretes honeydew in plenty.

Life stages: The former one is yellow with dark green legs and lives inside the central leaf. The latter is creamy and lives on the under the surface of lower leaves. These are not serious pests. Reproduction parthenogenetic. Cloudy and humid weather favours reproduction.

10. **Earhead bug:** *Calocoris angustatus* : Miridae: Hemiptera

Symptom of damage: No external symptom will be visible. The earheads should be tapped either on the palm or a piece of cardboard. A number of brownish or greenish nymphs and adults can be seen. On the developing grains small brownish spots will be visible. In severe infestation, the grains get shriveled without maturing and the earheads appear uneven.

Nature of damage: The adults and nymphs live inside the earhead and suck the milky fluid from the tender ripening grains. Due to the feeding, the grains get shriveled and chaffy and thus unfit for sowing and for consumption. No damage is caused to fully ripened grains. A reduction of 15 – 30% in the yield was estimated due to its attack. Usually high yielding varieties with compact earheads (Chitrai cholam) are subjected to more infestation than the loose earheads.

Egg: The female bug thrusts shining pale yellowish cigar shaped eggs into the tender tissues of the shoot between glumes in the centre of the florets.

Nymph: The newly hatched nymphs have light orange red abdomen, which changes to green in the advanced instars.

Adult: The adult is a slender green elongate bug about 1 cm long and active flier.

11. **Mirid bug**: *Creontiades pallidifer*: Miridae: Hemiptera

Nature of damage: It is a minor pest. Nature of damage is similar to earhead bug.

12. **Sorghum midge**: *Contarinia sorghicola*: Cecidomyiidae: Diptera

Symptoms of attack: The flowers appear damaged; earheads are devoid of grains and during severe attack, may appear blighted.

Nature of damage: This fly attacks the developing grains. The larvae develop by feeding inside the grains. This results in the failure of grain formation causing them to shrivel during serious infestation the entire earhead may appear to be blighted or blasted. This pest is a minor pest and assumed major pest status after the introduction of CSH 1 hybrid cholam.

Egg: Eggs are laid inside the glumes of closed or open flowers.

Maggot: The newly hatched maggot feed on the ovaries. The advanced stage larvae are pink in colour.

Pupa: pupate inside the damaged flowers.

Adult: The midge is a tiny (2 mm long) pinkish coloured fly.

13. **Gram caterpillar**: *Helicoverpa armigera*: Noctuidae: Lepidoptera

Nature of damage: Caterpillars feed on the grains at the time of maturity causing considerable damage.

14. Other pests

Red hairy caterpillar: *Amsacta albistriga*: Arctiidae: Lepidoptera

Angoumois grain moth: *Sitotroga cerealella*: Gelechiidae: Lepidoptera

Cryptoblabes sp.: Pyralidae: Lepidoptera

Flower webber: *Eublemma silicula*: Noctuidae: Lepidoptera

Dolichoris indicus:

Nezara viridula: Pentatomidae: Hemiptera

These pests are found on the earheads in the milky stage. The injury is only very little.

Lecture No. 5. PESTS OF FINGER MILLET, MAIZE AND TENAI

FINGER MILLET

1. Pink borer, *Sesamia inferens*, Noctuidae, Lepidoptera

Symptom of damage: Deadheart.

Nature of damage: Larva congregate inside the leaf whorls and feed on the central leaves causing typical 'pin hole' symptom. Severe feeding results in drying of the central shoot and results in dead heart formation.

Egg: Creamy white spherical eggs laid in batches in between leaf sheaths and stem of the plant.

Larva : Pinkish brown with a reddish brown head.

Pupa: Brown, obtect pupa, pupates inside the stem.

Adult: Straw coloured moth with forewings having 3 black spots and a faint brown mid-stripe with white hindwings.

2. White borer, *Saluria inficita*, Phycitidae, Lepidoptera

Symptom of damage: Deadheart.

Nature of damage: Larva found at the base of tillers close to soil level and attack the basal parts of the plants.

Larva: Creamy white with yellow head.

Pupa: Brown, obtect type, pupates inside the stem.

Adult: Small moth with dark brown forewings bearing a white band along the anterior margin and white hindwings.

3. Cutworm, *Spodoptera exigua*, Noctuidae, Lepidoptera

Symptom of damage: Defoliation in the nursery.

Nature of damage: Larva feed on leaves especially in the nursery. Larvae hide in the soil during daytime and feed on leaves at night.

Egg: Lays cluster of eggs on the lower portion of young plants.

Larva: Brownish green with wavy lines in dorsal surface and lateral yellow stripes.

Pupa: Pupates in the soil in earthen cocoons.

Adult: Brown moth with white hindwings.

4. Black hairy caterpillar, *Estigmene lactinea*, Arctiidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Larva feeds on the leaves.

Egg: Eggs are laid on the plants.

Larva: Thick with black head and hairs all over the body.

Pupa: Pupates in soil.

Adult: Large white moth with crimson markings on head, body and wings.

5. Flea beetle, *Chaetocnema pusaensis*, Alticidae, Coleoptera

Symptom of damage: Shot holes in the leaves of young plants.

Nature of damage: Adult bites and makes holes in the leaves of young plants and affects their vigour both in the nursery and in the young transplanted crop.

Adult: Dark blue beetle with enlarged hind femur.

6. Wingless grasshopper, *Neorthacris simulans*, Acrididae, Orthoptera

Symptom of damage: Defoliation.

Nature of damage: Nymph and adult defoliate the crop.

Adult: Greenish brown colour with a red stripe on the sides; without wings.

7. Aphid, *Schizaphis graminum*, Aphididae, Hemiptera

Symptom of damage: Yellowing of leaves and presence of ants.

Nature of damage: Nymph and adult suck the sap.

Adult: Greenish yellow aphids.

8. Aphid, *Hysteroneura setariae*, Aphididae, Hemiptera

Symptom of damage: Presence of colonies of aphids on leaves and ears.

Nature of damage: Nymph and adult suck the sap.

Adult: Brown coloured aphids.

9. Whitegrub, *Holotrichia consanguinea*, Melolonthidae, Coleoptera

Symptom of damage: Death of grown up plants. Leaves and tender shoots nibbled.

Nature of damage: Grub feed on the root and rootlets, results in the death of the plants.

Adults nibble on the leaves and tender shoots. They can move under soil, thus can migrate from one plant to another.

10. Root aphid, *Tetraneura nigriabdominalis*, Aphididae, Hemiptera

Symptom of damage: Wilting and drying of plants in patches. Presence of black ants, *Camponotus compressus*, around the base of the plants.

Nature of damage: Nymph and adult attack underground parts of the plants, they suck sap from roots. Plants become weak and may wilt.

Nymph and Adult: Pinkish globular aphids.

11. Aphid, *Rhopalosiphum maidis*, Aphididae, Hemiptera

12. Ash weevil, *Mylloceris* spp., Curculionidae, Coleoptera

MAIZE

1. Stem fly, *Atherigona orientalis*, Muscidae, Diptera

Symptom of damage: Dead heart.

Nature of damage: Maggot.

Adult: Small grey coloured fly.

2. Corn worm/ Earworm, *Helicoverpa armigera*, Noctuidae, Lepidoptera

Symptom of damage: Damage on grains and presence of broken grains in the earhead.

Nature of damage: Feeds on silk and developing grains.

3. Cutworm, *Agrotis ipsilon*, Noctuidae, Lepidoptera

Symptom of damage: Cutting of tender stem and defoliation.

Nature of damage: Larva defoliates the crop.

Larva: Greasy to touch; coil up at the slightest touch. Blackish brown with red head, greyish green laterally with dark stripes.

Adult: Stout moth with brownish forewings with wavy lines and spots; hindwings hyaline.

4. Phadka grasshopper, *Hieroglyphus nigrorepletus*, Acrididae, Orthoptera

Symptom of damage: Leaves defoliated from the margin; plants often bared.

Nature of damage: Nymph and adult feed on the leaves and shoots.

Egg: Gravid female trails its abdomen on the ground searching for a soft moist spot. It drills a hole with its ovipositor, inserts the abdomen with ovipositor, secretes a fluid and lays the eggs one by one. The fluid hardens into a capsule or egg-pod containing 30-40 eggs.

Nymph and Adult: Have green and brown forms, the brown being the most common form. Both have a conspicuous irregular black dorsal pronotal stripe. Adults mostly brachypterous.

5. Stem borer, *Chilo partellus*, Crambidae, Lepidoptera

6. Pink stem borer, *Sesamia inferens*, Noctuidae, Lepidoptera

7. Webworm, *Cryptoblabes gnidiella*, Pyraustidae, Lepidoptera

8. Cutworm, *Mythimna separata*, Noctuidae, Lepidoptera

9. Cutworm, *Spodoptera exigua*, Noctuidae, Lepidoptera

10. Ash weevil, *Myloccerus* spp., Curculionidae, Coleoptera

11. Leaf hopper, *Pyrilla perpusilla*, Lophopidae, Hemiptera

12. Aphid, *Rhopalosiphum maidis*, Aphididae, Hemiptera

13. Shoot bug, *Peregrinus maidis*, Delphacidae, Hemiptera

Lecture No. 6.

PEARL MILLET AND ITALIAN MILLET

1. Shoot fly, *Atherigona approximata*, Muscidae, Diptera

Symptom of damage: Dead hearts in young plants; corkscrew or chaffy grains in the upper portion and well-developed grains in the lower portion of earhead in mature crop.

Nature of damage: Maggot damages the growing point and causes 'dead heart'. It injures the leaf blades as well as the young shoots and tillers. It also infests the peduncle of earhead at the time of emergence from boot-leaf, preventing seed setting at advanced stage of crop growth.

Egg: Eggs are laid on the shoots near the soil surface.

Maggot: White cylindrical maggots.

Pupa: Pupa brown colour, pupates inside the stem. S

Adult: Greyish white fly.

2. Earhead midge, *Geromyia penniseti*, Cecidomyiidae, Diptera

Symptom of damage: Grainless glumes with white pupal case attached to the tip of the spikelet.

Nature of damage: Maggot attacks developing grains and feed on the ovaries. As a result of their feeding grain formation is affected and in case of heavy infestation entire head appear to be aborted.

Egg: Eggs are laid singly or in pairs in spikelets and may be found sticking to glumes.

Maggot: White cylindrical maggots.

Pupa: Pupa brown colour pupates inside the spikelet.

Adult: Light pink, fragile fly.

3. Leaf beetle, *Lema downsei*, Galerucidae, Coleoptera

Symptom of damage: Whitening and drying of leaves leading to burnt up appearance.

Nature of damage: Grub and adult scrape the green matter of leaves in rainfed crop causing whitening and ultimate drying.

Egg: Eggs laid singly on the leaf tissue.

Grub: Whitish with a black head, swollen humped body and has the habit of carrying its faecal matter dorsally.

Pupa: Pupation takes place inside the soil.

Adult: Straw coloured beetle.

4. Root grub, *Arthrodeis* sp., Tenebrionidae, Coleoptera

Symptom of damage: Yellowing and gradual wilting of entire plants.

Nature of damage: Grubs feed on the roots of rainfed crop.

Adult: Black coloured shiny beetle.

5. Red hairy caterpillar, *Amsacta albistriga*, Arctiidae, Lepidoptera

6. Black hairy caterpillar, *Estigmene lactinea*, Arctiidae, Lepidoptera

7. Wingless grasshopper, *Neorthacris simulans*, Acrididae, Orthoptera

8. **Ash weevil**, *Myloccerus* spp., Curculionidae, Coleoptera
9. **Pink stem borer**, *Sesamia inferens*, Noctuidae, Lepidoptera
10. **Semilooper**, *Antoba silicula*, Noctuidae, Lepidoptera
11. **Stink bug**, *Nezara viridula*, Pentatomidae, Hemiptera
12. **Stink bug**, *Dolycoris indicus*, Pentatomidae, Hemiptera

ITALIAN MILLET

1. **Stem borer**, *Anadastus parvulus*, Languriidae, Coleoptera

Symptom of damage: Scrapped leaves, plants wither and in severe cases.

Nature of damage: Grubs bore into the stem and cause withering of plants. Adult beetle scrapes green matter on the leaves.

Grub: Yellowish with chitinous spines on the surface of the anal segment.

Adult: Small smooth beetle with red head and thorax and blue wings.

2. **Stem fly**, *Atherigona destructor*, *A. atripalpis*, Muscidae, Diptera

Symptom of damage: Dead hearts in young plants.

Nature of damage: Maggot

Adult: Small grey coloured fly.

3. **Black bug**, *Scotinophara lurida*, Podopidae, Hemiptera
4. **Earhead bug**, *Leptocorisa acuta*, Alydidae, Hemiptera
5. **Ash weevil**, *Myloccerus* spp., Curculionidae, Coleoptera
6. **Shoot bug**, *Peregrinus maidis*, Delphacidae, Hemiptera

Lecture No. 7. PESTS OF PULSES- REDGRAM AND CHICKPEA

BORERS

1. Gram pod borer, *Helicoverpa armigera*, Noctuidae, Lepidoptera

Symptom of damage: In the early stages, plants seen defoliated. Boreholes seen on the pods and affected pods have no seeds.

Nature of damage: Young larva feeds on tender leaves, buds, flowers, and subsequently it bores into the pods and feeds on the seeds with its head and part of the body only thrust inside, the rest remaining outside. A single larva may destroy 30-40 pods before maturity.

