EXERCISE NO. 1
CLASSIFICATION AND CATEGORIES OF PESTS

Insects of economic importance

A. Injurious insects

a) Pests of cultivated plants (Crop pests)

Each cultivated plant harbors many insects pests which feed on them reduce the yield of the3 crop.

Field crops and horticultural crops are attacked by many insect species. e.g. cotton bollworm, Rice stem bores.

b) Storage pests

Insects feed on stored products and cause economic loss. e.g. Rice weevil, Pulse beetle.

c) Pest attacking cattle and domestic animals

Cattle are affected by pests like Horse fly, Fleshfly, Flese and Lice. They suck blood and sometimes eat the flash.

d) House hold and disease carrying insects

House hold pests include cockroach, ants, etc. Disease carrying insects are mosquitoes, houseflies, bed bugs, fleas etc.

B. Beneficial insects

a) Productive insects

i) Silk worm

The silk worm filament secreted from the salivary gland of the larva helps us in producing silk.

ii) Honey bee

Provides us with honey and many other byproducts like bees wax and royal jelly.

iii) Lac insects

The secretion from the body of these scale insects is called lac. Useful in making vanishes and polishes.

iv) Insects useful as drugs, food, ornaments etc,

(a) As medicine e.g. Sting of honey bees- remedy for rhenmatism and arthritis Eanthoridin - extracted from blister beetle –useful as hair tonic.

(b) As food - for animals and human being.

For animals- aquatic insects used as fish food.

Grass hoppers, termites, pupae of moths.

They have been used as food by human beings in different parts of the world.

(c) Ornaments, entertainers

Artists and designers copy colour of butterflies.

Beetles worm as necklace.

Insect collection is a hobby

(d) Scientific research

Drosophila and mosquitoes are useful in genetic and toxicological studies respectively.

(II) Helpful insects

(i) Parasitoids

These are small insects which feed and live on harmful insects by completing their life cycle in a host and kill the host insect.

e.g. Egg, larval and pupal parasitoids

(ii) Predators

These are large insects which capture and devour harmful insects.

e.g. Coccinellids, preying mantids.

(iii)Pollinators

Many cross pollinated plants depend on insects for pollination and fruit set.

e.g. Honey bees, aid in pollination of sunflower crop.

(iv)Weed killers

Insects which feed on weeds kill them thereby killers.

e.g. Parthenium beetle eats on parthenium. Cochineal insect feeds in Opuntia dillenii.

(v) Soil builders

Soil insects such as ants, beetles, larval of cutworms, crickets, collum bola, make tunnels in soil and facilitate aeration in soil. They become good manure after death and enrish soil.

(vi) Scavengers

Insects which feed on dead and decaying matter are called scavengers. They important for maintaining hygine in the surroundings.

e.g. Carrion bettles, Rove beetles feed on dead animals and plants.

d) House hold and disease carrying insects

Pests which cause damage to belongings of human being like furniture, wool, paper etc. e.g. Cockroaches, furniture beetle, sliver fish etc.

Pests which cause painful bite, inject venoms. e.g. Wasps, bees sting us. Hairy caterpillar nettling hairs are poisonous. Mosquitoes, bugs bite, piece and suck blood from us.

Disease causing Mosquito- Malaria, Filariasis ,dengue fever. Housefly- Typhoid, Cholera, Leprosy, Anthrax

Categories of pests

1. **Regular pests:** Occurring more frequently on a crop having close association with the crop. (eg) Brinjal shoot and fruit borer.
2. **Occasional pests:** Occurring infrequently with no close association with a particular crop (eg) Snake gourd semilooper.
3. **Seasonal pests:** Occurring during a particular part of the year. (eg) Red Hariy Caterpillar (RHC) in groundnut.
4. **Pesistent pests:** Occurring on a crop almost throughout the year (eg) thrips on chillies.
5. **Sporadic pests:** Occurring in a few isolated localities (eg) coconut slug caterpillar.
6. **Epidemic pests:** Occurring in severe form in a region or locality at a particular season (eg) RHC in groundnut in Bhavan Taluk.
7. **Endemic pests:** Occurring regularly and confined to a particular area or locality (eg) rice gall midge in Madurai dist.

Pesticide Application Methods

The desired effect of pesticide can be obtained only if it is applied by an appropriate method in appropriate time. The method of application depends on nature of pesticide, formulation, pests to be managed, site of application, availability of water etc.

1. Dusting

Dusting in carried out in the morning hours and during very light air stream. It can be done manually or by using dusters. Some times dust can be applied in soil for the control of soil insects. During is cheaper and suited for dry land crop pest control.

2. Spraying

Spraying is normally carried out by mixing EC (or) WP formulations in water. There are three types of spraying.

3. Granular application

Highly toxic pesticides are handled safely in the form of granules. Granules can be applied directly on the soil or in the plant parts.

The methods of application are

a) Broadcasting: Granules are mixed with equal quantity of sand and broadcasted directly on the soil or in thin film of standing water. (eg) Carbofuran 3%G applied @ 1.45kg/8 cent rice nursery in a thin film of water and impound water for 3 days.

b) In furrow application: Granules are applied at the time of sowing in furrows applied @ 3 g per meter row for the control of sorghum shootfly.

c) Side dressing: After the establishment of the plants, the granules are applied a little away from the plant (10-15 cm) in a furrow.

d) Spot application: Granules are applied @ 5 cm away and 5 cm deep on the sides of plant. This reduces the quantity of insecticide required.

e) Ring application: Granules are applied in a ring form around the trees.

f) Root zone application: Granules are encapsulated and placed in the root zone of the plant. (eg) by mixing it with equal quantity of sand in the central whorl of crops like sorghum, maize, sugarcane to control internal borers.

g) Pralinage: The surface of banana sucker intended for planting is trimmed. The sucker is dipped in wet clay slurry and carbofuran 3G is sprinkled (20-40 g/sucker) to control burrowing nematode.

4. Seed pelleting/seed dressing

The insecticide mixed with seed before sowing (eg.) sorghum seeds are treated with chlorpyriphos 4ml/kg in 20 ml of water and shade dried to control shootfly. The carbofuran 50 SP and imdacloprid is directly used as dry seed dressing insecticide against cotton sucking pests.

5. Seedling root dip

It is followed to control early stage pests (eg) in rice to control sucking pests and stem borer in early transplanted crop, a shallow pit lined with polythene sheet is prepared in the field. To this 0.5 kg urea in 2.5 litre of water and 100 ml chlorpyriphos in 2.5 litre of water prepared separately are poured. The solution is made upto 50 1 with water and the roots of seedlings in boundless are dipped for 20 min before transplanting.

6. Sett treatment

Treat the sugarcane setts in 0.05% malathion for 15 minutes to protect them from scales. Treat the sugarcane setts in 0.05% Imidacloprid 70 WS @ 175 g/ha or 7 g/l dipped for 15 minutes to protect them from termites.

7. Trunk/stem injection

This method is used for the control of coconut pests like black headed caterpillar, mite etc. Drill a downward slanting hole of 1.25 cm diameter to a depth of 5 cm at a light of about 1.5m above ground level and inject 5 ml of monocrotophos 36 WSC into the stem and plug the hole with cement (or) clay mixed with a fungicide. Pseudo stem injection of banana, an injecting gun or hypodermic syringe is used for the control of banana aphid, vector of bunchy top disease.

8. Padding

Stem borers of mango, silk cotton and cashew can be controlled by this method. Bark of infested tree (5x5 cm) is removed on three sides leaving bottom as a flap. Small quantity of absorbent cotton is placed in the exposed area and 5-10 ml of Monocrotophos 36 WSP is added using an ink filler. Close the flap and cover with clay mixed with fungicide.

9. Swabbing

Coffee white borer is controlled by swabbing the trunk and branches with lindane 1 per cent suspension.

10. Root feeding

Trunk injection in coconut results in wounding of trees and root feeding is an alternate and safe chemical method to control black headed caterpillar, eriophyid mite, red palm weevil. Monocrotophos 10 ml and equal quantity of water are taken in a polythene bag and cut the end (slant cut at 45) of a growing root tip (dull white root) is placed inside the insecticide solution and the bag is tied with root. The insecticide absorbed by root, enter the plant system and control the insect.

11. Soil drenching

Chemical is diluted with water and the solution is used to drench the soil to control certain subterranean pests. (eg) Chlorpyriphos / dimethoate used against cutworms, soilmealy bug.

12. Capsul placement

The systemic poison could be applied in capsules to get toxic effect for a long period. (eg) In banana to control bunchy top vector (aphid) the insecticide is filled in gelatin capsules and placed in the crown region.

13. Baiting

The toxicant is mixed with a bait material so as to attract the insects towards the toxicant. A) Spodoptera. A bait prepared with 0.5 kg molasses (jiggery), 0.5 kg carbaryl 50WP and 5 kg of rice bran with required water (3 litres) is made into small pellets and dropped in the field in the evening hours. B) Rats: Zinc phosphide is mixed of 1:49 ratio with food like popped rice or maize or cholam or coconut pieces (or) warfarin can be mixed at 1:19 ratio with food. Ready to use

cake formulation (Bromodiolone) is also available. C) Coconut rhinoceros beetle: Castar rotten cake 5 kg is mixed with insecticide.

14. Fumigation

Fumigants are available in solid and liquid forms. They can be applied in the following way. Soil: To control the nematode in soil, the liquid fumigants are injected by using injecting gun. Storage: Liquid fumigants like Ethylene dibromide (EDB), Methyl bromide (MB), carbon tetrachloride etc. and solid fumigant like Aluminium phosphide are recommended in godowns to control stored product pest. Trunk: Aluminium phosphide ½ to 1 tablet is inserted into the affected portion of coconut tree and plugged with cement or mud for the control of red palm weevil.

EXERCISE NO. 2
STUDIES ON PESTS OF CITRUS

1. Lemon butterfly : *Papilio demoleus* Linn., *Papilio polytes, Papilio helenus*
(Papilionidae : Lepidoptera)

Economic Importance: It causes severe damage to citrus particularly in nurseries.

Marks of Identification: Butterfly has yellow and black markings on wings Larva : Green colour and measures 38 mm, five larval instars. Early instar larva is dark with white patches resembling the "dropping of birds" when grown up it turns deep green in clolour. The larval stage lasts for 11-14 days. When disturbed they protrude two fleshy horns from the neck (Osmeterium). *P.demoleus* is a big beautiful butterfly with yellow and black markings on all the four wings, having wing expanse of about 50-60 mm. Its hind wings have a brick red oval patch near the anal margin and there is no tail like extension behind though common in Papilionidae. *P. polytes* males are black and females vary in form. *P. helenus* has black wings with three white distal spots.

Host plant: All citurs species and other plants like bael, ber, curry leaves, bawachi etc.

Life History:

Eggs: Greenish yellow colour 70 – 180, singly on tender leaves, I.P.: 3- 7 days.

Larva: L.P. 2 weeks

Pupa : Pupation on plant, remain attached by silken threads P.P. : 10-15 days, may extend upto 2-3 months in winter It pupates in a necked chrysalis attached to the plants by two fine strands of silk in the form of girdlers.

No. of Generations : 4 year.

Nature of Damage: Caterpillars feed on tender leaves right upto the midrib and defoliate the plants in case of severe infestation.

Natural Enemies: The egg parasitoids associated with this pest are *Trichogramma evanesens* Westwood (Trichogrammatidae), *Ptromalus luzonesis* (Petromilidae) and *Telenomus* sp. (Seclionidae). The larvae are attacked by yellow wasp *Polistates herebreus* and the praying mantid *Crebractor gemamatus,* the larval parasite is *Charops* sp. and *Brachymeria sp.* is parasitic on its pupa.

Management Practices :

Cultural control:

Grow attractant plants: Carrot family, Sunflower family, Buck wheat, hairy vetch, alfalfa, corn, shrubs(Lace wing)

Nectar rich plants with small flowers i.e. anise, caraway, parsley, mustard ,Sun flower, hairy vetch, buck wheat and cowpea(*Braconid* wasp)

Mechanical control:

Hand pick the larvae and destroy.

Biological control:

Conserve the parasitoids such as *Trichogramma evanescens*.

Telenomus spp on eggs *Brachymeria* spp, *Cotesia* on larvae and *Pterolus* sp. on pupae.

Chemical control:

Foliar spray Malathion @ 1 ml/ lit., Quinalphos 25%EC@ 2 ml/l of water

2. Leaf miner: *Phyllocnistis citrella.* S. (Phyllocnistidae: Lepidoptera.)

Economic Importance: Most destructive pests, active in monsoon season, infestation noticed in seedling stage. The pest in suspected to be responsible for the spread of bacterial infection causing '**citrus canker**'

Marks of Identification: Moths: Small, silver white colour, forewings with brown strip & prominent black spot near the tip. Caterpillar: Yellow in colour with brown mandibles, apodous, passes through four instars

Host Plants: All citrus species.

Life History :

Eggs : singly on underside of leaves I.P. : 3 – 6 days.

Larva : 1 – 2 weeks.

Pupa : Pupation inside the larval mines of leaves P.P. 3 – 4 weeks.

No. of generations : 9 – 13 / year.(Pest is active in monsoon season.)

Population of the pests decreases during hot summer months.

Nature of Damage: On hatching, the larva feed on leaf tissues between upper and lower surfaces of leaves making glistering zigzag tunnels. The leaves turn pale, curl & finally dry. Besides, mined leaves may get bacterial infection, which leads to 'citrus canker'.

Management Practices :

Mechanical control:

Use pheromone trap @ 5/acre.

Pruning of affected parts during winter and burning

Removal of infested leaves and their proper disposal in the initial stage.

Chemical control:

Carbofuran3%CG @ 20000g/acre

Foliar spray with Imidacloprid 17.8% SL@ 50ml and use spray volume depending on size of tree &Protection equipment used

Foliar spray Permethrin25% EC @160-240 ml in 400 l of water/acre

Granular application with Phorate 10% CG @ 6000 gm/acre

Biological Control:

Natural Enemies: The larvae are parasitised by *Cirrospiloideus phyllocnistodes*, the euliphod parasitoid's *Cirripilus quadristriatus* and *tretrachus phyllocnistoides*.

3. Citrus psylla: *Diaphorina citri* K. (Psyllidae : Hemiptera)

Economic Importance: Most destructive of all pests of citrus, also transmit "**Greening Melody**", a micoplasma disease in citrus.

Marks of ifentification: Adults: Small, dark brown in colour and measures 2.4 mm long. Wings are folded like roof over body. They remain mostly on the under surface of leaves with their heads almost touching the surface and rest of the body raised up

Host plants: Citrus & other plants belonging to family Rutaceae.i.e Curry leaves

Life History:

Eggs: In the folds of half opened leaves and leaf axis, 800, orange colour elongate thicker at the basal end anteriorly it is slightly curved & tapering I.P. : 4-6 days summer & 22 days in winter.

Nymph: They are light yellow with an orange tinge in the region of abdomen, five nymphal instars N.P. 2 weeks in summer & 3-4 weeks in winter.

Adult: Longevity may extend over 6 months. The insect is active from February and increase during March-April. It disappears by about the middle of October.

In a year there are about 9 generations. C.O.: Pests over wintering in adult stage.

Nature of Damage: Both nymph & adult suck the cell sap from tender leaves, shoot & buds, which as a result curl, dry up & ultimately drop down. Complete crop failures are reported in case of servere infestation. Honeydew exertion of the nymphs favours multiplication of black sooty mould (*Capnodium* sp.) on the leaves.

Management Practices :

Mechanical control:

Collect and destroy the infested plant parts

Biological control:

Conserve parasitoids such as *Tamarixia radiata, Diaphorencyrtus aligarhensis*

Conserve predators such as *Chrysoperla carnea*, Coccinellids, Syrphids.

Chemical control:

Systemic insecticides like imidacloprid 17.8%SL@ 50ml depending on size of tree & Protection equipment used are very effective at controlling both the nymphs and the adults.

Foliar spray Thiamethoxam 25%WG@40g in 400 l of water/acre.

Foliar spray with Oxydemeton-methyl25% EC @ 600-800ml in 600-800 l of water/acre

4. White fly: *Dialeurodes citri* A.

Black fly: *Aleurocanthus woglumi* A (Aleurdidae: Hemiptera)

Economic Importance: White fly, *D. citri* is common occurrence & destructive pest of citrus. It causes '**Kolshi**' in citrus & reduce plant vigour.

Marks of Identification: White fly: Adult: Minute insect with yellowish body & red eyes. Wings white or greyish, covered with mealy secretions. The longetivity of adults is about 2 to 8 days.

Black fly: dark orange with smoky wings and fore wings having four whitish areas of irregular shape. Nymphs : Oval shaped, scale like & blackish with marginal bristle like fringes. Black fly: Smaller in size & black, in colour.

Host Plant: Citrus, cotton, Castor Banana, Coffee & some ornamental plants.

Life History:

Eggs: Underside of leaves, I.P. 10 days.

Nymph: N.P. 3 – 10 weeks.

Pupa: Pseudo pupa (Quiescent stage) on underside of leaves, P.P.: 16 – 22 weeks.

Nature of Damage: Nymphs & adults of flies suck the cell sap from leaves, as a result leaves wither & turn brownish. Nymphs excrete honeydew on which black sooty mould develops. The blackish coating commonly called "Kolshi". Fruit setting is adversely affected in case of severe infestation.

Management Practices :

White Fly

Cultural control:

A regularly maintained program of hedging and topping can help avoid whitefly problems.

Biological control:

Parasites and predators attack the citrus whitefly

Chemical control:

Oxydemeton–methyl 25% EC @600-800 ml in 600-800 l of water/acre

Black Fly

Mechanical control:

Collect and destroy the damaged plant parts along with nymphs, pupa and adults.

Use light trap (wavelength of 550 nm)

Yellow sticky traps or cards reduce the density of black flies

Biological control:

Pupal parasitoids: *Encarsia formosa, Eretmocerus* spp

Predators: *Chrysoperla carnea,* Coccinellids, Spiders.

Chemical control:

Spray 0.05% Monocrotophos or0.03% dimethodate orphosphomidon 30 EC for second & third instar nymphs.

Spray 0.05% monocrotophos or 0.1% dimethoate or phosphomidon for the control of pupae.

Natural enemies: White fly : *Prospaltella lahorensis* is parasitic on the insect. Black fly: The hymenopterous insects parasitic on the insect are *Prospaltella divergens, Encarsia bennetti E. longifasciata, E merceti, E opulenta, E smithi, E tinctoriae, E transvena, Eretmocerus Serius, and Ablerus inquiremda, Ablerus macrocheta, Ablerus cinnectens.*

5. Fruit sucking moth: *Eudocima materna, Eudocima fullonica*, *Eudocima ancilla*, *Achoea janata* L. (Noctuidae: Lepidoptera.)

Economic Importance : Moths puncture the fruits & cases fruit rot.

Marks of Identification : Moth : Large sized, Forewings grey or brown. Hind wings orange or yellow with black spot in the center & marginal dark bands. Kidney shape black spots in *E.fullonica* & round black spots in *E.matema* Larva: Velvety dark, speckled with beautiful.

***E. materna*:** The moth has brownish black forewings with a white stripe and yellowish hind wings with a circular black spot in the middle.

E. fullonica: The moth has brownish forewings and yellowish black hind wings with a half moon or kidney shaped black spot.

E. ancilla: The forewings of this moth are dark brown with a green band in the middle; hind wings are yellowish with a kidney shaped black spot.

Host plants: Larva feeds on leaves of gulvel and vasanvel & moth feeds on fruits of Citrus, mango, pomegranate, grape, cashewnut etc.

Life History:

Eggs: 300, on leaves of weeds i.e. gulwel and vasan vel. I P: 3-4days.

Larva: Semilooper, 5 cm long, LP. : 20 days.

Pupa: Pupation in soil, PP: 9 days

S. O.: A pest is active in kharif season.

Nature of Damage: The moth emerges in large numbers after rains in July & August, when the fruits are half ripe and during nights pierce the ripening fruits with their long sharp proboscis and suck the juice. The attacked fruits develop a rot round around the seat of puncture and drop of prematurely. Bacterial infection to the infested fruit also causes rotting.

Management Practices :

Cultural control:

Use poison baits during Sep – Nov and Mar – May at initiation of fruit ripening with a solution of malathion 1ml + citrus fruit juice with 1% sugar/jaggery

Mechanical control:

Destruction of larval hosts (alternate host) around orchards. viz. gulvel and vasantvel

Collection and destruction of rotten and dropped fruits.

Adults are highly phototropic. One fluorescent light/ha one month before fruit maturation between 7.00 PM to 6.00 AM below which poison baits with sugar solution1% + fruit pulp + Malathion1 ml should be placed.

Bagging of fruits with polythene or paper covers, though effective is rather expensive and not practicable on large scale.

Creating smokes in the orchards after sunset to keep the pest away which is also rather laborious.

Chemical Control:

Arranging poison baits during Sep – Nov and Mar – May at fruiting under lights with a solution of malathion 1ml + fruit juice with 1% sugar to attract and kill adult moths.

6 Citrus Aphids: Black aphids : *Toxoptera aurantii* K (Aphididae :Homoptera)

Life Cycle:

Tristeza or quick decline is transmitted in semi persistent manner by aphid.

Eggs: Eggs are not produced by this species. Females give birth to living young.

Nymphs: There are four nymphal stages of this aphid. The first stage is approximately 1/36 inch in length and the last about 1/17 inch. They are without wings and brownish in color. Newly born nymphs are found grouped together since mothers do not move about while birthing.

Adults: Only females are found. They are oval, shiny black, brownish-black or reddish brown in color, either with or without wings, measuring 1/25 to 1/12 inch in body length and having short black-and-white banded antennae. Winged individuals tend to have darker abdomens and be slightly thinner. The incidence of winged individuals is dependent on the population density and leaf age. This is the only aphid with an **audible stridulation** or high piercing sound caused by the aphid rubbing two parts of it body together much like crickets. Large colonies will produce this scrapping sound when they are disturbed. About thirty generations succeed each other and overlap throughout the year.

Nature of Damage:

Both nymph & adult suck the cell sap from tender shoots , leaves, tender foliage and flowers. • It transmits Citrus Tristeza Virus disease. • Nymphs and adults suck the sap of leaves which leads to wilting and flower dropping. Infested leaves become cup shaped and crinkled. • Growth of the plants is hindered.