Egg: Spherical in shape with a flattened base, giving dome shaped appearance, surface is sculptured in the form of longitudinal ribs. Yellowish-white, glistening and change to dark brown, before hatching.

Larva: Newly hatched caterpillar is sluggish and whitish-green in colour. Full-grown larva is 3.5-4.0 cm in length with pale-green body colour. However, the colour varies according to the food intake. Dorsal surface bears dark broken stripes. Head is reddish-brown. Larva is highly cannibalistic and readily eats one another.

Pupa: It pupates in soil in earthen cell. Pupa is obtect type. Freshly formed pupa is greenish yellow in colour and darkened prior to emergence of moths.

Adult: It is a medium-sized light brown coloured moth. On the forewings, there is speck that forms a V-shaped mark. Hind wings are dull grey coloured with a black border on the distal end. Female moth is bigger than male and presence of tuft of hairs on the tip of the abdomen.

2. Blue butterfly, *Lampides boeticus*, Lycaenidae, Lepidoptera

Symptom of damage: Bore holes on buds, flowers, green pods and matured pods.

Nature of damage: The larva bores into the buds, flowers and green pods just within couple of hours after hatching and feeds inside the developing grains.

Egg: Eggs are laid on the buds, flowers, green pods and on shoot and leaves. Greenish white in colour, round in shape with a slight depression at the top.

Larva: Newly hatched larva is yellowish green in colour with black head and a dark-brown patch on the prothorax and cylindrical body with scattered hair. Full-grown larva is yellowish green to yellowish red sometimes light purple in colour, ventral surface is light green. Whole larva is covered with small setae and marked with irregular black markings. It looks like a slug. Brownish mid-dorsal and yellowish lateral lines are well marked.

Pupa: Pupa are green in colour later on it darkens and wings are also visible.

Adult: It is medium sized butterfly. The colour of the wings is violet metallic blue to dusky blue. The tail of hind wings is black and tipped with white. The female is slightly bigger than the male. In males, the abdomen is slender and tapering, while in female it is long and broader at the tip.

3. Gram blue butterfly, *Euchrysops (Catochrysops) cnejus*, Lycaenidae, Lepidoptera

Symptom of damage: Presence of regular, big, circular borehole on the flowers and pods. Presence of flat slug like green coloured larva on affected flowers or young pods. Black ants hovering around the plants.

Nature of damage: Larva bores into the buds, flowers and green pods and feeds inside the developing grains.

Egg: Laid on flower buds, green pods, shoots and leaves.

Larva: Flat, slug like, green or yellowish green, red coloured mid stripe and few hairs.

Pupa: Pupates in soil or on the plants

Adult: Blue coloured butterfly having five black spots on the dorsal surface of the hind wing and two black spots on the ventral surface.

4. Plume moth, *Exelastis atomosa*, Pterophoridae, Lepidoptera

Symptom of damage: Pods are scrapped in the early stages, later boreholes seen on the pods and seeds eaten away.

Nature of damage: Young larvae bore into the unopened flower buds for consuming the developing anthers. Grown up larvae first scrap the surface of the pods and then bore into pods. The larvae never enter the pod completely.

Egg: Minute eggs laid singly on young pods, flower buds or tender leaves.

Larva: Full-grown caterpillar is 1.3 cm in length, greenish-brown in colour and fringed with hairs and spines.

Pupa: Pupates on the pod surface or in the entrance hole itself. Pupa looks like larva.

Adult: It is lightly built and light brown in colour, wings deeply fissured, the forewings longitudinally cleft into two plumes and hind wings into three plumes. Forewings are extremely elongate. Legs are long and slender. Abdomen is dark-brown in colour.

5. Spotted pod borer, *Maruca testulalis*, Pyraustidae, Lepidoptera

Symptom of damage: Presence of semi-solid excreta at the junction of the borehole. Young shoot with dried tip, large scale dropping of flowers. Larva present inside the webbing of leaves, flowers and young pods, faecal material accumulates outside the borehole.

Nature of damage: It feeds on the seeds by boring into the pods.

Egg: Laid on or near the flower buds.

Larva: Light green with brown head and four pairs of black warts present on the dorsal surface of each segment, which form four black longitudinal lines on the body with short dark hairs.

Pupa: Pupates inside the affected pods or leaf fold in a thin silken cocoon. Pupa is yellow with greenish body.

Adult: Dark brown with a white cross band in the middle of the forewings and the hind wings are white with a darker border.

6. Spiny pod borer, *Etiella zincknella*, Phycitidae, Lepidoptera

Symptom of damage: Entrance hole in the green pod disappears and leaves little evidence that the pod is infested. In pods, the larva devours many seeds. The pod always contains a mass of frass and held together by a loosely spun web.

Nature of damage: Young larva bores into floral parts, making rough and irregular incision.

Egg: Laid singly or in small groups on immature pods either along the midrib or on the calyx. Freshly laid eggs are glistening white and adhere securely to whatever they touch.

Larva: Dorsal surface of mature larva is reddish pink, while the pleural and ventral surfaces of the body are pale-green or creamy-white.

Pupa: Light green in colour changes to light brown or amber. Pupates in the ground at a depth of 2 to 4 cm.

Adult: Greyish brown moth, distinct pale-white band along the costal margin of the forewings, hind wings are semi-transparent with a dark marginal line. Orange coloured prothorax.

7. Field bean pod borer, *Adisura atkinsoni*, Noctuidae, Lepidoptera

Symptom of damage: Affected pods and flowers have irregular bore holes.

Nature of damage: Young larva bores into floral parts and pods and feeds on it.

Egg: Small, spherical, laid singly on tender pods or buds.

Larva: Robust, green, resemble gram pod borer except for the presence of dark brown lateral stripe on each side and the humped segment.

Pupa: Pupates in soil or on flower spikes

Adult: Yellowish has light brownish forewings with V-shaped specks and pale brown markings on hind wings.

8. Redgram podfly/ 'Tur' podfly, *Melanagromyza obtusa*, Agromyzidae, Diptera

Symptom of damage: Shriveled pods and seeds. Damaged seeds become unfit for consumption and also do not germinate. However, the attack of the fly remains unnoticed by the farmers due to the concealed mode of life of this insect within the pods.

Nature of damage: Young maggot attaches itself on the immature seed inside the pod. In the beginning it feeds on the surface and thereafter mines into seeds and makes galleries just under the seeds epidermis, causing a ring like track. (One seed is enough for the development of a maggot. It never leaves the pod in which it enters once and completes its maggot stage)

Egg: Freshly laid eggs are white, broad and round at its posterior end which is embedded in the tissues of the pod and narrowed anteriorly into a somewhat elongated egg sheath.

Maggot: Freshly hatched maggot is white with dark-brown mouth hook. Full-grown maggot is cylindrical in shape and is narrower at the head end, which bears black mouthparts. It is creamy white but acquires a yellowish tinge just before pupation.

Pupa: Pupation takes place in hard chitinous puparium, which is found sticking to the side of pod or in the groove eaten into the grain by the larva. It is cylindrical with broadly rounded ends. Fresh pupa is yellowish white, but becomes darker subsequently.

Adult: It is slightly bigger than the male. Its wings are also slightly broader. Colour of a newly emerged adult is dull-white and smoky patches at places, but gradually it acquires the normal black colour with slight bright greenish tinge. Abdomen is glossy black, but in some cases it is slight bronzy, while in other cases it has a greenish-blue background.

9. Stem fly, *Ophiomyia phaseoli*, Agromyzidae, Diptera

Symptom of damage: Drooping of the tender leaves and yellowing characterize serious damage of young plants. The sites where maggot and pupae are present become swollen and start rotting. Older plants show stunting but are not usually killed.

Nature of damage: Maggot is the damaging stage. It mines sub-epidermally through the leaves. Plants are most seriously affected at the seedling stage, where stem is tunneled.

Egg: Eggs are laid inserted under the epidermis on the under surface of the leaves. Eggs are elongate, oval and white in colour with a smooth and transparent surface.

Maggot: Light yellow-coloured maggot moves in the leaf and then bores deeper into the stem. It travels downwards in the young plants. In older plants, the maggots do not move much. It cuts an exit hole in the stem for the adult before pupation.

Pupa: Pupation takes place in the underground portion in the young plants, whereas in the older plants, it is usually in the main stem or branches.

Adult: Light brown when freshly emerged, but fully developed adult is metallic-bluish or greenish-black in colour with light brown eyes. Wings are transparent. Female is slightly bigger than the male.

FLOWER FEEDER

10. Blister beetle, *Mylabris pustulata*, Meloidae, Coleoptera

Symptom of damage: Presence of blister beetles on the flowers. The adult beetles feed on flowers, leaves and tender panicles, thus preventing grain formation.

Nature of damage: These beetles are diurnal and general feeders.

Egg: Eggs laid on the ground or in the soil.

Larva: First stage larva is 'triungulins' (long-legged) and actively searches for the host. They moult to become eruciform or caraboid. (Hypermetamorphosis)

Pupa: Pupates in the soil.

Adult: Medium sized, 12.5-25.0 mm long. Conspicuous in appearance and are moderately robustly built. Beetles are bright metallic blue, green, black and yellow or brown in colour.

11. Flower webber, *Eublemma hemirrhoda*, *Eublemma silicula*, Nocutidae, Lepidoptera

Symptom of damage: Webbing of flowers.

Nature of damage: Larva webs the flowers on the inflorescence in greengram, blackgram and cowpea, and feeds on them.

Larva: Green with a black head and long white hairs on the body.

Pupa: Brown coloured, obtect type.

Adult: Moth has forewings with yellow and purple patches and white hind wings.

OTHER PESTS

12. Chafer beetle, *Oxycetonia versicolor*, Cetonidae, Coleoptera

13. Pod wasp, *Tanaostigmodes cajaninae*, Tanaostigmatidae, Hymenoptera

SAP FEEDERS

1. Bean aphid, *Aphis craccivora*, Aphididae, Hemiptera

Symptom of damage: Presence of aphid colonies on the leaves, terminal shoots and pods. In severe cases, the plants wither and vigour reduced.

Nature of damage: Colonies of nymphs and adults found on leaves, terminal shoots and pods and such the plant sap. Vector of stunt disease in chickpea, rosette of groundnut. Serious pest when the rainfall is low.

Nymph: Newly laid nymph is translucent with reddish brown compound eyes. After a couple of minutes changes to light yellow. After about 30 minutes, the nymph starts moving and in an hour starts feeding.

Adult: Apterous females are shiny, dark brown or black. Alate forms are greenish black with transparent wings.

2. Thrips, *Ayyaria chaetophora*, Thripidae, Thysanoptera

Symptom of damage: Leaves mottled with characteristic silvery on lablab, green gram, black gram and cowpea.

Nature of damage: Nymphs and adults suck the plant sap.

Adult: Tiny yellow fringe winged adults.

3. Whitefly, *Bemisia tabaci*, Aleyrodidae, Hemiptera

Symptom of damage: Yellowing of leaves, plant vitality reduced, development of sooty mould, plant dies in case of severe attack.

Nature of damage: Nymphs and adults suck the plant sap and also transmits yellow mosaic virus (YMV).

Egg: Stalked, sub-elliptical, light yellow at first, and turning brown later on. Eggs laid singly on adaxial (lower) side of leaves.

Nymph: Elliptical on emergence, soon they fix their mouthparts into the plant tissues and feed on the cell sap. Greenish yellow, oval on undersurface of leaves.

Adult: Small with yellow body covered with white waxy bloom.

4. Green leafhopper, *Empoasca kerri*, *Empoasca binotata*, Cicadellidae, Hemiptera

Symptom of damage: Affected leaves turn pale and then rust-red. They curl downwards; in severe cases, show 'hopper burn' symptom, dry and fall to the ground.

Nature of damage: Nymphs and adults suck the sap and inject toxins.

Egg: Yellow, laid on the underside of the leaf, embedding them into the leaf veins.

Nymph: Wedge-shaped, very active, suck cell sap from underside of the leaves

Adult: 3 mm long, greenish yellow during the summer acquiring a reddish tinge in the winter. Adults move briskly, forward and laterally and jump or fly away at slight disturbance and attracted to light at night.

5. Pod bug, *Riptortus pedestris*, *Clavigrella horrens*, *Clavigrella gibbosa*, *Anoplocnemis phasiana*, Coreidae, Hemiptera

Symptom of damage: Nymphs and adults cause substantial damage to pods and also to stem, leaves and flower buds. Attacked pods show pale-yellow patches. When the attack is heavy, the pods shrivel up. The grains in the attacked pods remain shriveled and extremely small.

Nature of damage: Both the nymphs and adults cause damage by sucking juice. The pest assumes serious proportions on the pods before the maturity of the crop.

Egg: Freshly laid eggs are flat dorsally and round in shape dull white brown in colour. Eggs are laid in cluster of 3-15.

Nymph: Newly hatched nymphs are reddish in colour and in the latter instars it changes to greenish-brown.

Adult: *R. pedestris*: Slender elongated, dark brown coloured bug with two black bands on ventral side of the abdomen. *C. horrens*: Robust, greyish brown in colour with spines at the anterior margin of the prothorax. *C. gibbosa*: Greenish-brown in colour, 2 cm in length, with spines on either side of the middle of the prothorax. Female bug is bigger and has a round and swollen abdomen in comparison with a narrow and pointed abdomen of the male. *A. phasiana*: Biggest of all the bugs with swollen curved hind legs.