Management Practices:

Mechanical control:

Use yellow sticky trap

Biological control:

Conserve and enhance population of Predators: like Lacewings birds, earwigs, some ground beetles and rove beetles, spiders.

Chemical control:

Foliar spray with dimethoate each at 30% EC@594792ml in 600-800 l is effective. Foliar spray with Chlorpyrifos 20% EC@600-800 ml in 600-800 l of water/acre Foliar spray with Monocrotophos 36% SL @ 600-800ml in 200-800 l of water/acre Foliar spray with Oxydemeton-methyl25% EC@ 480640ml in 600-800 l of water/acre

7. Mealy bug: *Planococcus citri* (Risso) (Pseudococcidae: Hemiptera)

Life Cycle:

Eggs: Eggs are deposited as white cottony masses called ovisacs on trunk and stems of citrus plants, giving the appearance of cotton spread on plants. The glossy, light yellow eggs are oval and approximately 0.3 mm long. A female can lay from 300 to 600 eggs in her life period, which are deposited in groups of 5 to 20. Depending on the season, egg hatch may occur after 6 - 10 days or several weeks. An average of 29 eggs per day is laid by females.

Nymphs: Nymphs emerge from the ovisacs and typically settle along midribs and veins on the underside of leaves, young twigs, and fruit buttons. Wax and honeydew secreted by crawlers are visible indicators of infestations. First instar female and male nymphs are called crawlers. The nymphs take 6 to 10 weeks to reach maturity. The nymphs are yellow, oval-shaped with red eyes, and covered with white waxy particles The female nymphs resemble the adult female in appearance, while male nymphs are more elongated. Female nymphs have four instars. Males differ greatly; they have three instars and a pre-pupal stage.

Adult: Adult size ranges in length from 3 mm (females) to 4.5 mm (males). The females are wingless, white to light brown in color, with brown legs and antennae. The body of adult females is coated with white wax and bears a characteristic faint gray stripe along their dorsal side. Short waxy filaments can be seen around the margins of their oval body with a slightly longer pair of filaments present at the rear end of their body. Female mealybugs are wingless and, therefore, must be transported to subsequent host plants, although they are able to crawl for short distances. The immature can be blown by wind. Females can live for up to 29 days depending on the host plant. Males are similar in color to females and have two long backward projecting white wax threads.

Nature of Damage:

Citrus mealybug is a sporadic pest of citrus, occurring primarily in older, well-shaded groves planted on heavy soils. They will feed on the roots, bark, foliage, and fruit. The citrus mealybug injects toxic salvia while extracting plant sap resulting in defoliation, fruit discoloration, fruit splitting, and fruit drop. Mealy bugs usually gather in large numbers, causing premature leaf drop and twig dieback when they feed. Like psyllids, they secrete honeydew, which attracts black sooty mold.

Management Practices :

Cultural control:

Prune affected shoots during winter.

Destroy ant colonies.

Grow attractant plants to attract the defenders Bachelor's Buttons or cornflower (*Centaure acyanus*), coriander attract wasps.

Mechanical control:

Collect and destroy the damaged leaves, twigs and stems. Use sticky barrier (5cm length) on trunk

Biological control:

Parasitoid: *Leptomastix dactylopii* for nymphs and adult. **Predators-** Field release of Australian lady bird beetle (*Cryptolaemus montrouzieri*) @10 beetles per tree. 2. Chrysoperla 3. Coccinellids

Chemical control:

Use fish oil rosin soap 25g/lit

Spray with methyl demeton (Metasystox) or dimethoate (Rogar) 2ml /lit or confidor 200 SL @ 0.4ml/lit

8. Scale Insects: *Coccus hesperidium* (Handlirsch) (Coccoidea : Hemiptera)

Management Practices:

Cultural control:

Pruning of the scale infested twigs.

Natural predators usually keep this insect in check.

Control ants and dust which can give the scale a competitive advantage.

Field release of Vadalia and Australian ladybugs.

Biological control:

Spray dormant oil in late winter before spring.

Spray horticultural oil, if needed, year round.

Apply mixture of manure compost tea, molasses and citrus oil.

Garlic-pepper tea also helps.

Chemical control:

Foliar spray with Quinalphos 25% EC @ 2 ml/ l of water.

9. Citrus thrips: *Thrips nilgiriensis* Ramak.(Thripidae: Thysanoptera)

Nature of damage

Nymphs and adults lacerate the leaf tissue and suck the sap from fruits

Leaf curling

Ring like appearance on the fruit

Irregular mottled patches on rind

Identification of pest

Adult: Yellowish, fringed wing

Management

Cultural control:

Collect and destroy the damaged plant parts

Biological control:

Encourage the activities natural enemies such as Syrphids and Chrysopid

Chemical control:

Spraying with systemic insecticides at flush growth periods Fipronil 1 ml/l, Spinosad 0.5 ml/l

Spray malathion 0.05% or carbaryl 0.1%

EXERCISE NO. 3
STUDIES ON PESTS OF MANGO

1. Mango stem borer: *Batocera rufomaculata* DeGeer (*Batocera rubus* L.) (Cerambycidae: Coleoptera)
Economic Importance: Entire tree gets killed in case of severe infestation.
Marks of Identification: Adult: Well built, conspicuously long and brownish yellow, five cm long with two pink spots and lateral spines on prothorax and antennae as long as the body.
Larva: 8-9 cm long and have strong jaws.
Host plant:: Mango, fig rubber, mulberry etc.
Life History:
Eggs: Under loose bark, I.P. : 1-2 weeks.
Larva: Grub period about 6 months.
Pupa: Inside stem, P.P. :3-4 months.
No. of generations : 1/year.
Nature of Damage: Grubs bore and tunnel into stem as a result branches dry up and mass of refuge exudes from the bored hole. Tree may die in case of severe infestation.
Management Practices :
Cultural Control:
The affected portions with grubs and pupae removed and destroyed, if branches are affected
Mechanical Control:
When burrows are superficial, extract the grubs with stiff hooked wire and paint bordeaux paste.
Chemical Control:
The bore holes traced and opened. A swab of cotton wool soaked in chloroform or petrol 5ml or carbon disulphide or kerosene oil or dichlorvos 10ml/l inserted in to the hole and sealed with mud. Methyl parathion 1 ml/l poured in to the hole or tablet of aluminium phosphide inserted into the hole to kill the grub.
Inject borer solution (2-part CS_2 +1 part chloroform +1 part Creosote oil) or CS_2 or Ed/CT mixture or petrol in live bored holes with syringes & seal with mud.

2 Mango nut or stone weevil: *Sternochetus mangiferae* Fab. (Curculionidae : Coleoptera.)
Economic importance: Totapuri, neelam and Alfanso varities are susceptible.
Marks of Identification: Adult: Weevil is short, stout, oval and dark. The insect is popularly known as nut weevil or stone weevil. Larva: Small, thick and white, apodus, fleshy, light in colour with dark head.
Hosts Plant: Mango only. (Monophagous)
Life History:
Eggs: eggs in the skin of ripening fruit.
Pupa : Pupation inside the stone.
One generation is completed in 40-50 days. Only one generation in a year
CO : Adult weevil remain inactive from July-August onwards, hiding in the soil or underneath the bark of trees until next season.
Nature of Damage: The grubs that hatch out from the eggs laid on developing mango fruits, tunnel in a zigzag manner through the pulp, endocarp and seed coat until they reach the cotyledons and passes its entire life inside the stone. The pulp is damaged when adult makes an exit hole in seed and comes out through the pulp, rendering them unfit for consumption. As a result, discoloration of pulp adjacent to the stone and larval excreta is often seen when the infested mangoes are cut. There is no external sign of infestation on developing fruits.
Control Measure:
Cultural control:
Collection and destruction of infested and fallen fruits at weekly interval till fruit harvest.
Ploughing of orchard after harvest to expose hibernating adults, reduce, infestation levels.
Destroy all left over seeds in the orchard and also in the processing industries.
Physical Control:
Hot water treatment 50% C after harvesting of fruits for 30 min.
Biological Control:
The natural enemies recorded on *S. gravis* include a mite *Rhizoglyphus* sp., ants (*Camponatus* sp., *Monomorium* sp. and *Oecophylla smaragdina*) and fungus *Aspergillus* sp., *Beauveria bassiana* was found to be pathogenic on mango weevil.
Chemical Control:
Spraying the tree trunks with kerosene oil emulsion after harvest of fruits to kill the adults.
Spraying on young fruits with 0.1% Malathion.

3. Mango fruit fly: **(Oriental fruit fly)** *Bactrocera dorslis H.* (Trypetidae: Diptera)
Economic Importance: Most destructive pest. Rotting of fruits occur.
Marks of Identification: Adults: Small fly is distinguished by its conical abdomen & brown marking on the wings resembling to common housefly. The fly hibernates as adult during cold months & become active in hot weather.
Maggot: White, small and tapers at one end.
Host Plants: Polyphagous - mango, guava, pomegranate, citrus, banana and several vegetable crops.
Life History:
Eggs: Shiny white, slightly curved cylindrical in shape & narrow at one end 50, under the rind of the fruit. I.P. : 2-3 days.
Larva: L.P.: 1-4 weeks whitish colour apodus.
Pupa: Pupation in soil, P.P. 8-10 days
C.O. : Pest hibernates in pupal stage in soil during winter.
S 0. :Pest is active in June - August.
Nature of Damage: Maggots bore into the fruit and feed on pulp. Affected fruits start rotting and drop down. Brown rotten patch appears on fruit. These fruits are unsuitable ter consumption.
Management Practices:
Cultural Control:
Collection and destruction of fallen, rotten fruits
Raking under the trees to expose the pupae
Physical Control:
Post-Harvest Control (Heat treatment techniques):

Hot water treatment: Submerging fruits in hot water at 43 to 46.7oC for 35- 90 min.

Double dip method: Immersion of mango fruits in water at 40oC for 20 minutes, followed by 10 minutes at 46oC to get 100 per cent mortality of *Bactrocera dorsalis* eggs.

Chemical Control:

Mixing of carbaryl 10D in soil @ 50-100 g/tree.

Hanging from tree branches plastic containers with bait made of methyl eugenol 2 ml + carbofuran 3G 3 g + water one litre (200ml of bait/plastic container) to attract and kill flies.

Foliar spray with malathion 2 ml/l or acephate 1.5 g/l.

After harvesting, dip the fruits in 5% sodium chloride solution for 60 minutes to kill the eggs, if any and also to decontaminate them of insecticide residue if at all present

Biological Control:

Natural Enemies: The parasitoid associated with this pest are *Opius compensatus, Biosleres arisanus* (Braconidae), *Dirhinus giffardi* (Chalcididae), *Trybliographa daci* (Eucoilidae)

4. Mealy bugs: *Drosicha mangiferae* Green. (Pseudococcidae: Hemiptera.)

Economic Importance: Sometimes cause severe damage to mango.

Marks of Identification: Bugs are flat, oval waxy whitish insects. Female wingless while males have brownish black wings.

Life history:

Eggs: 50-60 laid inside cottony white ovisac during April to beginning of June at a depth of 50 – 170 mm in loose soil near or away from the base of the tree. I.P. 6-7 months

Nymphs: Hatch out during September but mostly during November. Female have four nymphal instars and male three.