6. Lablab bug/ Stink bug, *Coptosoma cribraria*, Coremelanidae, Hemiptera

Symptom of damage: Bugs cluster on the plant parts.

Nature of damage: Nymphs and adults infest tender shoots and pods of lab-lab, redgram, cowpea, greengram and blackgram.

Adult: Small, sub-globular, greenish brown stink bug with characteristic buggy odour.

LEAF FEEDER

7. Leaf webber, *Eucosma critica*, Eucosmidae, Lepidoptera

Symptom of damage: During vegetative stage of the crop, the caterpillar damages leaves by webbing, while at the floral stages of the crop they enter the buds, flowers and pods and feed on the immature seeds.

Nature of damage: Young larva gets itself concealed into the frass produced during the course of scratching. The grown-up larva then draws the two leaves together and spins a thread between them, in which it passes later instar and also pupates.

Egg: Oval, creamy white in colour, laid singly in leaves, petioles or stem.

Larva: Young larvae are pale-yellow in colour, moderately stout, smooth, except for a few short scattered hairs. It hibernates in larval form.

Pupa: Yellowish in colour, gradually turn to light-brown and finally to dark brown. Pupates in thin papery white silken cocoon.

Adult: Dusky brown with forewings having four black dots and a silvery transparent mark

8. Leaf folder, *Anticarsia irrotata*, Noctuidae, Lepidoptera

Symptom of damage: Leaves folded together.

Nature of damage: Larva folds the leaf and remains inside the fold and defoliates it.

Larva: Green coloured.

Pupa: Green coloured, obsect type.

Adult: Yellowish brown moth with an oblique black line on the wings.

9. Lab-lab leaf miner, *Cyphosticha coerulea*, Gracillariidae, Lepidoptera

Symptom of damage: Leaves with large irregular papery mines on the dorsal surface.

Larva: Orange coloured caterpillar.

SUBTERRANEAN PEST

10. Termites/ White ants, *Odonototermes* sp., Termitidae, Isoptera

Symptom of damage: They live underground, but make small earthen mounds or earthen passages that are visible above the ground. On opening a portion of an earthen passage, greyish white and wingless insects are seen moving towards or away from the centre of their nest, where the queen of the colony resides.

Nature of damage: Termites generally damage the crop soon after germination and in subsequent growth stages. The damaged plants dry up completely and are easily pulled out.

OTHER PESTS

11. Leafhopper, *Empoasca kerri*, *E. binotata*, Cicadellidae, Hemiptera

12. Redgram scale, *Ceroplastodes cajani*, Coccidae, Hemiptera

13. Redgram leaf roller, *Caloptilia soyella*, Gracillariidae, Lepidoptera

14. Leaf eating caterpillar, *Azazia rubricans*, Noctuidae, Lepidoptera

15. Sphingid caterpillar, *Acherontia styx*, Sphingidae, Lepidoptera

16. Leaf cutter bee, *Megachile antracena*, Megachilidae, Hymenoptera

Lecture No. 10. PESTS OF OILSEEDS - MUSTARD

MUSTARD

1. Mustard aphid, *Lipaphis erysimi*, Aphididae, Hemiptera

Nature of damage: Suck the sap from under surface of leaves.

Nymph: Light yellowish green in colour and pear shaped.

Adult: Darker than nymph.

2. Mustard sawfly, *Athalia lugens proxima*, Tenthredinidae, Hymenoptera

Nature of damage: Grub nibbles the margins of tender leaves and pod.

Larva: Resembles lepidopterous caterpillar; oily black or green in colour.

Adult: Adult with dark head and thorax and orange colour abdomen and translucent smoky wings with black veins.

3. Painted bug, *Bagrada hilaris*, Pentatomidae, Hemiptera

4. Leaf miner, *Chromatomyia horticola*, Agromyzidae, Diptera

5. Bihar hairy caterpillar, *Spilosoma oblique*, Arctiidae, Lepidoptera

6. Flea beetle, *Phyllotreta cruciferae*, Alticidae, Coleoptera

7. Diamond back moth, *Plutella xylostella*, Plutellidae, Lepidoptera

Lecture No. 11. PESTS OF OILSEEDS - GROUNDNUT

LEAF FEEDERS

1. Red hairy caterpillar, *Amsacta albistriga*, Arctiidae, Lepidoptera

Symptom of damage: Defoliation

Nature of damage: All the leaves are eaten away by the larvae leaving the main stem alone. Larvae are voracious feeders. During severe attack, the caterpillars move in groups destroying field after field.

Egg: Light yellow spherical eggs are laid in clusters on the undersurface of the leaves.

Larva: Hairy caterpillar reddish brown with black band on either end having long reddish brown hairs all over the body.

Pupa: Reddish brown and elongate remains under soil for 9-10 months. Adults emerge after receiving the first monsoon showers.

Adult: Forewing white with brownish streak all over and yellowish streak along the anterior margin and head; hindwings white with black markings.

2. Leaf miner/ Surul poochi/ soybean leaf miner, *Aproaerema modicella*, Gelechiidae, Lepidoptera

Symptom of damage: Brown blotches in midrib; terminal leaflets with white patches; webbed together, distorted and finally get dried up.

Nature of damage: Minute larvae wander briefly and they mine into the leaves and eat the green matter of the leaves. Later they web several leaves together and feed inside the enclosed space thus formed.

Egg: Laid on the leaves and shoots.

Larva: Small, green in colour with dark head and prothorax.

Pupa: Reddish brown. Pupa is formed inside the mines.

Adult: Dark brown moth with a white spot on the costal margin of each forewing.

3. Tobacco caterpillar, *Spodoptera litura*, Noctuidae, Lepidoptera

Symptom of damage: Skeletonization, defoliation.

Nature of damage: Early instar larva remain gregarious and cause skeletonization. Later instar cause defoliation.

Egg: Yellow in colour, laid in mass and covered with hairs.

Larva: Pale greenish with dark markings; gregarious in the early stages.

Pupa: Brown colour, oblong pupa.

Adult: Moth with wavy white markings on a brown forewing. Hindwings white with a brown patch along the margin.

4. Gram pod borer, *Helicoverpa armigera*, Noctuidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Larvae feed on the leaves irregularly.

Lecture No. 12. PESTS OF OILSEEDS - GROUNDNUT

SUBTERRANEAN PESTS

5. Stem borer, Ver poochi, *Sphenoptera perotetti*, Buprestidae, Coleoptera

Symptom of damage: Branches may droop and the plants show wilting and may die when the grubs reach the root.

Nature of damage: Grubs tunnel the stem just below the soil surface and main roots, tunnel containing elongate flat-headed grubs.

Life stages

Egg: Small flat oval eggs laid on the main stem of the plants.

Grub: Slender pale whitish with flattened anterior portion, called 'flat-headed grubs'.

Pupa: Pupation occurs inside burrows (tunnels) from which the adult beetles emerge by cutting their way out.

Adult: Dark brown, shiny beetle, jewel like and small (1 cm) beetle.

6. White grub, *Holotrichia* spp., Melolonthidae, Coleoptera

Symptom of damage: Wilting of plants in patches. Wilted plants do not have taproot and rootlets.

Nature of damage: Both the grubs and adults do the damage. The grubs feed on the root and rootlets. Adult beetles feed on the foliage and are capable of defoliating plants and even trees like neem, banyan. Feeding is carried out during the night.

Egg: Laid in loose moist sandy or sandy-loam soil on the onset of monsoon.

Grub: White coloured.

Pupa: Exarate pupa.

Adult: Large-sized, copper coloured, nocturnal beetles. Adults remain at a depth of 10-20 cm and come out during the night for feeding. Diapause occurs from November to June.

7. Termite, *Odontotermes obesus*, Termitidae, Isoptera

Symptom of damage: Wilting of plants in patches. Taproots of wilted plants penetrated; bore holes in pods. Damage to soft tissue in pod (scarification) leaving thicker portion intact. Termites found hovering in and around plants.

Nature of damage: Adults feed on the taproots and pods.

Adult: Cream coloured tiny insects resembling ants with dark coloured head.

8. Pod borer (Earwig), *Euboriella* (= *Anisolabis*) *stali*, Forficulidae, Dermaptera

Symptom of damage: Young pods showing bore holes plugged with excreta, sand particles or discoloured pulps; pods without kernels.

Nymph: Nymph white in early stages and later turn brown.

Adult: Dark brown to black with forceps like caudal cerci and white leg joints.

9. Pod bug, *Elasmolomus sordidus*, Lygaeidae, Hemiptera

Symptom of damage: Freshly harvested pods having shrivelled kernels.

Nature of damage: Nymphs and adults suck oil from the kernels of mature pods especially after harvest making them unfit for use. Bug hides within rubbish heaps of semi-dry leaves.

Nymph: Pinkish in colour.

Adult: Dark brown bugs.

10. Millipede, *Spirostreptus* sp., Spriostreptidae, Spirostreptidae

Symptom of damage: Empty pods with hole.

Nature of damage: Young one and adult bores into soil attack developing pods and eaten away internal kernel.

Adult: Elongated body with annular ring-like segments with two pairs of legs in each segment, brown in colour.

SAP FEEDERS

11. Aphids, *Aphis craccivora*, Aphididae, Hemiptera

Symptom of damage: Wilting of tender shoots during hot weather. Leaves mottled with chlorotic or dark green spots and plants stunted.

Nature of damage: Nymphs and adults suck the sap from tender shoots. Vector of groundnut rosette. In cowpea and blackgram it can transmit yellow mosaic.

Nymph and Adult: Reddish to dark brown coloured aphids.

12. Leafhopper, *Empoasca kerri*, Cicadellidae, Hemiptera

Symptom of damage: Tip yellowing in leaves in the form of 'V' shape later turn brown, dry and brittle, called 'hopper burn'. Also cause distortion and whitening of veins, leaf curling and plants stunted.

Nature of damage: Nymphs and adults suck the sap from leaves and thus reducing plant vitality and yield. Attack the crop upto one month.

Egg: Eggs are inserted in the leaf tissue (vein).

Nymph and Adult: Elongate, active wedge shaped green insects found on the under surface of leaves.

13. Thrips, *Caliothrips indicus*, Thripidae, Thysanoptera

Symptom of damage: Older/lower leaves showing white spots/marks or streaks intermingled with black excreta on the upper surface.

Nature of damage: Nymphs and adults suck the sap from tender shoots.

Nymph and Adult: Dark blackish brown with fringed wings. Forewings have three pale white coloured bands.

14. Thrips, *Scirtothrips dorsalis*, Thripidae, Thysanoptera

Symptom of damage: Tender leaves showing yellowish green patches on the upper surface and brown necrotic areas and silvery sheen on the lower surface.

Nature of damage: Nymphs and adults suck the sap from tender shoots.

Nymph and Adult: Creamy to white nymph and black adult.

15. Thrips, *Frankliniella schultzei*, Thripidae, Thysanoptera

Symptom of damage: Young/ terminal leaves showing white scars, transmit bud necrosis.

Nature of damage: Nymphs and adults suck the sap from tender shoots.

Nymph and Adult: Yellowish nymph and black adult

Lecture No. 13. PESTS OF GINGELLY AND SUNFLOWER

GINGELLY

1. Leaf webber, Leaf roller, Sesame webworm, Til leaf roller, Simsim webworm, pod caterpillar, *Antigastra catalaunalis*, Pyraustidae, Lepidoptera

Symptom of damage: Top leaves rolled and webbed together and damaged in vegetative phase; flowers and young capsules bored at reproductive phase.

Nature of damage: Larvae start attack from 15th day of sowing. In 1st instar stage, acts as *leaf miner*, in later stage, comes out of the mine and acts as *webber* by webbing the top leaves or tip of shoot, by remaining within epidermis results in drying of webbed portion. When the flowers are formed, it bores into flowers and feeds on reproductive parts. When capsule formed, it acts as *capsule borer*. By suitably adjusting its feeding habit, it attacks throughout the crop period. Pest is active during rainy season.

Egg: Eggs are oblong, shining pale green, laid singly on the tender leaves or flowers at night.

Larva: Dirty white with dark prominent head. Grown up larva are greenish white in colour with black warts and fine hairs all over the body. Hibernates as caterpillar within pods.

Pupa: Pupates in silken cocoon under fallen leaves or in soil crevices. Pupa is slender, greenish brown in colour.

Adult: Forewings are reddish-yellow colour with zigzag indistinct reddish decorative markings on them; hindwings are pale yellow and rather transparent.

2. Gall fly, *Asphondylia sesami*, Cecidomyiidae, Diptera

Symptom of damage: Gall formation.

Nature of damage: Maggots feed on floral parts and cause malformation like galls (tumors) on the buds, which fail to develop.

Egg: Eggs laid singly on buds, flowers and capsules.

Maggot: White, found inside the flowers.

Pupa: Pupation occurs inside the galls.

Adult: Minute sized flies with bright coloured wings bearing superficial resemblance to mosquitoes.

3. Sphinx, Death's head moth, hawk moth, *Acherontia styx*, Sphingidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Massive larva is voracious feeder on leaves defoliating the whole plant.

Egg: Large yellowish eggs are laid singly on leaves.

Larva: Stout, sturdy and greenish with dark green or yellow oblique lines on its sides also decorated with pleasant mixture of soft colours; measures 90-100 mm long and 12-15 mm broad and bears a curved caudal horn.

Pupa: Pupates in soil.

Adult: Large, robust, greyish brown insect, which is an active flier. Forewings have dark-brown and grey patterns with dark wavy markings and a prominent yellow spot

on each wing while the hindwings are ochre background with black border and few black spots, two dark brown wavy broad cross strips. Wingspan is about 10 cm. The thorax bears a prominent Death's head mark. Abdomen is ochraceous in general hue with dark-brown cross bands.

4. Leaf hopper, *Orosius albicinctus*, Cicadellidae, Hemiptera

Symptom of damage: Phyllody.

Nature of damage: Vector of sesamum phyllody.

Adult: Light brown coloured hoppers.

5. Aphid, *Aphis gossypii*, Aphididae, Hemiptera

6. Stink bugs, *Eusarcocoris ventralis*, Pentatomidae, Hemiptera

7. Stink bugs, *Nezara viridula*, Pentatomidae, Hemiptera

8. Stink bugs, *Dolycoris indicus*, Pentatomidae, Hemiptera

9. Lygaeid bug, *Aphanus sordidus*, Lygaeidae, Hemiptera

10. Lygaeid bug, *Nysius inconspicuus*, Lygaeidae, Hemiptera

SUNFLOWER

1. Capitulum borer, *Helicoverpa armigera*, Noctuidae, Lepidoptera

Nature of damage: Feeds on capitulum and leaves.

2. Tobacco caterpillar, *Spodoptera litura*, Noctuidae, Lepidoptera

3. Black hairy caterpillar, *Estigmene lactinea*, Arctiidae, Lepidoptera

4. Bihar hairy caterpillar, *Spilosoma oblique*, Arctiidae, Lepidoptera

5. Ash weevil, *Mylloceris* spp., Curculionidae, Coleoptera

6. Stink bug, *Nezara viridula*, Pentatomidae, Hemiptera

7. Stink bug, *Dolycoris inidcus*, Pentatomidae, Hemiptera

8. Peach leaf curl aphid, *Brachycaudus helichrysi*, Aphididae, Hemiptera

9. Compositae tingid, *Cadmilos retiarus*, Tingidae, Hemiptera

CASTOR

1. Shoot and capsule borer, *Conogethes* (= *Dichocrocis*) *punctiferalis*, Pyraustidae, Lepidoptera

Symptom of damage: Capsules with bore holes, damaged capsules webbed together, peduncle and capsules show galleries made of silk and frass.

Nature of damage: In early stage, larvae are present at junction of the petiole feed on petiole and young leaves. They also bore into capsule and peduncle.

Egg: Eggs are laid on tender parts of plants.

Larva: Pale greenish with pinkish tinge, black blotches and fine hairs with dark head and prothoracic shield.

Pupa: Pupation takes place in cocoons of silk, inside the stem or capsule.

Adult: Yellowish with black spots on both pair of wings.

2. Castor semilooper, *Achaea janata*, Noctuidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: First instar larva nibbles on the leaves while the second instar makes holes and late instars eating the leaves completely. Caterpillars destroy leaves, bark and capsules. Moths suck citrus fruit, so called fruit sucking moth, doing great damage to citrus.

Egg: Eggs laid in batches of six on both surfaces of the leaves.

Larva: Slender and of varied colour with longitudinal stripes of red and white on the body. Body colour changes to velvety black. It has a pair of reddish anal processes. Caterpillar walks with a semi looping motion.

Pupa: Pupates in loosely threaded silken cocoon, on the ground amongst wrapped up leaves.

Adult: Adult moths are stout bodied and of a fairly large size. Forewings are pale-reddish brown. Hindwings possess a medially white patch and three large white patches on the outer margin on a black background.

3. Semilooper, *Parallelia algira*, Noctuidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Larva feeding on castor leaves.

Egg: Eggs are laid singly on leaves.

Larva: Olive green with numerous longitudinal lines.

Pupa: Pupation in soil or in leaf folds.

Adult: Forewing with white band, hindwing with a white median band and grey outer margin.

4. Castor slug caterpillar, *Latoia* (= *Parasa*) *lepida*, Cochlidiidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: The slug-caterpillars feed on the leaves. When they are young they remain in clusters and feed by scrapping the green matter of the leaves on the underside. Affected leaves may dry.

Egg: Eggs are flat and shining, laid in batches of 20-30 on the lower surface of leaves.

Larva: Young caterpillars remain gregarious on the lower surface of the leaves and scrape the green matter. A caterpillar is fleshy with yellowish-green body bearing a greenish blue stripe it is called blue-striped nettle grub. There are six rows of spiny scoli on the dorsal surface while the ventral body surface is flat. The spines are highly irritating to touch.

Pupa: Pupation takes place on the tree trunk in a hard shell-like, elliptical, greyish to chocolate-brown cocoon. Pupal body is flat on the ventral surface and convex dorsally.

Adult: Moth is short and stout. Wings are greenish in colour fringed with brown patches along the margins.

5. Tussock caterpillar, *Notolopus (=Orygyia) postica*, Lymantriidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Caterpillars of the moth feed on the leaves.

Egg: Eggs are laid in clusters on the leaves and covered over with hairs.

Larva: Caterpillars are gregarious in young stages. Full grown larva possess a brown head, a pair of long pencil of hairs projecting forwardly from the prothorax, yellowish tuft of hairs arising from the lateral side of the first two abdominal segment and long brownish hairs arising from 8th abdominal segment.

Pupa: Pupation takes place in silken cocoon.

Adult: Small adult with yellowish brown wings. Female moth is wingless. Presence of bipectinate antenna.

6. Hairy caterpillar, *Euproctis fraterna*, Lymantriidae, Lepidoptera

Symptom of damage: Defoliation

Nature of damage: Caterpillars feed on the leaves.

Larva: Full grown larva has red head and dark reddish brown body completely covered with white hairs and a single tuft of hairs in the head and pre-anal segment.

Pupa: Pupation takes place inside the plant in a yellowish cocoon.

Adult: Medium sized, yellowish colour with pale transverse lines and three black spots on the border of the forewings.

7. Hairy caterpillar, *Porthesia (=Euproctis) scintillans*, Lymantriidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Caterpillars feeds on the leaves.

Larva: Larva has yellowish brown head with middle red and lateral yellowish stripes on the body. There are tufts of black hairs on the segments between the true legs and prolegs.

Pupa: Pupates in a yellowish silken cocoon.

Adult: Small, yellow moth with reddish tinge and two lighter lines and spots on the border.

8. Hairy caterpillar, *Dasychira mendosa*, Lymantriidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Caterpillars feed on the leaves.

Larva: Larva is greyish brown in colour with dark prothoracic and pre-anal tuft of hairs.

Tip of prolegs are crimson coloured.

Pupa: Pupates in a yellowish silken cocoon.

Adult: Bigger, yellowish brown moth with bulged abdomen.

9. Castor butterfly, Spiny caterpillar, *Ergolis merione*, Nymphalidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Caterpillars lie on the upper surface of the leaf. It feeds from margin and cause defoliation.

Life stages

Egg: Sculptured eggs laid singly on the leaves or in groups of 3-11.

Larva: Green body covered with branched hairs and yellow stripe on dorsal side.

Pupa: Brownish chrysalis pupa.

Adult: Brown colour adult with black wavy lines on wings.

10. Woolly bear, *Pericallia ricini*, Arctiidae, Lepidoptera

Symptom of damage: Defoliation

Nature of damage: Caterpillar feeds on the leaves.

Larva : Robust, greyish black or blackish brown larva with red head and thick tuft of hairs are arising from the body.

Adult: Greyish brown or black colour and black spots on wings. Hindwings are pink or red colour with black spots.

11. Whitefly, *Trialeurodes ricini*, *T. rara*, Aleyrodidae, Hemiptera

Symptom of damage: Yellowing and development of sooty mould.

Nature of damage: Nymphs and adults suck the sap from undersurface of leaves and cause yellowing. They produce honeydew, which in turn favours the sooty mould fungus development.

Nymph: Small white wax covered nymphs, remain in large colonies.

Adult: Very small bug yellowish in colour with white wings.

12. Leafhopper, *Empoasca flavescens*, Cicadellidae, Hemiptera

13. Thrips, *Retithrips syriacus*, Thripidae, Thysanoptera

14. Gall fly, *Asphondylia ricini*, Cecidomyiidae, Diptera

15. Tobacco caterpillar, *Spodoptera litura*, Noctuidae, Lepidoptera

SUCKING PESTS

1. Leafhopper / Jassid, *Amrasca devastans*, Cicadellidae, Hemiptera

Symptom of attack: Yellowing of leaves, crinkling, backward curls of leaves, bronzing and hopperburn, plants become stunted .

Nature of damage : Nymphs and adults remain between the veins on the undersurface of the leaves and sucks the sap.

Egg : Elongate, yellowish eggs are laid singly within the leaf veins in the parenchymatous layer between the vascular bundles and the epidermis on the upper leaf surface.

Nymph : Light green, translucent, wingless and wedge shaped.

Adult : Slender green insect, wedge shaped

2. Cotton aphid, *Aphis gossypii*, Aphididae, Hemiptera

Symptom of attack : Young plants become weak, leaf curl up and wither.

Nature of damage : Nymphs and adults suck the plant sap and lower the plant vitality. They produce honeydew, which results in development of black sooty mould. The damage is more severe in young plants.

Adult :Soft, yellow, exist both in winged and wingless forms. Both forms reproduce parthenogenetically and are viviparous.

3. Thrips, *Thrips tabaci*, *Scirtothrips dorsalis*, Thripidae, Thysanoptera

Symptom of attack : Silvery sheen on the undersurface of the leaves . When infestation in heavy, leaves shrivel and have ragged edges. Attacks leaf and flowers.

Nature of damage : Nymphs and adults lacerate the tissue on the under surface of the leaves and suck up the sap.

Adult : Small slender insects, colour vary from yellow to brown with fringed wings.

4. Whitefly, *Bemisia tabaci*, Aleyrodidae, Hemiptera

Symptom of attack: White chlorotic spots appear on leaves, which coalesce forming reddish yellow area, which extends from veins to the outer edges. Leaves fall prematurely. Number and quality of flowers squares and bolls gets reduced. Nymphs and adults secrete honeydew, which lead to sooty mould formation.

Nature of damage : Nymphs and adults remain in cluster and desap. It also acts as vector of cotton leaf curl virus, vein-clearing disease in bhendi, tobacco leaf curl and cassava mosaic.

Egg : Stalked eggs, laid singly on the undersurface of the leaves

Nymph : Oval, greenish yellow

Pupa : Oval and seen on the undersurface of the leaves.

Adult : Minute with yellow body and hyaline wings dusted with a waxy powder

5. Red cotton bug/cotton stainer, *Dysdercus cingulatus* Pyrrhocoridae, Hemiptera

Symptom of attack: Young bolls are affected, which turn dark brown and fail to burst, Lint stained red. Seeds shrivel.

Nature of damage: Nymphs and adults suck the sap from the plant and bolls, reduce the vigour of the plant, produce poor quality lint.

Egg: Ovoid, yellowish eggs are laid in loose masses in the soil and protected with soil/dry leaves.

Nymph: Reddish with white band on the abdomen.

Adult: Red and black with white stripes ventrally on the abdomen.

6. Dusky cotton bug, *Oxycarenus hyalinipennis*, Lygaeidae, Hemiptera

Symptom of attack: Presence of nymphs and adults on the bursted bolls, lint gets discoloured; seeds shrivel and fail to germinate.

Nature of damage: Nymphs and adults suck the sap from the bursted / open bolls.

Egg: Cigar shaped white eggs, laid in clusters within half opened bolls or on the bolls, flower or buds.

Adult: Small flat, dusky brown bugs with pointed head and hyaline wings.

7. Scales : Black scale : *Saissetia nigra* ,

Yellow scale: *Cerococcus hibisci*,

White scale: *Pulvinaria maxima* , Coccidae, Hemiptera

Symptom of attack : Presence of scales on the tender shoots, leaves, stem and bolls, stunting of the plants and bears only few bolls. Movement of ants seen. Sooty mould development also seen.

Nature of damage : Nymphs and adults remain in group and suck the sap from leaves and shoots.

Adult : *S.nigra* - full grown female scale is black in colour.

8. Mealy bug, *Ferrisia virgata* , Pseudococcidae, Hemiptera

Symptom of attack: Presence of mealybugs on tender shoots, leaves, stem and bolls. Yellowing of leaves initially and later the plants die. Leaves and bolls fall prematurely.

Nature of damage: Nymphs and adults remain in-group and suck the sap. Generally the damage is noticed towards the end and in places where ratooning is practiced.

1. Spotted bollworm, *Earias vittella*, Noctuidae, Lepidoptera**Spiny bollworm, *Earias insulana*, Noctuidae, Lepidoptera**

Symptom of attack: Terminal shoots wither and droop; shedding of buds, flowers and bolls, flaring of bracts, bore holes on bolls plugged with excreta, bolls eaten and lint discoloured.

Nature of damage: Larva bores into the tender top shoot during vegetative stage and during reproductive stage they bore into the buds, flowers and bolls.

Egg: Sculptured, shining bluish eggs are laid singly on tender parts of the plant.