The pre pupal & pupal period of male ranges from 2-5 and 6-13 days respectively.

There is only one generation in a year

Host Plant: Mango, Citrus & 60 other plants.

Nature of damage: The nymphs and adults suck the sap from tender stem, leaves and fruits. In case of severe infestation the tree shows sickly appearance. In citrus the growth is impaired. Leaves and flowers are shed resulting in poor setting and premature fruit fall. The honeydew excreted by the insect favours development of black sooty mould, which also affects normal photosynthetic activity of the plant. Older fruits do not develop properly.

Management Practices :

Cultural Control:

Deep summer ploughing up to base of the tree trunks, after harvesting to expose eggs of mealy bugs.

Mechanical Control:

Wrapping 25 cm wide, 400 guage polythene sheet on the tree trunk 30 cm above ground level and pasting greeze over it to prevent migration of freshly hatched first instar nymphs during winter (Nov-Dec) from soil to trees, one week before their emergence. Crawlers collecting beneath the polythene sheet may be scraped with a knife.

Chemical Control:

Dusting methyl parathion 2D or endosulfan 4D around tree and incorporating in to the soil.

Spraying with dichlorvos 1 ml or imidachloprid 0.3 ml/l or phosphamidon 1ml/l when severe mealybug infestation noticed on the twigs.

Spray with 0.04% monocrotophos or chlorpyriphosor 0.1% carbaryl.

Natural Enemies: *Menochilus sexmaculatus, Chrysopa sceletes, Beauveria bassiana Coccinella sperumpunctata, C undecimpunctata, Cheilomenes sexmaculatus, Rodolia fumida, Aulis vestita* (Coccinellidae)

5. Mango hoppers or Jassids: *Amritodus atkinsoni (* largest), *Idioscopus clypealis* (smallest), *I. niveosparsus* (medium) (Cicadellidae: Hemiptera)

Economic Importance: Most destructive pests, occur regularly during flowering season and cause huge losses.

Marks of Identification: They are wedge shaped measuring 3 to 7 mm in length and move diagonally.

Among these

A. atkinsoni is the largest and light brown having two black spots on scutellum, the anterior argin of pronotum and vertex.

I. clypealis is the smallest and lighter in colour with two spots on the scutellum dark spots on the vertex. Clypeus is entirely black.

I. niveosparsus is slightly smaller with three spots on the scutellum and prominent white bar crossing its dusky wings. It is the most injurious species in South India.

Host plants: Polyphagous: Mango, citrus, mulberry, chikoo etc.

Life History:

Eggs: Heavy egg laying on flowers and midribs of young leaves. I.P.: 4-6 days.

Nymph: N.P.: 8-13 days.

Life cycle: Completed in 12-29 days.

C.O. : Adult hibernates under the bark of trunk.

S.O. : Pest is active during flowering season. (Feb. – April)

Nature of Damage: Both nymphs and adults suck the cell sap from the young leaves, tender shoots and flower (inflorescence) due to which flowers, buds wither and die off. The damage is more pronounced in flowering season. Premature dropping of flowers and fruits occur. Also excrete honeydew, which encourages development of black sooty mould. As a result upper surface of leaves, flowers and shoots become black which affect the fruit setting.

Management Practices :

Cultural Control:

Keeping orchard clean

Avoiding overcrowding and waterlogging

Proper pruning of the tree after harvesting to facilitate proper sunlight and air that minimises hopper population

Chemical Control:

Spray schedule is recommended as follows

At flower bud initiation, endosulfan 3 ml/l or carbaryl 3 g/l

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

During anthesis and pollination, insecticides should not be sprayed. In case of very high population of hoppers at this stage, endosulfan 2ml/l is recommended

When fruits are of pea size, phosphamidon 1ml/l or dimethoate 2ml/l or acephate 1g/l

Adding sulphur 3.5g/l to the insecticide based on need to check mites and sooty mould,*Capnodium mangiferum*

Directing the spray first to stem/ trunk, then branches, twigs, leaves and finally inforescence is a recommended method.

Biological Control:

Natural Enemies:*Chrysopa lacciperda*, *Epipyrops fuliginosa, Menochilus sexmaculatus, V.lecanii.*

6. Shoot borer: *Chlumetia transversa* WIK. (Noctuidae: Lepidoptera.)

Nature of Damage: Caterpillar feeds on tender leaves initially and then bore into the growing shoots from the growing tip downward and kill the shoots completely.

Management Practices :

Cultural Control:

Clipping off and destruction of affected shoots

Chemical Control:

Foliar spray with carbaryl 3 g/l or quinalphos 2 ml/l at the time new flush.

7. Slug Caterpillar *Parasa* (*Latoia*) *lepida* (Limacodidae : Lepidoptera)

Marks of Identifications:

Caterpillar - fleshy and slug like, greenish body with white lines

Four rows of spiny tipped red or black which causes irritation and pain due to glandular secretion.

Adult - green wings with prominent dark patch at the base of each forewing.

Life Cycle:

Moth lay eggs flat shining eggs in batches of 20-30 on undersurface of leaves.

The caterpillars feed on leaves. The full grown larva is 2.5 mm approximately. Larva possesses spines which cause irritation and pain if touched.

Pupation takes place on stem in compact elliptical cocoon.

Nature of Damage:

Feed gregariously on the leaves.

Cause defoliation – leaving only the midrib and veins.

Management Practice:

Mechanical Control:

Light traps maybe installed when adult moth of the caterpillar emerged.

Chemical Control:

Spray quinalphos 2 ml/l water.

8. Thrips *Thrips hawaiiensis* Thripidae: Thysanoptera

Thrips mainly infest flowers and tender fruits. They lacerate the tissues of tender fruits and suck oozing out sap. Damage causes scab on fruits which lose their marketability.

Management Practice:

Chemical Control:

Foliar sprays with acephate 1.5 g/l or fipronil 2 ml/l when thrips are found along with mango hoppers, thiamethoxam 0.3 g/l are recommended.

9. Leaf Gall Midges

Amradiplosis echinogalliperda, Procontarinia matteiana Cecidomyiidae: Diptera

Flies are mosquito like; maggots are small, yellow and apodous. Areas of ovipositional punctures on leaf develop into galls. Maggots feed within the galls.

Management Practice:

Chemical Control:

Spraying NSKE 5% or quinalphos 2 ml/l at new flush is effective.

EXERCISE NO. 4
STUDIES ON PESTS OF GRAPEVINE

1. Flea beetle or Udadya beetle: *Scelodonta strigicollis* M. (Chrysomelidae: Coleoptera)
Economic Importance: It causes severe damage to buds and tender shoots. The damage may extend from 11 to 31%.
Marks of Identification: Adult: Small, shining flea beetle with metallic bronze colour & 6 dark spots on the elytra. Grub : Small, dirty white.
Host plant : Specific to grapevine, however recorded on pangara.
Life History:
Eggs: In crevices of vines and under bark, I.P. : 4-8 days.
Larva: L.P. 35-45 days, feed on roots.
Pupa: Pupation in soil, 6-8 cm deep in earthen cells, P.P. : 7-10 days.
C.O. : Adult beetles hibernate under the bark from November to April
S.O. : Pests is very destructive to fresh flush after pruning.
Nature of Damage: Adult feed voraciously on sprouting buds & tender shoots soon after prunning. Buds dry up and do not develop. Beetle also feed on mature leaves giving shot hole appearance. Grubs feed on roots but do not cause severe damage. It has been reported to cause 11-31% damage in the vineyards.
Management Practices :
Cultural control:
Wider row spacing - reduces the attractiveness to the flea beetles
Mechanical control:
Remove the loose bark at the time of pruning to prevent egg laying.
Shake vines to dislodge adult beetles, collect into trays containing kerosenated water (1 kerosene: 9 water) and destroy them.
Botanical control:
Neem based, emulsifiable water soluble formulations can be sprayed. Doses depend on azadirachtin concentrations in formulations viz., 50000 ppm formulation is sprayed at 1ml / l, while that with 10000 ppm and 3000 ppm can be sprayed at 2.5 ml and 5 ml per liter dose, respectively.
Chemical control:
First spraying when buds swell in early morning or evening hours to kill beetles and second spray after 10 days with monocrotophos 1.6 ml/l or or imidachloprid 0.3 ml/l or quinalphos 2ml/l or lambda-Cyhalothrin 4.9%CS @0.5 g / l of water malathion50% EC @ 0.5 ml l of water.

2. Thrips: *Rhipiphorothrips cruentatus* H. (Thripidae: Thysanoptera)
Economic Importance: It is one of the important pests of grapevine causing scab formation in berries.
Marks of Identification: Adults : Minute with black fringed wings . Females dark brown, males bright yellow. Nymphs: Reddish.
Host Plants: Polyphagous - mango, pomegranate, rose, guava, jack fruit, cashew etc.
Life History: Both sexual and parthenogenesis reproduction occur.
Eggs : In leaf tissues, I.P. 3-8 days.
Nymph: Nymphal period 11-22 days.
Pupa: Pupation in soil, P.P. 2-5 days.
Adults longevity of male-2 to6 days,while female 18-20 days.
Life cycle ; Completed in 14-33 days. No. of generation : 5-8/year.
C.O. : Pests over winter in pupal stage in soil.
S.O. : Pests is active in summer.
Nature of Damage: Both nymphs and adults scrap the ventral surface of leaves, flower stalks, berries and suck the oozing cell sap. As a result affected leaves show silvery white scorchy patches with curly tips, flowers shed & scab formation noticed on infested berries.
Management Practices :
Cultural control:
Install 4-20blue sticky coloured traps (15 X 7.5 cm) per acre 15 cm above the canopy to monitor thrips population.
Deep ploughing in summer or raking of soil in vineyards helps to destroy its nymphal stages and minimizing the incidence.
Removal of weeds and alternate host plants like hibiscus, okra, custard apple, guava etc. in and nearby vineyards in and around the vineyards throughout the year.
Collect and destroy damaged leaves, fruits and flowers.
Biological Control
Natural enemies of thrips:
Predators: Predatory mite (*Amblyseius swirskii*), predatory thrips (*Aeolothirps spp.*), anthocorid bug (*Orius insidiosus*), The parasitoid associated with this pest is *Thripocentus maculatus* wat.
Chemical control:
Emamectin benzoate 5% SG @ 88 g in 200-400 l of water/acre or fipronil 80%WG @ 20-25 g in 300-400 l of water/acre or lambda-cyhalothrin 4.9% CS @100 g in 200-400 l of water/acre

3. Mealy bug: *Maconellicoccus hirsutus* Green (Pseudococcidae : Hemiptera)
Economic Importance: It cause severe damage, infest grape bunches.
Markers of Identification: Adults : Females are pinkish covered with mealy white waxy secretion. Eggs and crawlers are orange in colour.
Host Plant: Hibiscus, bhendi, ambadi, mulberry, custard apple, guava etc.
Life History :
Eggs : 350 – 500, cracks, crevices in cottony cushion ovisac (under bark) I.P. : 5 – 10 days.
Nymph : Female 3 instars, male – 4 instars.
Pupa : Noticed only in males.
Life Cycle: Completed in 1 month.
S.O.: Pest is active in the month Feb & March and June to August.
Nature of Damage: Both nymphs and adults suck the cell sap from leaves, shoots and bunches, Develop sooty mould on bunches and cause severe damage to fruit bunches.
Management Practices:
Cultural control:
Removal of weeds and alternate host plants like hibiscus, okra, custard apple, guava etc in and nearby vineyards throughout the year.
Deep ploughing in summer or raking of soil in vineyards helps to destroy its nymphal stages and minimizing the incidence.

Mechanical control:

Remove and destroy the loose bark.

Biological Control:

Natural enemies of mealybug:

Parasitoid: Parasitic wasps,

Predator: Release exotic predator, *Cryptolaemus montrouzieri* @ 10 beetles/vine

Neem based, emulsifiable water soluble formulations can be sprayed. Doses depend on azadirachtin concentrations in formulations viz., 50000 ppm formulation is sprayed at 1ml / l, while that with 10000 ppm and 3000 ppm can be sprayed at 2.5 ml and 5 ml per l, respectively.

Chemical control:

Buprofezin25%SC@2 ml/l of water or methomyl 40% SP@ 2.5 g /l of water

4. Mites: *Tetranychus urticae* Koch. (Tetranychidae: Acarina.)

Economic Importance: The pest is of regular occurrence and is more serious now a day Active during summer months.

Marks of Identification: Adults : Minute, have 4 pair of legs, reddish or yellowish white in colour with two black spots on the abdomen hence called two spotted mite.

Nymphs : White in colour.

Host Plants: Grapevine, roses, banana, papaya, brinjal and marigold.

Life History:

Eggs : 50 under surface of leaves, I.P. : 7-9 days.

Nymph : Nymphal period 2 weeks

Life cycle : 9 – 15 days. S.O. : Pest is active in summer months.

Nature of Damage: Both nymph and adult suck the cell sap from lower surface of tender leaves. The infested leaves turn yellowish along the leaf veins. Brown burnt patches develop on leaves, which wither and finally dry. Berries do not develop properly, become pale and wrinkled.

Management Practices :

Cultural control:

Proper irrigation scheduling reduces the water stress and also increases the humidity thereby reducing the mite population

Biological control:

Several predatory insects and spiders feed on mites but the most efficient natural predators of mite pests are predatory mites.

Natural enemies of mites:

Predators: Predatory mites (*Phytoseiulus persimilis*, *Amblysius* spp.), predatory beetles such as small staphilinids (*Oligota* spp.), ladybird beetle, lacewing, predatory thrips, anthocorid bug (*Orius* spp.), mirid bug; *Lacanicillium (Verticillium) lecanii, Beauveria* spp. (entomo pathogenic fungi)

Chemical Control

Spray 0.05% chlorpyriphos 20 EC, / 80% Walable sulphur, Dicofol 2 ml/l, fenazaquin 2.5 ml/l water as soon as the indecencies noticed.

5. Stem Girdler: *Sthenias grisator* fab (Cerambycidae: Coleoptera.)

Economic Importance::Minor pests but may assume a serious status.

Nature of Damage: During the day hours adults hide on the lower side of leaves or under the forkings of branches. The girdling of green branches is an essential event before egg laying. This results in considerable damage to the vines as they dry up above the point of gridling. The bark and wood are cut right up to the center and at times even the branches are cut in to two bits. Girdlings is done at any place from 15 cm to 3 meters above the ground. Branches varying from 1.25 to 2.50 cm in thickness are preferred.

Management Practices:

Cultural control:

Cutting of infested shoot bellow the lower girdle before adult emerge in the summer and destroy them may help to reduce the population of insects.

If low levels of grape cane borer are present in your vineyard, populations can be reduced by cultural practices such as removal and destruction of affected canes and excess dead wood from the canopy during pruning.

Chemical control:

Malathion 50% EC @ 0.5 ml /l of water

Spray the vines with monocrotophos 40 EC 1.6 ml/l or Carbaryl 50 WP 1 g/l.

EXERCISE NO. 5
STUDIES ON PESTS OF GUAVA

1 Fruit fly : *Bactrocera dorsalis, B. diversus, B. zonatus, B. cucurbitae* (Trypetidae : Diptera)

Economic Importance: It is a pest of potential importance on guava. Pest is seen allover the country.

Of many species Bactrocera, *B. dorsalis* is the most common causes considerable loss to fruit yield.

Host Plants : It is a pest of several fruits such as mango, guava, brinjal, chillies, loquat, apricot, plum, peach, cherry, chiku, ber, citrus etc.

Egg: Fly lays the eggs on developing fruits.

Larva: Maggots enter into the fruit and feed on the pulp. The damage leads to the formation of soft patches on the fruit and premature drop of fruits.

Pupa: The mature maggots come out of the fruit and fall to the ground and pupate in soil.

Nature of Damage: Premature fruit drop, fruits with exit holes and soft patches are the symptoms of damage.

Management Practice:

Cultural Control:

Collection and destruction of fruits, periodical raking of the plant basins.

Chemical Control:

Incorporation of carbaryl 10D @ 50-100 g / tree manages the pupa. Poison baiting with a mixture of molasses / sugar @ 200 g and malathion 50 ml in 2litres of water kept in small earthen pots in the field attracts and kills the adults.

2. Spiraling white fly : *Aleurodicus dispersus* Rus. (Aleyrodid : Hemiptera)

Economic Importance: This is polyphagus species is widly distributed through out the world and was first reported to occur in India in 1995 on tapioca and other cultural crops. The pest mostly attacks old leaves during November and during April attacks tender leaves. Peak activity of pest is seen during the month of February. Adult spiralling whitefly is bigger than the other aleurodids.

Marks of Identification: Female are bigger in size and the males are recognizes distinct elongate claspurs.

Life cycle :

Eggs are laid in groups of 15-25 on the undersurface of the leaf in circular fashion, hence spiralling whitefly. Fecundity is 200 eggs. Nymphs are covered with white cottony mass. Nymphs: 12-30 days

Host plant: It has many cultivated and wild hosts. The host plants include trees like Guava, papaya, banana, flower plants, forest trees and weeds.

Nature of damage: Both nymph and adults suck the cell sap from the leaves. Its infestation divatalise the plants due to extensive draining of sap and also development of sooty moulds on the honeydew excreted by the nymphs which fall on the leaves and fruiting bodies. The vigour of the plant and fruit yields are reduced.

Management Practices :

Mechanical Control:

Timely pruning of plants and balanced nutrition. Arranging yellow sticky traps in the gardens especially during night times for the flying adults

Biological Control:

Aphelinid, Encarsia sp. Are the most important in reducing the population. *Cryptolaemus montrouzieri* and *Mallada* sp. are the other natural enemies associated with this pest.

Chemical Control:

Spray application of also reduce the damage Spray application of malathion 1% or neem oil 5% 0.5 ml /l or neem based product, the insect growth regulator diflufenthiuron 12% minimize severity of infestation. Acetamiprid 1 gm/l.

3. Bark eating caterpillar or Bark borer: *Inderbela quadrinotata* W. *I. tetraonis* M

Inderbellidae: Lepidoptera

Economic Importance: It causes severe damage to guava in Maharashtra State. Occasionally these pests in large numbers cause severe damage especially to old trees.

Marks of Identification: Moth: Short, stout, ashy grey in colour, large size with wings span of about 4 cm in female and about 3 cm in male, light grey to light brick red in colour with dark brown patches or dots on wings. Larva: Dirty brown in colour & measures 4 cm., ribbons of wood chips, frass & silken threads over the bark surface from the webbing.

Host Plants: Citrus, mango, ber, guava, pomegranate etc.

Life History :

Eggs : 350, but in small groups of 15-20 eggs each on bark in May/June, IP: 8-11 days

Larva: L.P. 8-10 months till about 3rd week of April (Long larval period).

Pupa Pupation inside larval tunnel, PP. : 21-41 days.

Moth longevity: 3 days. No. of generation - 1/year.

Nature of Damage: Larvae bore into wood making short tunnels in which they remain hiding practically the whole day & come out for feeding on fresh areas only during night on the bark. Dirty, elongate, zigzag, ribbon like messy web consisting of bits of bark pices, exceta, an inch or more in width or even upto 2 feet in length found on trunks and branches of tree and their very presence gives an unhealthy look. As a result of feeding on bark the sap conducting tissues are damaged which interupt the translocation of cell sap. The growth & fruit setting is adversely affected.

Management Practices :

Mechanical Control:

Remove ribbon like silken webs from affected branches or trunks.

Probing - Killing the grubs by inserting pointed iron wires inside the holes.

Chemical Control:

Inject CS2 or borer solution (2 parts CS_2: + 1 part chloroform + 1 part Creosote oil) in borer holes & plaster the holes with mud.

Insert insecticide-soaked cotton plugs into the borer holes & plaster the holes with mud.

Spray 4g carbaryl 50 WP or 10 ml fenitrothion 50 EC or 20 ml dichlorvos or chlorpyriphos 35 EC 20 ml in 10 lit of water. These chemicals should be applied after removing webbings.

Biological Control:

Natural enemies- The parasite *Zenilia haterusiae* has been noticed attacking the larvae of this pest.

4. Fruit Borer Complex:

a. Capsule borer: *Conogethes punctiferalis* Guenée (Lepidoptera: Crambidae)
b. Pomegranate butterfly: *Deudorix isocrates* Fabricius (Lepidoptera: Lycaenidae)
c. Fruit borer: *Rapala varuna* (Hewitson) (Lepidoptera: Lycaenidae)

Life Cycle:

Egg: Eggs are laid singly on tender leaves, stalks and flower buds.

Larva:

Pale reddish brown with black blotches and tubercles on body. (Capsule borer)
Dark brown, short and stout, covered with short hairs, larval period lasts for 18-47 days. (Guava fruit borer/ pomegranate butterfly)

Pupa: Pupates on plants in stem or capsule. (Capsule borer)
Development occurs either inside the damaged fruits or on the stalk holding it. (Guava fruit borer/ pomegranate butterfly) Pupal period lasts for 7-34 days. Total life cycle is completed in 1 to 2 months.

Nature of Damage:

Capsule borer:

Stem dries up as larva bores into it and then damages capsules.
Caterpillar bores into young fruits but they may also bore into buds and tender shoots.
Feeds on internal contents (pulp and seeds)
Infected fruits dry up and fall off without ripening
The affected fruits are generally deformed at the point of entry of larvae.
Larvae faeces may be seen exuding out of the borer hole. Such fruits weaken, rot and drop down.

Guava fruit borer/ pomegranate butterfly

Caterpillar/larva bores into young fruits.
Feeds on internal contents (pulp and seeds) making the fruit hollow from inside.
Fruit rotting and dropping.

Magement Practice:

Cultural control:

Detect early infestation by periodic monitoring.
Keeping basin clean.
Maintain adequate aeration by proper training and pruning
Castor should not be cultivated close to guava as this is the most preferred host of this pest.
Collect and destroy the infested fruits regularly.
Cover fruits with paper bags.
Remove and destroy the affected fruits.
Pomegranate should not be cultivated close to guava as this is the most preferred host of this pest
Collect and destroy the infested fruits regularly.