Larva: *E. vittella*: Chocolate brown with dorsum showing a white median longitudinal streak. *E. insulana*: Last 2 thoracic segments and all the abdominal segments have two pairs of fleshy tubercles.

Pupa: Boat shaped, dirty brown cocoons seen on the base of the bolls or amongst the fallen leaves.

Adult: *E. vittella*: Buff coloured small moth, forewings buff coloured with a green wedge in the middle. *E. insulana*: Buff coloured small moths, forewings uniformly green.

2. Pink bollworm, *Pectinophora gossypiella*, Gelechiidae, Lepidoptera

Symptom of attack: Premature shedding of the buds and bolls, infested flowers are spun together to form rosette shaped bloom and boll fails to open, premature opening of the bolls, seeds destroyed, lint quality declines seed germination reduced, presence of interocular burrow in the opened bolls.

Nature of damage: Larvae feed inside the buds, flowers and bores into bolls. They feed on the developing anthers and style and occasionally ovary. The external injury caused by them heals up.

Egg: Flat eggs, laid singly on tender leaves, flowers or immature bolls

Larva: Initially white later turn pink with several dark and light alternating bands running the entire length. They also hibernate.

Pupa: Pupates amongst the fallen leaves, debris or under a clod of soil.

Adult: Small brown moth with black spotted forewings and fringed hindwings.

3. American bollworm, *Helicoverpa armigera*, Noctuidae, Lepidoptera

Symptoms of attack: Regular circular boreholes on bolls, presence of granular faecal pellets outside the bore hole.

Nature of damage: Caterpillar cuts a hole on the boll and feed on the boll by thrusting their heads alone inside. The affected bolls may rot due to fungus attack. Yield is considerably reduced.

4. Red bollworm, *Rabida frontalis*, Noctuidae, Lepidoptera

Symptom of attack: Bolls showing irregular bore holes.

Nature of damage: Larvae remain inside the bolls and feed.

Larva: Stout light pink caterpillar.

Pupa: It pupates in the ground for a period of 3 to 4 weeks in Oct to Nov.

Adult: Pale brown with yellow marking on forewings and white hindwings.

Lecture No. 17. Mid-semester Examination

Lecture No. 18. COTTON FOLIAR FEEDERS

DEFOLIATORS

1. Leaf roller, *Sylepta derogata*, Pyraustidae, Lepidoptera

Symptom: Leaves rolled in the form of trumpets and fastened by silken threads, defoliation.

Nature of damage: Larva remain within the fold and eat away the leaves. A single larva can damage several leaves.

Egg: Round, yellowish green, laid singly on undersurface of the leaves.

Larva: Green, glistening with dark head and prothoracic shield.

Pupa: Naked, obtect, pupates within leaf roll / under fallen leaves / debris.

Adult: Medium sized, yellowish wings with brown wavy markings.

2. Semiloopers: *Anomis flava*, *Xanthodes graellsii*, *Tarache nitidula*: Noctuidae, Lepidoptera

Symptom of attack: Defoliation, leaves with midribs, presence of larva

Nature of damage: Larvae defoliate the plant.

Egg: Singly laid.

Larva: *A. flava* - Green with five white longitudinal lines and red prolegs; *X. graellsii* - Green with a pair of horse-shoe shaped black mark on each segment and black warts on the abdomen; *T. nitidula* - Dark brown caterpillar.

Pupa: *A. flava* - obtect, pupates within leaf folds; *X. graellsii* - pupates in soil.

Adult: *A. flava* - medium sized, brown moth; forewings reddish-brown provided with dark coloured zig-zag bands. Hindwings are light brown; *X. graellsii* - yellowish with a brown streak; *T. nitidula* - Stout and white moth with black spots.

3. Ash weevil, *Mylloceris* spp., Curculionidae, Coleoptera

Symptom of attack: Holes in the leaves, leaf margins notched, roots eaten up, plants wilt and they come off easily when pulled

Nature of damage: Grubs remain underground and feed on the root system. Adults they damage the above ground parts

Egg: White, laid in the rhizosphere.

Grub: White apodous.

Pupa: Exarate, pupates in soil.

Adult: Green / Brown / Grey with or without markings on the elytra.

4. Cotton grasshopper, *Cyrtacanthacris tatarica* (= *ranacea*), Acrididae, Orthoptera

Symptom of attack: Defoliation.

Nature of damage: Nymph and adult defoliate the plant.

Nymph: Nymph with broad yellowish stripes on prothorax.

Adult: Pale brown, stout elongated grasshopper.

OTHER PESTS

Flower weevil, *Amorphaidea arcuata*, Curculionidae, Coleoptera

Tobacco caterpillar, *Spodoptera litura*, Noctuidae, Lepidoptera

Hairy caterpillar, *Euproctis fraterna*, Lymantriidae, Lepidoptera

Surface grasshopper, *Catantops pulchellus*, Acrididae, Orthoptera

Tobacco grasshopper, *Atractomorpha crenulata*, Acrididae, Orthoptera

Wingless grasshopper, *Chrotogonus oxypterus*, Acrididae, Orthoptera

Blister beetle, *Mylabris pustulata*, Meloidae, Coleoptera

BORERS**1. Stem weevil, *Pempherulus affinis*, Curculionidae, Coleoptera**

Symptom of attack: Swellings of stem at the point of attack (collar region) and the plant break off from this point, when heavy winds blow.

Nature of damage: Adults feed on the bark while the young grub cuts through medullary rays, tunnels round the stem along the cambium and feed on the soft portion.

Egg : White, globular, oval eggs are laid in cavities scooped in tender nodes. The cavities are sealed with a gummy secretion.

Grub : White, apodous.

Pupa : Exarate, pupates in a pupal chamber within the stem.

Adult : Brownish weevil, 3 mm long, with two small white patches on the elytra.

2. Shoot weevil, *Alcidodes affaber*, Curculionidae, Coleoptera

Symptom of attack: Galls in the stem and petiole, defoliation.

Nature of damage: Grubs bore into stem and petiole causing gall like swelling. Adults feed on leaves, buds and tender terminal shoots.

Egg: Eggs are laid singly in the tissue.

Grub: Creamy yellow, apodous.

Pupa: Pupation inside the stem.

Adult: Dark greyish brown with pale cross bands on elytra. It is bigger than stem weevil.

3. Surface weevil, *Atactogaster finitimus*, Curculionidae, Coleoptera

Symptom of attack: Severing of seedlings

Nature of damage: Adults cut the stem of seedlings at the time of germination under rainfed condition in the black soil tract of Tirunelveli district.

Adult : Large blackish grey weevil.

4. Stem borer, *Sphenoptera gossypii*, Buprestidae, Coleoptera

Symptom of attack :Stem tunneled, stem swollen at the base and dries up.

Nature of damage : The grub burrows into the stem feeding on the internal tissues.

Egg : Laid singly on the bark of the tender stem near the ground level or half way between the base and the crown of the plant.

Grub : Grubs are 2.5 cm long.

Pupa : Pupates within the larval gallery.

Adult : Shinning, coppery brown beetle , 8mm long.

BORERS

1. Early shoot borer, *Chilo infuscatellus*, Crambidae, Lepidoptera

Symptom of damage: Deadheart in 1-3 month old crop, which can be easily pulled out, rotten portion of the straw coloured dead-heart emits an offensive odour. A number of bore holes at the base of the shoot just above the ground level.

Nature of damage: Caterpillar bores into the central shoot and feeds on the internal tissue. This cause interference in the translocation of plant sap and damage the sugar storing tissues.

Egg: Flat-scale like eggs are laid in 3-5 rows on the lower surface of leaves in masses of 4-100. The masses are slightly overlapping like tiles.

Larva: Larva is dirty white with five dark violet longitudinal stripes and dark brown head.

Pupa: Pupation takes place within the tunnel. Caterpillar before pupating makes a large exit hole in the stem and blocks the opening with silken discs.

Adult: Pale greyish brown moth with black dots near the costal margin of the forewings and with white hindwings.

2. Internode borer, *Chilo sacchariphagus indicus*, Crambidae, Lepidoptera

Symptom of damage: Internodes constricted and shortened, with a number of boreholes and fresh excreta in the nodal region. Affected tissues reddened.

Nature of damage: Caterpillars attack sugarcane plants after 3 months of planting. They bore into the canes near the nodes; entry holes are plugged with excreta. Entry is generally confined to the first five internodes.

Egg: Scale-like white eggs are laid by female moths in batches of 9-11, near the midribs, on leaf sheaths or on stem.

Larva: White larva with four violet longitudinal stripes and light brown head.

Pupa: Pupation takes place in semi-dried leaf sheath.

Adult: Pale brown with white hind wings.

3. Top borer, *Scirpophaga excerptalis*, Pyralidae, Lepidoptera

Symptom of damage: Deadheart in grownup canes, which cannot be easily pulled; deadheart reddish brown in colour; parallel row of shot holes in the emerging leaves and red tunnels in the midribs of leaves; bunchy tip due to the growth of side shoots.

Nature of damage: Caterpillars are mainly found in the apical portion of the canes, boring through the growing point and down the upper joints until it reaches the sappy portion of the stem, there it feeds on the tissues and destroys the cane. They also bore into the unfolded leaves preferably into the midrib, mining its way to the base.

Egg: Eggs are laid on the lower surface of top leaves in clusters particularly near midribs. The clusters are covered with buff coloured hairs.

Larva :Smooth, white or cream coloured with a red coloured mid-dorsal line and yellow head.

Pupa: Pupation takes place within the larval tunnel in a chamber with an exit hole constructed by the caterpillar.

Adult: White coloured moth (with a buff coloured anal tuft in the abdominal tip of female).

Lecture No. 21. PESTS OF SUGARCANE - SUCKING PESTS AND SUBTERRANEAN PESTS

SUCKING PESTS

1. Whiteflies, *Aleurolobus barodensis*, Aleyrodidae, Hemiptera

Symptom of damage: Yellowing of leaves, turn pinkish and later gradually dry. Infested leaves look white, while those below are black due to the growth of sooty mould on the honeydew.

Nature of damage: Nymphs suck the sap from the leaves.

Egg: Females lay eggs in a line near the midrib or anywhere on the lower surface of the leaves. Eggs are yellowish with a small curved stalk. Colour changes to black about two hours after the eggs are laid.

Nymph: Neonate nymphs are pale yellow in colour, flat and oval in shape, later turn shiny black. Its body is surrounded by fringes of wax.

Pupa: The fourth instar being the pupal stage, is flat, oval, greyish in colour and slightly bigger than the nymph. There is a 'T' shaped white marking on the thorax, which splits at the time of adult emergence.

Adult: Pale yellow body with hyaline wings dusted with waxy bloom, exhibit brisk fluttering movements.

2. Whiteflies, *Neomaskellia bergii*, *Neomaskellia andropogonis*, Aleyrodidae, Hemiptera

Symptom of damage: Black, grey or white dot like pupae on the undersurface of leaves.

Nature of damage: Nymph suck plant sap from the lower surface of leaves. Drainage of sap adversely affects plant growth.

Egg: Eggs are laid on the undersurface of the leaves in circular or semicircular masses. Freshly laid eggs are yellowish white, which later become dusky yellow.

Nymph: Oval in shape and brownish in colour. Their bodies surrounded by white wax.

Pupa: Pupation occurs on the leaves.

Adult: Pale brown with black bands on wings.

3. Leaf hopper, *Pyrilla perpusilla*, Lophopidae, Hemiptera

Symptom of damage: Yellow leaves, covered with black sooty mould; top leaves gets dried up and lateral buds germinate.

Nature of damage: Nymphs and adults remain in groups on the lower surface of leaves and suck the plant sap. They secrete honeydew, which attract sooty mould development. Severe attack results in loss of sugar content in the canes, to the extent of 34% and growth is suppressed.

Egg: Eggs are laid in clusters on the lower surface of leaves or in the leaf sheaths. Eggs are covered with white fluffy waxy filaments.

Nymph: Soft pale brown dorsally and pale orange ventrally with two characteristic anal filaments.

Adult: Soft, straw coloured with the head pointing forward as snout. Wings fold over the abdomen like hood; they are densely veined and transparent.

4. Mealybug, *Saccharicoccus sacchari*, Pseudococcidae, Hemiptera

Symptom of damage: Pinkish oval insects beneath leaf sheath on the nodes, with whitish mealy coating, main cane stunted also attack roots. Sooty mould develops on the plant.

Nature of damage: Both adults and nymphs suck cell sap from the plants. The insects congregate at the lower nodal regions of the stem, particularly under the leaf sheaths. The leaves often turn red at the base. Vitality of the plants is adversely affected. Ratoon crops suffer more. It also acts as vector of spike disease.

Egg: Eggs are retained in the female reproductive organs until almost fully mature. Incubation period is short. The females may bring forth hundreds of young ones parthenogenetically. An egg is yellowish, smooth, cylindrical and rounded at both ends.

Nymph: Newly emerged nymphs are quite active with a pinkish transparent body.

Adult: White with mealy coating, sessile.

5. Scale insects, *Melanaspis glomerata*, Diaspididae, Hemiptera

Symptom of damage: Dark encrustations on the internode.

Nature of damage: Both adults and nymphs remain inside the scale and suck the plant sap. This causes shriveling and stunting of canes. In susceptible varieties germination get adversely affected.

Nymph: Females multiply ovo-viviparously. The nymphs that hatch out from the eggs within the female's body come out through the genital aperture. They are called 'crawlers'. They settle after selecting suitable site for feeding.