Mechanical control:

Remove the affected ruits of the plant and destroy.
Remove weeds of compositae family
Prune the affected parts of the plant and destroy them.
Detect early infestation by periodic monitoring & install light trap @ 1/ acre to monitor in between 6 pm and 10 pm.and mechanical collection of insects

Chemical Control

Insecticides: malathion 50 EC 0.1% two rounds, one at flower formation and next at fruit set.

5. Green Scale Insects: *Coccus viridis* (Coccidae: Hemiptera)

It is distributed through world.

Mark of Identification:

Nymphs pale lemon yellow.
Adults – green colour, flat and oval shaped softe scale

Nature of Damage:

Nymphs and adult suck cell sap from leaves.
Yellowing of leaves takes place.

Management Practices:

Cultural control:

Pruning of the scale infested twigs.

Biological control:

Natural predators usually keep this insect in check.
Field releases of Predator- *Cryptolemus montrouzieri* - 20 beeteles/tree.
Parasitoids- *Aneristis spp, Coccophagus cowperi, C. bogoriensis*

Chemical control:

Foliar spray with Quinalphos 25% EC @ 2.5 ml/l of water, Thiamethoxam 25% WG 0.25 gm/ lit water.

6. Mealy bugs: *Ferrisia virgata* Cock. (Pseudococcidae: Hemiptera.)

It is otherwise called white tailed mealy bug /striped mealy bug. It is a widely distributed species in tropical and subtropical countries.

Host Plants: It also infests bhendi, amaranthus, coccinia, colocasia, lab lab, tomato, brinjal, cashew, anona, guava, amla, grape, tobacco, pepper, cotton, betelvine

Mark of Identification: Female bug is apterous with two long prominent waxy filaments at the posterior end and a number of waxy hairs over the body covered with waxy powder. In the posterior end of the body, the dorsum has a prominent blackish patch.It has the habit of encircling itself by secreting thin glassy threads of wax specially when its population is less.Reproduction takes place both sexually and parthenogenitically, the latter being more common. Mating takes place only once and lasts for about 12-23 minutes.

Life cycle: The female lays the eggs in groups which lie under its body. Fecundity ranges from 109 to 185 during aoviposition period of 20-29 days. Incubation period is about 3-4 hours. Male and female nymphs moult 3 - 4 times respectively and their development period varies from 26 to 47 and 31 to 57 days. Longevity of female is 36-53 days and that of male is only 1-3 days.

Nature of Damage :Nymphs and adults remain clustering upon the terminal shoots, leaves and fruits and suck the sap which results in Yellowing, withering and drying of plants or shedding of fruits etc. Formation of sooty mould due to honey dew excretion. In dry weather they may move down below ground and inhabit the roots.

Management Practice:

Cultural:

Periodical raking of basins and application of balanced dose of fertilizers especially N.

Mechanical:

Pruning and destruction of the infested twigs. The branches that are touching the ground to be cut and destroyed.

Arranging the polythene sheet around the stem.

Biological control:

Predators Chrysoperla carnea, Cryptolaemus montrouzieri, Pullus sp. suppress the natural population.

Chemical Control:

Spray dichlorvos1.0 ml/l or acephate 1.5 g/l.

EXERCISE NO. 6
STUDIES ON PESTS OF BANANA AND PAPAYA

PESTS OF BANANA

1. Banana Root Stock/Rhizome Weevil: *Cosmopolites sordidus* Germar Curculionidae: Coleoptera

Economic Importance:

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

Lifele Cycle:

Eggs: White elongated oval eggs are laid singly in small pits made in the pseudo stem near ground level. They measure about 2-3 mm long. Eggs hatches in 5 -8 days.

Grub is dwarf, stumpy, legless creamy white with a red head and wrinkled body. Larval period 14-21 days.

Pupa: Pupation takes place in an oval chamber prepared just beneath the surface of the sucker. The pupal period is 5-6 days.

Adult is medium sized, 10-13 mm long, stout, brown initially but turns almost black after a few days. Longitudinal ridges are seen on elytra and abdomen is not covered fully. The adults also tunnel within the stem feeding on internal tissues during night.

Nature of Damage:

The grubs tunnel the rhizome, which is roughly circular and increases in size with the growth of the grubs. The rhizome becomes riddled with tunnels. The leaves turn yellow and dry. The tissue at the edge of the tunnel turns brown and rots. The grub also bores into the pseudo stem even up to 2-3' up. Due to the damage, the banana plants may break down when there is strong wind.

Blackened mass of rotten tissue in which case the grub deserts the rhizome.

The plants may show premature withering, the leaves become scarce, and the fruits become under sized. Very few suckers emerge from the affected plant.

MANAGEMENT:

Cultural Control:

Obtaining suckers from healthy fields for planting.

Clean cultivation and sanitation in the orchard.

Avoiding ratooning and changing the field every year.

Uprooting and destroying the affected pseudo stem and rhizome in which grubs are present.

Trimming the rhizome

Avoid growing Robusta, Karpooruvally, Malbhog, Champa and Adukkar

Grow less susceptible varieties like Poovan, Kadali, Kunnan, Poomkall

Mechanical Control:

Use cosmolure trap at 5/ha

Give temporary support to the plant.

Chemical Control:

Before planting, the suckers should be dipped in 0.1 per cent quinalphos emulsion.

Dusting the pits with carbaryl 10D 50g/ pit or 250 g neem cake/ pit before planting.

Applying contact insecticide during July - September at fortnightly intervals to prevent attack.

Soil incorporation at the time of planting: carbofuran 3 G 10g, phorate 10 G 5 g/plant.
Spraying the pseudostem and drenching around the base of the tree with chlorpyriphos 2ml /l and after a week spraying and drenching with malathion 2 ml/ l
Apply castor cake 250g or carbaryl 50g dust or phorate 10g per pit before planting also prevents infestation
In Severe attack dimethoate, methyl demeton may be sprayed around the collar region.

2. Banana (Pseudo) stem weevil / borer: *Odoiporus longicollis* Olivier Curculionidae: Coleoptera
It is a serious pest of banana in Tamil Nadu, Uttar Pradesh, Manipur, West Bengal, Kerala, Assam, Bihar, Karnataka.
Life Cycle:
Eggs are laid at random on cut ends of pseudostem, yellowish-white, cylindrical in shape. Egg period is 3-5 days in summer and 5-8 days in winter
Grubs are apodous, creamy white with dark brown head. Larval period is 26 to 68 days in summer and winter, respectively.
Pupa is pale yellow colour, fibrous cocoon formed inside the tunneling on the periphery. pupal period is 20-29 days in summer and 37-44 days in winter.
Adults are robust, reddish brown and black weevils. 20-25 days.
Nature of Damage:
Grub bore into pseudostem making tunnels.
Tunneled part decomposes and pseudostem becomes weak.
They also Cut holes on outer surface later blackened mass comes out from the bore hole.
Wilting of the plant. Infestation of the weevil normally starts in 5 month old plants.
Management Practice:
Cultural control:
Remove dried leaves periodically and keep the field clean
Prune the side suckers every month
Use healthy and pest free suckers to check the pest incidence
Do not dump infested materials into manure pit
Uproot infested trees, chop into pieces and burn
Chemical Control:
Foliar spray with chlorpyriphos 2.5 ml/l two to three times at three weekly intervals, injection of dichlorvos 1ml/l into the bore hole are effective measures.

3. Banana Rust thrips: *Chaetanaphothrips signipennis* Bagnall Thysanoptera: Thripidae
Pest is prominent in Uttar Pradesh. Warm and humid weather is favorable. Adult banana rust thrips reproduce sexually. The entire life cycle (egg to adult) of banana rust thrips is completed in approximately 28 days but may take up to 3 months during the cooler season.
Life Cycle:
Egg: After mating, females lay kidney-shaped eggs that are invisible to the naked eye by depositing them in plant tissue where the thrips feed. Eggs hatch into nymphs in 6 to 9 days
Nymphs are gregarious and feed by sucking the plant sap with their mouthparts.
Prepupa and pupa: Prepupae look similar to nymphs but have wing pads. After 2 to 5 days, prepupae enter the pupal stage, which has longer wing pads. Both stages remain in the soil, medium or debris beneath the host plant and are capable of crawling but do not feed.
Adult - Yellowish white with shaded wings.
Nature of Damage:
Yellowing of leaves and rusty growth over fruit. The early symptoms appear as water-soaked smoky areas where the colonies congregate to feed and oviposit between touching or adjacent fruit. Rusty reddish discolouration on the fingers. These areas then develop the typical rusty-red to dark brown-black discolouration.
Management Practice:
Cultural Control:
Destroya all volunteer plants and old neglected plantation.
Use healthy and pest free suckers for plantaion.
Regular checking of fruit under the bunch covers is essential to ensure the damage.
Mechanical control:
Hot water treatment prior to planting.
Bunch covers (which cover the full length of the bunch) protection applied very early.
Bilogical Control:
Nymphal parasitoid of thrips: *Ceranisus menes*
Predators of thrips: Syrphid fly, Predatory thrips, Lacewing, Coccinellid.
Chemical Control:
Bunches, pseudostem and the suckers should be sprayed with chlorpyrifos 2 ml/l.
Soil application of fipronil and bifenthrin.

4. Banana aphid: *Pentalonia nigronervosa* Coquerel Aphididae: Hemiptera
Pest is distributed in West Bengal, Uttar Pradesh, Tamil Nadu, Karnataka, Maharashtra, Kerala, Delhi, Gujarat, Andaman and Nicobar.
Life Cycle:
Nymph: Oval or slightly elongated, reddish brown with six segmented antennae. 3-5 days.
Adult: Small to medium sized aphids, shiny, reddish to dark brown or almost black. They have six segmented antennae and prominent dark veins. Adults start producing young one day after reaching maturity. They can give birth to 4 aphids per day. A single female produces 35-50 nymphs during its life span of 27-37 days. There are four instars and each instar is completed in 2-3 days. 30-40 overlapping generations are seen in a year.
Nature of Damage:
The nymphs and adults suck sap from the plant parts and in case of severe infestation progressive leaf dwarfing, leaf curling is seen. Fruit bunches become small and the fruits are distorted. These aphids also act as persistent vectors of **Bunchy top of banana**.
Management Practice:
Cultural control:
Musa AAB variety of banana is resistant to aphids and thus resistant to Bunchy top.
Ensure clean cultivation.
Biologiocal Control:
Predators: Encourage activity of predator coccinellids such as *Scymnus*, *Chilomenes sexmaculatus*, and lacewing, *Chrysoperla carnea*, ladybird beetles and parasitic wasps. Carrot family, Sunflower family, Marigold, Buck wheat, Spear mint (Syrphid mite, lace wing, Minute pirate bug, Damsel bug and lady beetle).

Chemical control:

Spray application of dimethoate 30% EC 2 ml/l or monocrotophos 1.6 ml/ l is effective. Apply carbofuran 3% CG @166 g/sucker, direct the spray towards the crown and pseudostem base upto ground level.

5. BananaTingid or Lacewing Bug: *Stephanitis typicus* Distant (Hemiptera: Tingidae)

Pest is distributed in Tamil Nadu, Malbar Coast, Gujarat. Small, whitish lacewing bug found in colonies on the foliage.

Host Plants: Coconut, oil palm, banana, turmeric, cardamom, and Colacasia.

Life Cycle:

Nymphs: Yellow colour nymphs found on the under surface.

Adult: Yellow colour with minute fringed wings, seen under surface of leaves.

Nature of Damage:

Nymphs and adult suck the cell sap from underside of leaves and leave become pale, yellowish. Infestation leads to the formation of white leaf spots surrounded by brown yellow hallow.

Management Practice:

Cultural control:

Collect and destroy the damaged leaves, flowers and fruits along with life stages

Mechanical control:

Use yellow sticky trap at 15/ha

Chemical control:

Spraying dimethoate 30 EC 2 ml/lit.

6. Banana leaf eating caterpiller: *Spodoptera litura* Fabricius (Lepidotera: Noctuidae)

It is found throughout the tropical and sub tropical parts of the world, wide spread in India.

Host Plants: Besides tobacco, it feeds on cotton, castor, groundnut, tomato, cabbage and various other cruciferous crops.

Life Cycle:

Eggs: Female lays about 300 eggs in clusters. The eggs are covered over by brown hairs and they hatch in about 3-5 days.

Larva: Caterpillar measures 35-40 mm in length, when full grown. It is velvety, black with yellowish – green dorsal stripes and lateral white bands with incomplete ring – like dark band on anterior and posterior end of the body. It passes through 6 instars. Larval stage lasts 15-30 days.

Pupa: Pupation takes place inside the soil, pupal stage lasts 7-15 days.

Adult: Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings. Hind wings are whitish with brown patches along the margin of wing. Pest breeds throughout the year. Moths are active at night. Adults live for 7-10 days. Total life cycle takes 32-60 days. There are eight generations in a year.

Nature of Damage:

Young larvae feed by scrapping the leaves from ventral surface

Later on feed voraciously at night on the foliage.

Management Practice:

Cultural methods:

Collect and destroy egg masses and caterpillars

Use burning torch to kill the congregating larvae

Summer ploughing to expose to the pupae.

Grow repellant plants: Osimum/ Basil

Attractant plants: Carrot family, Sunflower family, Buck wheat, hairy vetch*, alfalfa, corn, shrubs(Minute pirate bug & Lace wing)

Nectar rich plants with small flowers i.e anise, caraway, dill, parsley, mustard, Sun flower, hairy vetch*,buck wheat and cowpea (Braconid wasp)

Mechanical control:

Hand pick and destroy the egg masses and caterpillars

Collect and destroy the damaged plant parts.

Use pheromone @ 4-5 traps/acre.

Use light trap to attract and kill the adults.

Stir the soil at the base of the plant to expose the pupae.

Biological control:

Field release of egg parasitoids

Telenomus spodopterae

Telenomus remus

Encoerage the activity of larval parasitoids *Ichneumon promissorius Carcelia* spp*, Campoletis chlorideae*

Pupal parasitoids: *Ichneumon* sp

Predators: *Chrysoperla carnea,* Coccinellids, King crow, Braconid wasp, Dragon fly, Spider, Robber fly, reduviid, Praying mantis, Fire ants, *Chaetopthalmus* (crab),

Conserve nematode, *Ovomermis albicans*

Chemical control:

Spray quinalphos 25 EC @ 2 ml/lit water, Flubendiamide 0.5 ml/l of water.

PESTS OF PAPAYA

1. Mealybug: *Paracoccus marginatus* Williams & Granara de Willink Pseudococcidae: Hemiptera

The papaya mealybug is believed to be native of Mexico and/or Central America, where it never acquired the status of a serious pest. The pest has been recently noticed in other states such as Karnataka, certain parts of Andhra Pradesh and Malappuram and Thrissur districts of Kerala. The pest has also spread to Pune area of Maharashtra and is likely to be reported from other parts of the country as well.

Life Cycle:

Egg: Females usually lay 100 to 600 eggs. Eggs are greenish yellow and are laid in an **ovisac sac** that is three to four times the body length and entirely covered with white wax. Egg-laying usually continuous over a period of one to two weeks.

Nymph: Eggs hatch in about 10 days, and nymphs or crawlers begin to actively search for feeding sites.

Adult: The adult female is yellow, approximately 3 mm long and 1.4 mm wide and is covered with a white waxy coating. Adult males are pink, especially during the pre-pupal and pupal stages, but appear yellow in the first and second instars. Adult males are approximately 1.0 mm long, with an elongate oval body that is widest at the thorax (0.3 mm).

Nature fo Damage:

Nymph and adult suck cell sap. Initially the affected portion will be cholotic, later changed to brown and dry away. These bug excrete honey dew and as a result infested portion becomes shiny and moist and to this, secondary infection by sooty fungus,*Capnodium* occurs results in black covering the affected parts. Papaya mealy bug is polyphagous pest. Pest can be observed on leaves, stem and fruits as clusters of cotton like masses.

Cultural control:

Removal of weeds and alternate host plants like hibiscus, bhindi, custard apple, guava etc in and nearby vineyards throughout the year.

Mechanical control:

Detrash the crop on 150 and 210 DAP.

Biological control:

Natural enemies of the papaya mealybug include the commercially available mealybug destroyer *Cryptolaemus montrouzieri*, ladybird beetles, lacewings, hover flies, Scymnus sp. and certain hymenopteran and dipteran parasitoids. Conservation of these natural enemies in nature plays important role in reducing the mealybug population. In the nature, lepidopteran predator, *Spalgis epius* (Lycaenidae) is a well known representative of carnivorous butterfly feeding on various species of pseudococcids and coccids.

Chemical Control:

Locate ant colonies and destroy them with drenching of chlorpyriphos 20 EC @ 2 .0 ml/litre of water. If the activities of natural enemies are not observed, use of botanical insecticides such as neem oil (1 to 2%), NSKE (5%), or Fish Oil Rosin Soap (25g/litre of water) should be the first choice. Apply recommended chemical insecticides as the last resort such as profenophos 50 EC (2 ml/litre), chlorpyriphos 20 EC (2ml/litre), buprofezin 25 EC (2 ml/litre), dimethoate 30 EC (2 ml/litre), thiomethoxam 25 WG (0.6 g/ litre), imidacloprid 17.8 SL (0.6 ml/litre).

2. Papaya whitefly *Bemisia tabaci* Gennadius Aleyrodidae : Hemiptera

Papaya is one of the important commercial fruit crops of India and is known to be attacked by several insect pests. Among the pests, papaya whitely *Bemisia tabaci* is becoming a very serious pest in papaya growing areas particularly during summer months, (from February to April). Whitefly is the vector for leafcurl viral disease.

Life Cycle:

Eggs: Female whitefly lays about 50-80 eggs mainly under the surface of leaves in 2-12 days. Eggs hatch de-ending upon the condition i.e., in April - September months 5-1 days, in December January months 17-33 days and in February March 7-16 days are required.

Nymphs are greenish yellow in colour, and nymphal period varies depending upon the conditions which vary from 14-86 days & pupates for 2-8 days.

Adults are yellow in colour.

Nature of Damage:

Both the nymphs and adults suck the sap from the lower surface of the leaves. These insects cause the damage directly by sucking the sap which leads to yellowing of leaves and later on the leaves wither away and also indirect damage is caused by spreading of the leaf curl virus from one plant to other.

Management Practice:

Cultural Control:

Sow sorghum or maize around the field (2-3 lines) to prevent whiteflies migration from other fields.

Biological Control:

The pest can be successfully tackled by *Chrysoperla* spp.and *Brumus* spp. are the natural enemies for the pest.

Chemical Control:

If incidence is observed in field, spray 1 ml. dimetnoate, on 2.0 ml malathion a 1ml oxydemeton methyl on 1.5 ml. trizophos 40% EC in one liter water.

Avoid pyrethroid spray until the menace of whitefly is brought under control.

3 Green peach aphid *Myzus persicae* Aphididae: Hemiptera

Life Cycle:

Adult - Dark brown to chocolate brown colour

Nature of Damage:

Nymphs and adults suck the sap from leaves, petioles and fruits

Leaf curling and falling. Premature fruit drop.

Management Practice:

Mechanical Control:

Remove and destroy damaged plant parts

Biological Control:

Field release of parasitoid *Aphelinus mali* and predators, *Coccinella septumpunctata*.

Chemical Control:

Spray dimethoate 0.03% or methyl demeton 0.025%

4. Ash weevils, *Myllocerus spp* Curculionidae: Coleoptera

Life Cycle:

Grub – small, apodous

of leaf margin by adults.

Adult – greenish white with dark lines on elytra

Nature of Damage:

Grub feed on the roots. Wilting of young saplings notching

Management Practice:

Mechanical Control:

Collect and destroy the adults

Mechanical Control:

Dust lindane 1.3 D at 25 kg/ha to kill grubs.

Spray carbaryl 50 WP at 2g/lit.

EXERCISE NO. 7
STUDIES ON PESTS OF SAPOTA (CHIKU)

1. Chiku moth / Sapota Leaf Webber: *Nephopteryx eugraphella R. (*Pyralidae : Lepidoptera)
Economic Importance: It causes considerable damage to leaves and buds.
Marks of Identification: Adult moth : Small, grey coloured, slender bodied insect having black forewings with yellow spots on the basal half and black transverse lines on the remaining half.
Caterpillar : 25 mm long slender small, active, deep pink in colour with 3 longitudinal pinkish brown strips on each side of the body.
Host plants: Sapota and bakul.
Life History:
Eggs : Pale yellow, oval shape, 225, singly or in groups on tender shoots or ventral side of leaves, 2-4 days in summer and 4-11 days in winter.
Larva : L.P. : 13-26 days in summer and 31-60 days in winter.
Pupa : Pupation inside the fold of webbed leaves. P.P. 1-2 weeks in summer and 2-4 weeks in winter. Life cycle : 4-5 weeks in summer and 7-13 weeks in winter.
S.O. : Pest is active in June-July.
Nature of Damage: The caterpillar webs the tender leaves with silken treads and excreta and feeds on them under concealed condition. Also bore the buds and tender fruits. The infestation of the pest can be detected by the presence of webbed shoots, dark brown patches on leaves and dried leaves in clusters on the tree.
Management Practices:
Cultural control:
Collection and destruction of leaf webs with caterpillars, Clean cultivation
Biological control:
Neem seed kernel extract (NSKE) 5 %
Chemical control:
Spray application of chlorpyriphos 2 ml/l or monocrotophos 1.6 ml/l or carbaryl 3 g/l is effective.

2. Sapota Seed Borer: *Trymalitis margarias* Meyrick (Lepidoptera: Tortricidae)
It is native of Mexico or Central America.
Host plants: Sapota
Life History:
Eggs: A female moth lays eggs on medium sized immature fruits of sapota with the fecundity of 29 to 255 eggs / female.
Larva: The larvae are very minute, white in colour with pinkish tinge. L.P. **:** 13-12
Pupa: Pupation inside the fold of webbed leaves or in soil. P.P. 11-14 days Life cycle**:** 31-36 days.
Adults: The adult is a small delicate greyish white moth with bell shaped wings and resembles bird droppings.
Nature of Damage: The seed borer is a monophagous pest attacking immature fruits of sapota. A neonate larva bore into the fruit and finally enters the seed. The larvae feed only on endosperm of the seed. Full grown larvae prepare a tunnel to come out for pupation. Due to the infestation of the pest quality of the fruit deteriorates and hence the market price goes down.
Management Practicies:
Mechanical Control:
Sanitation: Sanitation is to be maintained for eliminating the sources of seed borer infestation.
Collection and destruction of the off season stray mature sapota fruits after main harvest till November will bring down the pest incidence. Eliminate the sourse of seed infestation.
Light Trap 1/Ha
Chemical Control:
Spraying of Deltamethrin 2.8% EC @ 1 ml/l of water, *Bt* @ 1 gm/l of water.