Adult: Greyish black or brown circular scales, they cover the nodal region forming a thick encrustation.

6. Black winged bug, *Proutista moesta*, Derbidae, Hemiptera

Nature of damage: Nymphs and adults suck the plant sap.

Adult: Small, black in colour with long wings.

7. Aphid, *Melanaphis sacchari*, Aphididae, Hemiptera

Symptom of damage: Found on senescent leaves.

Nymph: Yellow in colour.

Adult: Purple when crowded.

8. Skipper, *Telicota augias*, Hesperidae, Lepidoptera

Symptom of damage: Leaves folded into tubular cells.

Nature of damage: Larva folds the leaves into tubular cells by binding the two edges together. It feeds on the leaves from margin inwards leaving behind the midrib intact.

Egg: Light yellow colour eggs laid singly on the leaves.

Larva: Green coloured with constricted neck and dark head and dark spot on the anal flap.

Pupa: Yellowish-green pupa. Pupation takes place in the leaf tube.

Adult: Brownish black butterfly with yellow patches on wings. Antenna is clubbed with curved tips.

SUBTERRANEAN PESTS

1. Termites, *Odontotermes obesus*, Termitidae, Isoptera

Symptom of damage: Poor germination of setts (after planting), characteristic semi-circular feeding marks on the margin of the leaves in the standing crop. Entire shoot dries up and can be pulled out. Setts hollow inside and may be filled with soil. Cane collapses if disturbed; rind filled with mud.

Adult: Creamy coloured tiny insects resembling ants with dark coloured head.

2. Root borer, *Emmalocera depressella*, Crambidae, Lepidoptera

Symptom of damage: Young shoots with deadhearts which cannot be pulled out easily and do not emit any smell. Grown up canes with yellow leaves.

Nature of damage: Caterpillars bore at the base of a stem, which is very close to the root. Although they do not actually bore into the roots, but since they do so near the soil surface they are called root borers. It differs from the shoot borer damage in the way that the dead-heart when pulled out the whole plant comes out and it does not possess bad smell. Besides central leaf whorl, some side leaves also dry.

Egg: Eggs are laid singly on the leaves, stem or in soil. Eggs are flat, oval and creamy white in colour.

Larva : Creamy white with an yellowish brown head and light brown prothoracic shield.

Pupa: Pupates within the stem and makes an exit hole for emergence of the adult about 1-1.5 cm above the ground surface.

Adult: Small moth with pink head, brown thorax and abdomen, forewings and hindwings light yellow. Forewings possess light black longitudinal stripes. Adult moth is 27 mm across the wings.

3. Whitegrub, *Holotrichia consanguinea*, Melolonthidae, Coleoptera

Symptom of damage: Drying of crown, preceded by yellowing and wilting of leaves. Affected canes come off easily when pulled. Cause extensive damage to roots.

Grub: Fleshy 'C' shaped, whitish yellow in colour found close to the base of the clump.

Adult: Dark brown.

4. Root aphid, *Tetraneura javensis*, Aphididae, Hemiptera

Symptom of damage: Root colonized with aphids; movement of black ants.

Adult: Spherical yellowish aphids.

OTHER PESTS

Gurdaspur borer, *Bissetia steniellea*, Crambidae, Lepidoptera

Grasshopper, *Oxya velox*, Acrididae, Orthoptera

Spiny beetle, *Asmangulia cuspidata*, Hispididae, Coleoptera

Lecture No. 22 & 23

PESTS OF GREEN MANURE CROPS AND FORAGE CROPS

SESBANIA

BORERS

1. **Sesbania stem borer**, *Azygophleps scalaris*, Cossidae, Lepidoptera

Symptom of damage: Drying of sesbania plants.

Nature of damage: Stoutly built larva bores into the stem and feeds, the faecal matter getting accumulated at the entrance hole.

Egg: Laid in masses attached to the leaflets.

Larva: Robust larva of 7 cm length, light brown with a reddish brown head.

Pupa: Pupa has spines anteriorly with the help of which it moves up and down inside the tunnel in the stem.

Adult: Sluggish yellowish brown moth.

2. **Stem weevil**, *Alcidodes bubo*, Curculionidae, Coleoptera

Symptom of damage: Drying of the terminal branches or whole plant, lodging of the plants during monsoon seasons; affected stem with numerous bore holes and swelling symptoms. Presence of apodous grub inside the stem.

Nature of damage: Grubs riddle into stem and cause thickenings on stem. The growth and vigour of the plants are impaired to a great extent.

Egg: Laid on the stem.

Grub: Apodous whitish grub.

Adult: Reddish brown weevil with white transverse markings on the elytra.

LEAF FEEDERS

3. **Green semilooper**, *Pericyma glaucinans*, Noctuidae, Lepidoptera

Symptom of damage: Defoliation of plants preceding with leaflets damage.

Nature of damage: Caterpillar feeds on the leaflets remaining along the ribs of leaves.

Larva: Pale green, semilooper with broad yellow lateral stripes.

Adult: Dark brown with black lines

4. **Green looper**, *Semiothisa peruelgata*, *Semiothisa emersaria*, Geometridae, Lepidoptera

Symptom of damage: Defoliation of plants preceding with leaflets damage.

Nature of damage: Larvae feed on the leaves.

Egg: Oval greenish eggs laid singly on leaves.

Larva: Pale green looper with white lines and when full grown becomes pink with horizontal bands of violet patches dorsally on the abdominal segments.

Pupa: Pupates in the soil.

Adult: White colour with three dark lines and spots on the wings.

5. **Brown looper**, *Hyposidra succesaria*, Geometridae, Lepidoptera

Symptom of damage: Defoliation of plants preceding with leaflets damage.

Nature of damage: Larvae feed on the leaves.

Egg: Deposited in clusters.

Larva: Reddish brown in colour with spots.

Pupa: Pupates in soil.

Adult: Reddish in colour with faint lines.

6. Leaf webber, *Striglina scitaria*, Thyrididae, Lepidoptera

Symptom of damage: Webbing of terminal leaflets into conical structures.

Nature of damage: In the early stage the larva twists the terminal portion of the leaflet in the form of a small cone and lives inside scraping the green matter. As it grows, it webs together the leaflets and lives inside the tunnel of the web and ultimately pupates inside it.

Egg: Laid in groups of 2-4 in a row on the edges of leaflets.

Larva: Greenish caterpillar with black head.

Pupa: Pupates within the leaf web itself.

Adult: Light brown moth with oblique lines on wings.

7. Pierid butterflies, *Eurema hecabe var. contubernalis*, Pieridae, Lepidoptera

Symptom of damage: Defoliation of the leaflets.

Nature of damage: Caterpillar feeds on leaves.

Egg: White spindle shaped eggs laid singly on leaves.

Larva: Greenish caterpillar with white lateral lines.

Pupa: Chrysalis pupa attached to the stem with a girdle.

Adult: Yellow coloured butterfly with black margins.

8. Mottled emigrant, *Catopsilia pyranthe*, Pieridae, Lepidoptera

Symptom of damage: Defoliation of the leaflets.

Nature of damage: Larvae feeds on the leaves.

Larva: Greenish caterpillar with lateral yellow stripes and black dots.

Adult: Male forewing chalky white or greenish with apical and terminal black border.

Female: Black markings broader than in male.

9. Semilooper, *Grammodes stolidia*, Noctuidae, Lepidoptera

Symptom of damage: Defoliation.

Larva: Velvety black larva with a row of red spots.

Adult: Forewing with a large black patch occupying the whole wing except the basal, coastal and outer areas. Hind wings with medial pale band.

10. *Spodoptera litura* 11. *Dasychira mendosa*

SAP FEEDERS

12. **Stink bug**, *Piezodorus rubrofasciatus* and *Cyclopelta siccifolia*, Pentatomidae, Hemiptera

14. **Stink bug**, *Brachyplatys vauhli*, Plataspididae, Hemiptera 15. *Coptosoma cribraria* 16. *Riptortus pedestris* 17. *Clavigrella horrens* 18. *Clavigrella gibbosa* 19. *Aphis craccivora*

SUNHEMP

1. Hairy caterpillar, *Utethesia pulchella*, Arctiidae, Lepidoptera

Symptom of damage: Defoliation of the plant.

Nature of damage: Larva feeds on leaves and also cause severe damage by feeding on the contents of developing pods.

Larva : Hairy caterpillar with brown head. Yellow lines on the dorsal and dorso-lateral side with black stripes and orange patches. Body has long brownish hairs arising on warts.

Pupa: Pupates in the soil.

Adult: Red and black spots on the white forewings.

2. Hairy caterpillar, *Argina cribraria*, *Argina syringa*, Hypsidae, Lepidoptera

Symptom of damage: Defoliation.

Nature of damage: Larvae feeds on the leaves.

Egg: Yellowish eggs laid in clusters on the undersurface of the leaves.

Larva : Hairy caterpillar with black transverse markings and white spots.

Pupa: Pupates on the plant or the surface of the soil.

Adult: *A. cribraria* has black spots on yellowish wings. *A. syringa* has black spots on reddish brown wings.

3. Flea beetle, *Longitarsus belgamensis*, Alticidae, Coleoptera

Nature of damage: Adult makes minute holes on leaves, grub feeds on the roots by mining.

Egg: Laid in soil.

Grub : Yellowish grub.

Pupa: Pupates in earthen cells in the soil.

Adult: Yellowish brown small beetle with enlarged hind femur.

4. Sunhemp mirid, *Ragmus importunitas*, Miridae, Hemiptera

Symptom of damage: Minute chlorotic spots, later coalescing to cause yellowing of leaves.

Nature of damage: Nymphs and adults suck the sap from tender leaves and shoots and cause yellowing of leaves and in severe attack, death of plants.

Egg: Eggs laid singly into plant tissue.

Adult: Greenish bug.

5. Stem borer, *Enarmonia tricenra*, Eucosmidae, Lepidoptera

6. *Etiella zinckenella*

FORAGE CROPS

LUCERNE

1. Spotted alfalfa aphid, *Therioaphis maculata*, Aphididae, Hemiptera

Nature of damage: Nymph and adult suck the sap.

Adult: Yellow coloured aphids with series of spots.

2. Lucerne weevil, *Hypera variabilis*, Curculionidae, Coleoptera

Symptom of damage: Leaves with irregular holes. Affected plants remain stunted.

Nature of damage: Grub and adult cause the damage.

SUBABUL

1. Jumping lice, *Heteropsylla cubana*, Psyllidae, Hemiptera

Symptom of damage: Wilting of growing shoots resulting in die back; plants unable to put forth new growth. Honeydew deposition and sooty mould development.

Nature of damage: Nymph and adult cause the damage.

Nymph: Minute yellow. Adult: Pale greenish yellow.

Lecture No. 24 RODENT DAMAGE AND THEIR MANAGEMENT

Vertebrata

Class : Mammalia

Order : Rodentia

1. House rat, Roof rat, Black rat, *Rattus rattus*

Nature of damage: It eats up all food materials and can damage wood, plastic, rubber and even soft metals also. As it is responsible for plague, it is considered as the most expensive rat of India. Generally the droppings are found scattered and banana shaped.

Habit: Being nocturnal in habit, it can be rarely seen during day time. It is a good swimmer and good climber also. It prefers to stay in dusty places. It is rarely found in sewers also. It rarely moves out of houses or crosses the big lanes. It can climb high to enter through roofs.

2. House mouse, *Mus musculus*

Nature of damage: Their infestation imparts a typical smell to store rooms and stocks. They feed on cereals, cereal products, vegetables, meat, fats, carbohydrates, etc. and can damage wooden furniture, paper, clothes, rubber, plastic and leather goods, etc. They damage more than what they eat. They are responsible for contamination of food with hairs, urine, excreta; and also spreading *Salmonella* organisms responsible for food poisoning. They may cause virus infection not only by faecal infection but also by walking over the foodgrains etc. They are responsible for disease like ringworm. The droppings are scattered and spindle shaped.

Habits: It prefers to stay in holes, in floors or under the boxes or any other dark place suitable for hiding. It is active during night but can be seen in daytime also. Movements are almost like darting. Feeding is confined normally upto 10 meters. A mouse does not run along 'rat runs'.

3. Norway rat, Brown rat, Sewer rat, Ship rat, *Rattus norvegicus*

Nature of damage: Feeds on grain. Damage containers i.e. bags/ cartons. Pollutes grain with excreta, droppings and hairs. Spread various diseases. Droppings found in groups and spindle shaped.

Habits: It is habituated of making burrows outside grain stores but often lives in sewers. The burrows are only on surface with two to five openings. Normally it stays within a radius of 25 to 30 meters. It is a good swimmer. Life span is for one year.

4. Smaller bandicoot, Indian mole rat, Lesser bandicoot, Outdoor rat, *Bandicota bengalensis*

Nature of damage: Being omnivorous it feeds on grains, fruits, vegetables, nuts, sometimes flesh of young ones and dead animals. It damages crops in fields (sugarcane, wheat, paddy, maize, etc.) and gardens besides grain in granaries at times. But the damage to cereals is little as it prefers to cut cereal crop plants particularly 'ear heads'

thereby affecting yield considerably. It hoards grains in its burrows upto 6 kgs. Occasionally it attack poultry. It is an important plague carrier too. In godowns besides waste and contamination, it adds filth also. Droppings are scattered and oval shaped.

Habits: It is an expert in digging burrows with characteristic mounds of soil, which hide the opening of burrows hence the name - mole rat. It is an excellent swimmer, often living in bunds; it swims to damage even flooded fields of paddy. Being mainly nocturnal, it prefers to stay in burrows during daytime. Burrows have never been noticed inside warehouses or stores.

5. Larger bandicoot, The Bandicoot, *Bandicota indica*

Nature of damage: It makes big burrows, which weaken the foundation of walls, river bunds, railway tracks etc. It damages crops by cutting tillers/ leaves thus reducing yield drastically. It hoards grain in burrows. In stores, it mainly depends on cereals and other grains. Droppings are scattered and spindle shaped.

Habits: It is the biggest rat found in thickly populated areas and markets of grain stockists and also on the periphery of villages. It is less attracted towards flesh or meat and is mainly grain feeders. Besides burrowing underground tunnels it is expert in gnawing furniture and doors by powerful chisel shaped incisors. The grunting noise of this rodent is typical.

DETECTION OF RODENT INFESTATION

Visual sighting and typical noise, rat burrows, rat droppings and urine marks, feet or tail marks on dusty floors, greasy marks left by rats, gnawed articles (torn bags and spilled grains etc. or damaged doors and windows), pet excitement and disappearance of bait.

RODENT CONTROL: The following methods can be adopted for rodent control.

I. NON-CHEMICAL

1. Physical methods

a. *Rat proofing:* While constructing new godowns, care should be taken to construct them rat proof. The characteristics of an ideal godown are as follows: Godowns should be away from habitation. Should be on high plinth. Water accumulation in the nearby places should be avoided. Pucca masonry cement concrete structures are preferable. No tree or branches of the tree should hang over the godowns roof. All windows ventilators, gutters, drains should be fitted with 24 gauge ¼" (0.6 cm) expanded metal mesh. Manholes should be properly covered. Doors must be closely fitted. Clearance between doors and floors, should not exceed ¼" (0.6 cm). Must have 3' (90 cms) deep pucca foundations. Doors should be equipped with 9" (25 cms) metal sheet lining at the bottom. Platform stairs in front of godowns should not be allowed overnight. Platform should have 12" (30.5 cm) projection in an inversed L shaped manner. All the walls and floors should be plastered smooth with cement. Any rat hole observed must be closed with cement. If the hole is big enough, it should be filled with glass pieces. Automatic door closers help in banning rat entry. Regular inspection and sanitation of godowns is a must for effective rat control.

b. *Hygiene and sanitation*: Food should be kept in rat proof containers. Waste foods and empty food tins should be thrown in dustbin with tightly fitting lids. Food stocks should be stored in such a way that they can be inspected from all sides at frequent intervals. Piles of rubbish, timber and bricks should not be allowed to accumulate in or near the godowns. Best time for removing rubbish is just before taking temporary control measures. By using rat repellent in stores.

c. *Use of ultrasonic devices*: Sound waves emitted by ultrasonic devices are unbearable by rats and mice and are unheard by humans. These are reported to repel the rats without producing any harm to human beings. However, so far effective equipment is not available.

2. Mechanical:

a. *Trapping*: It reduces the population but does not control further multiplication. It is effective only when the population is low. Trapped rats should be killed by drowning cages in ponds and dead rats buried. Break back traps kill the rats while trapping. Placing of trap and selecting of bait play an important role of controlling rodents in fields, houses and godowns. The tanjore bamboo bow traps, pot traps and break back trap type are very useful in controlling field rats. In warehouses/ houses the physical methods adopted are plugging the holes with glass pieces and cement plastering, having snugly fitting doors, constructing a plinth of 75 cm high without any steps or ladder and rat proofing by fixing metallic sheets at the bottom of doors and use of box trap and wonder trap.

b. *Killing of solitary rats* by sticks, brooms and some other ways by individual.

3. Cultural

a. *Deep ploughing*: Ploughing upto 18" (45 cms) will unearth rat burrows and the pest will be exposed to enemies, like dogs, cats, kites etc. But it can be done only once before sowing operations. Due to their high rate of multiplication rats recover the same population level.

b. *Flooding the fields*: Burrows in the fields can be flooded with water, which kill the rats.

c. *Formation of narrow bunds*: Rodents prefers broader bunds for making burrows.

4. Biological

a. *Predators* : Snakes and mongooses are well known predators of rats. Fixing bamboo poles near the rat burrow. Birds like owls, eagles etc come and sit on them. As and when the rat comes out they catch and kill. Keeping cats in houses also checks the rat population.

b. *Parasites*: *Salmonella* sp. of virus can be used for rodent control but not recommended due to health threat to non target species.

II. CHEMICAL: Compounds, which kill the rats by their chemical action, are known as rodenticides. These poisonous rodenticides can be divided into two groups.

a. *Acute/ Single dose poison*: Zinc phosphide, Barium chloride, Red squill, Thallium sulphate are some of the compounds which have been used as rat poisons. These are

called as 'acute poison' as these are highly toxic in nature i.e. they show immediate fatal results. The defect of acute poisons is that these create poison shyness and bait aversion in rodents. E.g. Zinc phosphide 2 parts, food grains 96 parts and any edible oil 2 parts.

b. *Chronic/ Multiple dose poison*: The modern way to kill rodents in houses or godowns is by using anticoagulants. If consumed regularly in sufficient quantity for a prolonged period causes blood hemorrhage in mammals. These are easy to handle and involve no health hazard to man. These do not create bait shyness.

i. *Ready to feed*: Rodents can be fed directly when the bait is of ready to use type.

ii. *Dry baits*: In case of dry concentrate form, the bait is to be prepared in the following manner. Anticoagulant 25 gms (5 tea spoonfuls), flour 450 gms (4 tea cup fulls), sugar or jaggery (in powder form) 15 gms (3 tea spoonfuls), any edible oil 10 gms (2 tea spoonfuls). It should place in rat runs, dark places, where rats can consume bait without disturbance even during day-time. Consumed baits should be replaced daily. Rats start drying after a period 6-7 days. Baiting should continue for 21 days to get an effective kill.

c. *Fumigation of rat burrows*: It gives quick results as problems like new object reaction and bait shyness do not arise.

i. *Cyanogas fumigation*: Calcium cyanide was used as a fumigant. Before starting fumigation work all rat burrows should be closed by loose earth. The following day, freshly opened (live burrows) should be cleared and 10-20 gms (3-4 tea spoonfulls) of fumigant applied with the pump-applicator (6-10 strokes of the pump). The burrows should be immediately closed tightly after removal of pump hose to avoid any leakage of poisonous gas. Next day the fumigated burrows are again examined and any reopened burrows are refumigated.

ii. *Phosphine gas fumigation*: Aluminium phosphide pellets of 0.6 gms are utilized for carrying out burrow fumigation exactly in the same manner as discussed above for cyano gas. Since the pellets are to be utilized, no pumping is necessary. A simple rod like hollow applicator is thrust deep into the burrows and two pellets are put in each burrow. A bamboo tube hollow from inside can be utilized in the same manner. In the absence of applicator, even direct burrow fumigation can be resorted to. The process is repeated twice in the following days on noticing any opened burrows.

MITES

Order : Acarina Class : Arachinda

Plant pests belong to the orders Tetranychidae (spider mites), Tenipalpidae (false spider mites), Tarsonemidae (tarsonemids), Eriophyidae (blister or gall mites) and Eupodidae (eupodids). Of these spider mites are the most important and prevalent. Mites normally feed on the undersurface of the leaves but the symptoms are more easily seen on the uppersurface. Tetranychids produce blotching on the leaf-surface, tarsonemids and eriophyids produce distortion, puckering or stunting of leaves and other parts of the plant. Some species of eriophyids produce distinct galls or blisters.

Family : Tetranychidae

1. *Tetranychus cinnabarinus*, *Tetranychus neocaledonicus*, *Tetranychus ludeni*: This species has a world-wide distribution. Its infestation recorded on cotton, castor, pulses, groundnut, daincha, sesbania. Brinjal, cotton and bhendi are the worst sufferers.

Symptom of damage: Undersurface of the leaves get covered with strands of webbing which affect photosynthesis and so the yield. Chlorotic spots coalesce into pale or silvery patches. Eventually the leaves dry up and fall off. Growth, flowering and fruit setting in the plants are greatly affected. Both nymphs and adults cause the damage.

2. *Oligonychus indicus*: It is a serious pest of sorghum, maize, sugarcane and some cereals.

Symptom of damage: White or red patches on the lower surface of leaves of sorghum and sugarcane. Both nymphs and adults cause the damage.

3. *Oligonychus oryzae*: It infests rice. White spots on lower surface of leaves which coalesce leading to development of white or silvery patches. It is severe during summer.

Family: Tarsonemidae

4. *Polyphagotarsonemus latus* (yellow mite, broad mite, chilli muranai mite): These are pests of chilli, cowpea, greengram, horsegram, sesamum, lablab, jute and cotton.

Symptom of damage: Sudden curling and crinkling of leaves followed by development of blister patches. Severe stunting of growth and death of plants.

Family Eriophyidae

5. *Aceria cajani*: It is a vector of sterility mosaic of pigeonpea.

6. *Aceria sorghii*: Leaf crinkling, general chlorosis and choking of terminal leaves. Host plant is sorghum.

Management of mite pests

Cultural: Avoid monocropping, do intercropping using non-host crops, clean culture.

Chemical: Acaricides viz., tetradifon, chlorbenzalite, dicofol/ kelthane, can be used to kill phytophagous mites in all stage of development.

Biological: Some of the predatory mites and insects (coccinellids, *Scolothrips indicus*, *Chrysopa*) produce effective control.

BIRDS

1. House Crow, *Corvus splendens*, Corvidae, Passeriformes

It is grey and has black and grey wings with a black area on the throat and the forehead. It is omnivorous and feed on dead rats, carrion, kitchen scraps, locusts, termites, the eggs of other birds and the ripening grains of maize and fruits. Crow are particularly attracted to maize when it is exposed on the cob. They are often seen in flocks in maize and other fields.

Management: Hanging a dead crow on the top of a pole can effectively be used as a scarecrow. Maize cobs can be protected by wrapping one or two of the nearby leaves around them. A large-wire gauze cage, 2x1x1 metres having on one side a converging entrance, can be used as a trap for crows if some attractive food is kept inside.

2. Common Myna, *Acridotheres tristis*, Saturnidae, Passeriformes

It is a dark- brown bird, with a bright yellow bill, its legs and patches around the eyes. As it flies, large white patches become visible on the wings. It is omnivorous and feed on insects, earthworms, grasshoppers, fruits and kitchen scraps. They are seen in ripening maize and wheat fields feeding on the grains and their flocks are found alongside those of crows and parakeets.

Management: Destroying the nests goes a long way in checking their multiplication.

3. House sparrow, *Passer domesticus*, Ploceidae, Passeriformes

Female is ash to greyish brown above and fulvous ash-white below. The male is 15 cm long, darker above, with blackish streaks on the wings and a black patch on the throat and breast. It has prominent white cheeks. Feeds on grains of maize.

Management: Spraying the wheat crop when ears are in the milky stage with Tetra Methyl Thiuram Disulphite (TMTD) 0.6% repels the sparrows and protects the crop.

Other bird pests are parrot, baya weaver, peacock, seven sisters.

Management of birds

Cultural: Deep sowing of seeds, covering the seeds with soil, pre-and post dating of sowing, growing of trap crops near the main one and use of plant varieties that are physically and gustatorily unattractive to birds.

Electrified perches: Bird perches could be electrified to disperse the birds or kill them by regulating the voltage.

Use of deterrents: Scare-crow (a human figure erected in the fields) or acetylene gun, a device by which loud bangs are produced by the action of water on calcium carbide; use of bioacoustics, in which bird's stress or alarm signals are recorded and played in

the fields at intervals which should be kept changing to prevent the birds getting used to them; use of repellents or feeding deterrent, TMTD.

Other methods are Use of nylon nets, Fumigation of nests with Aluminium phosphide tablets, Trapping, use of reflecting ribbons.

SNAILS AND SLUGS

Invertebrata

Phylum : Mollusca

Class : Gasteropoda

Snails differ from slugs in having a spirally coiled shell over their body which in slugs is reduced and completely hidden under the mantle.

Common garden snails : *Helix*, *Macrochlamys indica*

Green house snail : *Opeas gracilis*

Giant African snail : *Achantina fulica*

They do a lot of damage to vegetables, garden plants, the damage being more serious in the seedling stage. Giant African snails even damage plantation crops like arecanut, rubber buds and coffee.

Common Indian slugs : *Limax* sp., *Laevicaulis alte*, *Arion* sp.

Management:

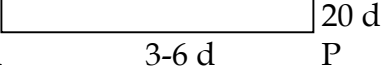
Cultural: They can be handpicked and killed.

Chemical: Metaldehyde (5%), copper sulphate solution (1%) and insecticides (arsenates, persistent organochlorines, etc.)

PRIMARY PESTS

1. Rice weevil, *Sitophilus oryzae*, *S. zeamais*, *S. granarius*, Curculionidae, Coleoptera

Host range: Wheat, rice, maize, jowar, paddy.

Life history: 150-250 E 4-5 d L


Symptom of damage: Presence of irregular holes of 1.5 mm diameter on grains of rice, sorghum, wheat, barley, maize before harvest and in store.

Nature of damage: Both grub and adults cause the damage. Grains are hollowed out; kernels are reduced to mere powder. *S. oryzae* and *S. zeamais* starts its attack in field itself. Adults cut circular holes. Heating takes place during heavy infestation, which is known as 'dry heating'.

Egg: Translucent white, plugs the egg hole with gelatinous secretion, laid singly.

Grub: White with yellowish brown head, apodous, fleshy, curved, remains within the grain

Pupa: Pupates inside the grain.

Adult: Small, reddish brown to chocolate coloured weevils has characteristic snout, elbowed antennae, slightly clubbed. Hindwings present except in *S. granarius*. *S. zeamais* is the largest amongst the three species.

2. Sweet potato weevil, *Cylas formicarius*, Apionidae, Coleoptera

Host range: Sweet potato.

Life history: 200 E 3-5 d G
 Total life cycle : 1-1 ½ mon

Symptom of damage: Grubs and adults bore into the tubers and make them unfit for consumption.

Nature of damage: It is an important pest both in the field and in storage. Grubs bore into the tubers and make them unfit for consumption. They also attack the vines. Adult weevils feed on leaves, vines and tubers.

Egg: Eggs are laid singly in small cavities on vines and tubers.

Grub: Whitish grub is apodous and has a brown head.

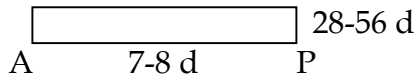
Pupa: It pupates inside the vine or tuber.

Adult: Slender, ant-like with a long snout, shiny black with reddish brown thorax and legs.

3. Lesser grain borer/Hooded grain borer/paddy borer beetle, *Rhyzopertha dominica*, Bostrychidae, Coleoptera

Host range: Paddy, rice, wheat, maize. It is able to attack paddy more easily than *S. oryzae*.

Life history: 550 E 4-6 d G 4



Total life cycle : 25 d

Symptom of damage: Presence of round tunnel (1 mm) in grains and root crops. In bagged storage irregular messy waste flour spots indicate infestation of the pest. Presence of frass, shelled grains and foul smell.

Nature of damage: Heating is very common. Infestation is confined to a small area. Grubs and adults cause damage and are voracious feeders. Adults reduce the grain kernels to mere frass. Grubs eat their way into the grain or feed on the grain dust or starchy material and are capable of attacking grain externally.

Egg: Eggs are laid on the surface or on the interstices of cereal grains singly or in clusters.

Grub: White, apodous with brown head, free living upto 3rd instar.

Pupa: Grub enters the grain after 3rd instar for pupation.

Adult: Brown to blackish beetle, head is deflexed downwards below prothorax to such an extent that it is almost hidden in a dorsal view. There is a prominent constriction between prothorax and elytra. Antenna clubbed with large loose three-segment.

4. Cigarette beetle, *Lasioderma sericorne*, Anobiidae, Coleoptera

Host range: Wheat flour, cereal bran, peanuts, cocoa beans, cottonseed, spices and even insecticides containing pyrethrum, meat and fishmeal, ginger, turmeric and chillies.

Symptom of damage: Circular, pinhead sized bore holes on processed tobacco.

Nature of damage: Grub causes the damage.

Grub: White, fleshy and hairy grub.

Adult: Small, robust, oval, light brown round beetle with its thorax and head bent downward; gives the insect a humped appearance. Elytra have minute hairs on them and are not striated. Total life cycle is 30-50 days. Six generations in a year.

5. Drug store beetle, *Stegobium paniceum*, Anobiidae, Coleoptera

Host range: Turmeric, coriander, ginger, dry vegetable and animal matter.

Symptom of damage: Circular pin-head sized bore hole.

Nature of damage: Grub causes the damage.

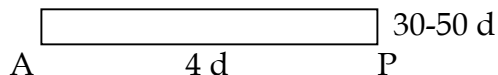
Grub : Similar to cigarette beetle but not hairy.

Adult: Reddish brown round beetle with striated elytra and clubbed antenna.

6. Pulse beetle, *Callosobruchus chinensis*, *C. maculatus*, Bruchidae, Coleoptera

Host range: All whole pulses, beans and grams.

Life history: 80-100 E 5 d G 4



Symptom of damage: Grains with white cigar like eggs on seed coat and circular exit hole.

Nature of damage: Grubs eat up the grain kernel and make a cavity. Adults come out making exit holes.

Egg: Laid singly, glued to the surface of the pod (in fields) or on grains (in stores). Fresh eggs are translucent, orange cream in colour, changing to greyish white with age.

Grub: Fleshy, curved, creamy white in colour with black mouth parts.

Pupa: Pupation takes place in a pupal cell prepared beneath the seed coat.

Adult: Brownish grey beetle with characteristic elevated ivory like spots near the middle of the dorsal side. It is small, short, active with long conspicuous serrate antenna. Elytra do not cover the abdomen completely, which is called as pygidium. Pygidium is black with a central longitudinal white streak. Adults are short lived, it is harmless and do not feed on storage produce at all.

7. Tamarind beetle, *Pachymeres gonagra*, Bruchidae, Coleoptera

Symptom of damage: Circular holes on fruits of tamarind both in tree and storage.

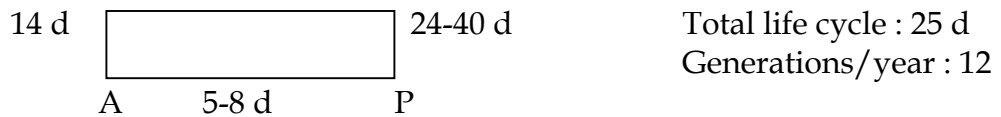
Nature of damage: Grub causes the damage.

Adult: Small grey coloured beetle.

8. Khapra beetle, *Trogoderma granarium*, Dermestidae, Coleoptera

Host range: Wheat, maize, jowar, rice, pulses, oil seeds and their cakes.

Life history: 80-125 E 4-10 d G



Symptom of damage: Stored grains reduced to frass, seed coat chewed up in an irregular manner on all cereals.

Nature of damage: Adults are harmless. Grub damages the grain starting with germ portion, surface scratching and devouring the grain. It reduces the grain into frass. Excessive moulting results in loss of market value due to insanitation caused by the cast skin, frass and hair. Crowding of larvae leads to unhygienic conditions in warehouses. Damage is confined to peripheral layers of bags in bulk storage.

Egg: Eggs are laid on the grains or crevices.

Grub: Grub is straw coloured and hair with dark brown hairy bands on each segment and typical posterior tuft forming a tail of long hairs. It is active, move and feed freely.

Pupa: Pupation takes place on the surface of the grain in bulk and overlapping edges of bags.

Adult: Reddish brown, convex, oval in shape with practically no distinct division of head, thorax and abdomen. Abdomen size is comparatively larger.

9. Angoumois grain moth or Grain moth, *Sitotroga cerealella*, Gelechiidae, Lepidoptera

Host range: Paddy, maize, jowar, barley and wheat (rarely). It is not capable of attacking milled rice or other cereal products.

Life history: 100 E 4-30 d L 4



Symptom of damage: Grains with circular emergence hole with characteristic flap/trap door

Grub: Worm like, whitish cream colour, faint stripes, two spines like appendages at the end segment. Pupa: Pupa remains loosely lying in the grain and is naked.
Adult: Oblong, flat, brown in colour. In *T. confusum*, the compound eyes are completely notched and antennae are not gradually thickened whereas in *T. castaneum*, the notch is not complete and antennae have a clear 3-segmented club.

12. Long headed flour beetle, *Latheticus oryzae*, Tenebrionidae, Coleoptera

Host range: Cereal flours, packaged food, rice and rice products, grains with excessive dust, dockage and broken grains with high moisture contents preferred.

Life history: 400 E 7-12 d G
15-80 d Total life cycle : 25 d
A 5-10 d P

Nature of damage: Both grubs and adults feed.

Egg: White, smooth, cylindrical eggs at random in grain and seams of the bags.

Grub : Active grub feeds voraciously. Pupa: Pupa is naked.

Adult: Light brown with elongated body, resembles *Tribolium* sp. Antennae shorter than head, 11 segmented with 5 clubbed apical segments.

13. Flat grain beetle, *Cryptolestus minutus*, *Laemophloeus pusillus*, Cucujidae, Coleoptera

Host range: Rice, maize, wheat with excessive brokens, different flours, groundnut particularly with high moisture and mouldy grain.

Life history: E 5 d G
6-12 mon 21 d Total life cycle : 6 weeks
A P

Nature of damage: Both adults and grubs feed on stored products and are important pests of mills. Grubs feed on germ portion and even on dead insects. Adults are only scavengers, cause heating in grain and flour in case of heavy infestation.

Egg: White eggs are laid loosely in flour, grain or crevices.

Grub : Cigar like, yellowish white with two reddish brown spines at anal segment.

Pupa: Matured larvae pupates in a gelatinous cocoon covered with dust particles.

Adult: Tiny, light to dark reddish brown beetle with filiform antennae.

14. Saw toothed grain beetle, *Oryzaephilus surinamensis*, Silvanidae, Coleoptera

Host range: Rice, wheat, maize, cereal products, oil seeds and dry fruits.

Life history: 300 E 3-17 d G
3 years/ 14-20 d Total life cycle: 3 weeks
6-10 mon A 7-21 d P

Symptom of damage: Presence of off odour in grain.

Nature of damage: Adults and grub cause roughening of grain surface and off odour in grain. Grains with higher percentage of broken, dockage and foreign matter sustain heavy infestation, which leads to heating of grain.

Egg: Whitish eggs laid loosely in cracks of storage receptacles or godowns.

Grub : Grub is slender, pale cream with two slightly darker patches on each segment.

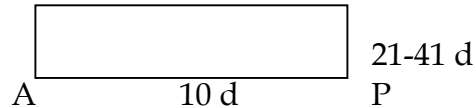
Pupa: Full grown grub makes protective cocoon like covering with sticky secretion.

Adult: Narrow, flattened, thorax having six teeth like serrations on each side. Antenna clubbed. Elytra cover abdomen completely.

15. Ricemoth, *Corcyra cephalonica*, Galleridae, Lepidoptera

Host range: Rice, jowar, other millets, whole cereals, cereal products, pulses, processed products of cereals, pulses, oil seeds, nuts, dry fruits and milled spices.

Life history: E 3-5 d L



Symptom of damage: Presence of dense webbing of grains and foul smell, which makes the grains unfit for human consumption.

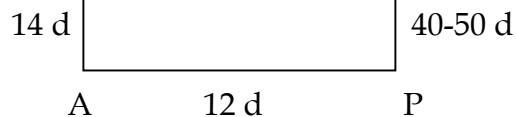
Nature of damage: Larva is only responsible for damage. It contaminates foodgrains with frass, moults and dense webbing. In whole grains, kernels are bound into lumps upto 2 kg.

Egg: Small, oval, elliptical laid on wall, bags or on grain. Larva : Creamy white has prothoracic shield. Pupa: It webs silken shelter before pupation. In case of heavy infestation cocoons may be seen sticking to the grain bags. Cocoon dense white and tough. Adult: Pale buff brown colour.

16. Fig or Almond or Warehouse moth, *Ephestia cautella*, Phycitidae, Lepidoptera

Host range: Wheat, rice, maize, jowar, groundnuts, spices.

Life history: 200-250 E 3-4 d L



Symptom of damage: Before pupation, large number of wandering larvae trails behind silken threads. Such fine threads form the carpets of white sheen over the bags. Matured larva spins a silken cocoon at the junction of two overlapping edges of stacked bags.

Nature of damage: Larva feeds on germ portion leaving the rest of the kernel undamaged. In bulk infestation its damage is limited to peripheral top layers only. Web formation covers the bags, floor-space and mill machinery thereby leading to clogging in mills.

Egg: Eggs are laid in grains exposed at the sampling tube spots in jute bags.

Larva : Greyish white, hairy with dark brown head with 2 dark areas on the first segment behind the head.

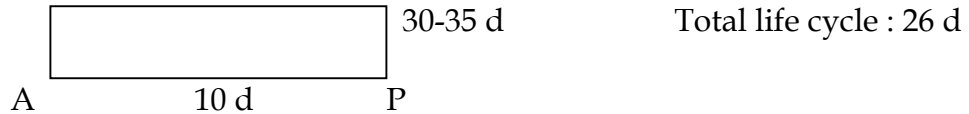
Pupa: Spins silken cocoon at the time of pupation.

Adult: Dirty white to greyish in colour with indistinct black bands,

17. Indian meal moth, *Plodia interpunctella*, Phycitidae, Lepidoptera

Host range: Maize, cereals, dry fruits, groundnuts and cereal products.

Life history: 39-275 E 2-17 d L



Symptom of damage: Borehole on the grain.

Nature of damage: Larva causes serious damage to ear and grain of maize; contaminates the grain with excreta, cast skins, webbings, dead individuals and cocoons; prefers to eat the germ portion and hence grains lose viability. It feeds superficially but may construct more than one silken tunnel.

Egg: Greyish white with granular surface, laid indiscriminately at night.

Larva: Transparent, dirty white, skin is granular with hairy body.

Pupa: Straw coloured, changes colour to greyish with age, in silken cocoon.

Adult: Forewing basal half silver white or greyish, outer 2/3 portion is reddish copper bronze lustre with irregular bands.