3. Fruit fly: *Bactrocera (Dacus) dorsalis* (Diptera: Tephritidae)
Fruit flies are important fruit pests that attack several cultivated species of high commercial value in subtropical and tropical areas of the world. Its larvae infest sapote, sapodilla, willowleaf lucuma, and related fruits.
Life History:
Egg: The eggs of Bactrocera species are very similar. Size, 0.8 mm long, 0.2 mm wide, with the micropyle protruding slightly at the anterior end. The chorion is reticulate (requires scanning electron microscope examination). White to yellow-white in colour.
Maggot: The third-instar, which has a typical maggot appearance, is about 10 mm in length and creamy white. The only band of spinules encircling the body is found on the first segment. The external part of the anterior respiratory organs, the spiracles, located one on each side of the pointed or head end of the larva, has an exaggerated and deflexed lobe at each side and bears many small tubercles. The caudal segment is very smooth. The posterior spiracles are located in the dorsal third of the segment as viewed from the rear of the larva. The mature larva emerges from the fruit, drops to the ground, and forms a tan to dark brown puparium about 4.9 mm in length. The entire larval stage lasts for 11-15 days.
Pupa: When mature, larvae drop to the ground and pupate in the soil. The puparium is yellowish-brown and seed-like. Adults emerge in about 10 days.
Adult: Generally, the abdomen has two horizontal black stripes and a longitudinal median stripe extending from the base of the third segment to the apex of the abdomen. These markings may form a "T" shaped pattern, but the pattern varies considerably. Females begin to lay eggs about 8 days after emergence from the puparium. Under optimum conditions, a female can lay more than 3,000 eggs during her lifetime, but under field conditions approximately 1,200 to 1,500 eggs per female is considered to be the usual production. Ripe fruit are preferred for egg laying, but immature ones may be also attacked.
Nature of Damage:
Maggot bore into semi-ripen fruits with decayed spots and dropping of fruits.
Oozing of fluid.
Brownish rotten patches on fruits.
Management Practicies:
Cultural Control:
Collect fallen infested fruits and dispose them by dumping in a pit and covering with soil.

Mechanical Control:

Raking the soil around the tree to expose the pupa

Monitor and mass trap the fruit flies with methyl eugenol traps.

Use bait spray combining any one of the insecticides and molasses

Biological Control:

Natural enemies of fruit fly:

Parasitoids: *Fopius arisanus*, *Diachasmimorpha kraussi*

Chemical Control:

Traps of Methyl Eugenol and spray of pesticide is recommended. Spray malathion 50% EC 2ml/lit. There is a range of other chemical products that can be applied via cover spray, such as clothianidin and chlorpyrifos.

4. Sapota stem borer: *Plocaederus ferrugineus* L. (Cerambycidae: Coleoptera)

Life History:

Adult - medium sized reddish brown beetle.

Head and thorax - dark brown or almost black.

Nature of Damage:

Presence of small holes at the collar region, Gummosis.

Extrusion of frass through the bore holes at the collar region

Yellowing and shedding of leaves. Drying up of twigs and gradual death of the tree.

Management Practice:

Cultural Control:

Collect and destroy the damaged plants

Field sanitation.

Mechanical Control:

Scraping the loose bark to prevent oviposition by adult beetles.

Hook out the grub from the bore hole.

Mechanical Control:

Swab Coal tar + Kerosene @ 1:2 or Carbaryl 50 WP 20 g / l on the basal portion of the trunk (3 feet height) ater scraping bark.

Padding with monocrotophos 36% WSC 10 ml in 2.5 cm /tree soaked in absorbent cotton. If infestations are severe then apply the copper oxychloride paste on the trunk of the tree. Apply monocrotophos 10 to 20 ml/ hole ater hook out of grub **(or)** One celphos tablet (3 g aluminum phosphide) per hole. Apply carbofuran 3G 5 g per hole and plug with mud.

5. Sapota hairy caterpillar: *Metanastria hyrtaca* Cramer (Lasiocampidae: Lepidoptera)

Life History:

Egg: Eggs are laid in rows or group. Egg period is 9-12 days.

Larva - yellowish brown with black spots and long lateral tufts of hairs. Caterpillar is 6.5 cm long. Black head and median dorsal brownish band extending to second abdominal segment. Larval period is 45-60 days.

Pupa: It pupates on tree trunks in a cocoon made up of silk andbody hairs.

Adults: Grayish head and thorax and whitish abdomen. Males have a white spot in the centre of a black patch on forewing.Hind wings are white**.** Stout greyish brown female moth is bigger than the males.

Nature of Damage:

The caterpillar feeds voraciously on leaves. Defoliation takes place.

Management Practice:

Cultural Control:

Field sanitation

Free from weeds and debris

Mechanical Control:

Collect and destroy the egg mass

Burning the groups of larvae found on tree trunks with torches when found in groups on tree trunks.

Biological Control:

Field release of chalcidid wasp, *Brachymeria* sp.

Chemical Control:

Spray chlorpyriphos 20% EC 2 ml/l

Dusting carbaryl 10 D on the trunk and branches (around the tree 4 feet). Spray application of carbaryl 3 g /l or dichlorvos 1ml/l are effective during early stages.

6. Sapota Leaf/ Midrib Folder: *Banisia myrsusalis* Walker (Thyrididae: Lepidoptera)

Pest is found in North America, Southern Asia (India, Shrilanka) and Africa. *Banisia myrsusalis* Walker relatively a new pest, is becoming serious under hill zone of Karnataka. The sapota midrib folder was recorded for the first time at ZHRS, Mudigere under hill zone of Karnataka.

Life History:

Eggs: The female moth (B. myrsusalis) within four to five days of oviposition period laid eggs in three to four batches (7-14 eggs per batch) in a group. The eggs were firmly glued on lower surface of tender leaves as well as matured leaves near to the midrib.

Adult: The adult male possesses dark almond colour head, thorax and abdomen, while light colored head, thorax and abdomen in female. A white irregular spot in middle of each forewing was visible in few adults but not in all. The tip of abdomen was blunt in female whereas pointed in male. The adult male possessed dark almond colour head, thorax and abdomen, while light coloured head, thorax and abdomen in female

Larvae: The neonate larva moulted four times with five distinct larval instars. The second instar larva was pale yellow with brown head and brown prothoracic shield. Final instar larva before pupation turned from pale green to creamy white, stopped feeding, sluggish and shrunken body.

Pupa: The newly formed (obtect) pupa was reddish brown and turned to black before adult emergence.

Nature o Damage:

Larvae chew holes in the base of floral buds or mature flowers, enter the flower, and consum all floral structures except the sepals. A single larva would tend to clump several flowers and floral buds together by using silk. Larvae could also fold leaves or bore into the fruit and could complete their immature development feeding on folded leaves, flowers, or inside a fruit. In contrast, *B. myrsusalis* is strictly a leaf-folder.

Management Practice:

Cultural Control:

Field sanitation

Mechanical Control:

Collect and destroy the leaf flower clumps. Leaf folds along with larva.

Chemical Control:

Spray chlorpyriphos 20% EC 2 ml/l

7. Sapota Bud borer: *Anarsia achrasella,* Latreille (Gelechidae: Lepidoptera)

Life History:

Eggs: The eggs of A. achrasella were smooth, oval and white in colour at the time of oviposition and turned to light brown before hatching. The incubation period varied from 4 to 6.

Larva: The larva is small, slender, pinkish brown with black head and passed through four instars on sapota buds. The newly hatched caterpillar was light yellow in colour, shiny with black head. It was tiny and delicate with slender body.

Pupa: This pre-pupal condition lasted for about one day during which the larva did not exhibit any movement unless it was disturbed. The prepupal period lasted for 1 to 2 days. A newly formed pupa was obtect type, brick-red in colour and changed into dark brown prior to the emergence as adult. The pupation took place either inside or out side of the flower buds.

Adult: Grey moth with black patch on wings.

Nature of Damage:

The bud borer webs together flower buds and flowers and reported to cause huge damage ranged from 2-15%. Shedding of buds and flowers. The bud borer feeds by making holes into the petals and ovary resulting in significant crop loss. Larvae damages inflorescences of the trees. Bore holes and excreta seen on attacked flowers.

Management Practice:

Cultural Control:

Field sanitation

Chemical Control:

Spray application of neem oil 2% @ 0.5 ml/ha or neem seed kernel extract 5 %. Application of per cent dichlorvos 2 ml/l cypermethrin 1.5 ml/l and malathion @ 2 ml/ha found promising.

EXERCISE NO. 8
STUDIES ON PESTS OF COCONUT, ARACANUT AND CASHEWNUT

PESTS OF COCONUT

1. Rhinoceros beetle: *Oryctes rhinoceros* Guest Scarabaeidae (Dynastidae): Coleopetera

Economic Importance: Most destructive pest cause serious damage to young trees. The beetle most wide spread and persistence in all coconut growing areas in India. The adult beetle cause serious damage to the coconut palm. It is abundant during March-May. Occasionally 5-6 beetles may be present on a tree.

Marks of Identification: Beetle: Stout, elongate, blackish in colour, 3.5 to 5 cm. long, head bears a large tapering horn. Horn is well developed in male than the female and female is slightly smaller in size. Grub: stout, fleshy, 10 cm long and always curl up ventrally.

Host plant: Coconut and other palms, occasionally banana, pineapple etc.

Life History:

Eggs: in decaying organic matter or in manure pits or compost heaps at a depths of 5-15 cm, 140 egg. The egg is oval, creamy white and fairly big in size. I.P.: 8-14 days.

Larva: L.P. 4-5 months.

Pupa: Pupation in soil, 15-60 cm deep, P.P. 20-60 days.

Adult: The beetles lives for about 290 days. Beetles are nocturnal in habit

Life cycle : Completed in 10-12 months. **S.O.:** Pest is active in monsoon season.

Nature of Damage: Only beetles are harmful. They damage unopened central leaflet (tender fronds) & feed voraciously on softer tissues of growing points, with the result because of feeding the growth of the tree is arrested which ultimately wither and dies. Injury can be recognized by clipping of leaves (fan like appearance) and fibrous mass oozes out of the bored hole. The beetles are nocturnal andnot capable of longer flight.

Management Practices:

Cultural Control:

Collect and destroy the various life stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits.

Mechanical Control:

During peak period of population build up, the adult beetle may be extracted from the palm crown using GI hooks.

Install aggregation pheromone traps away from the main plantation.

Set up pheromone trap for rhinoceros beetle @ 1 trap/100 ha by fixing it to the plant at 0.6 to 1 m height to trap and kill the beetles.

Biological Control:

Release of Baculovirus oryctes inoculated adult rhinoceros beetle @ 6 beetles/acre reduces the leaf and crown damage caused by this beetle.

Soak castor cake at 1 Kg in 5 l of water in small mud pots and keep them in the coconut gardens to attract and kill the adults.

Apply mixture of either neem seed powder + sand (1: 2) @ 150 g/palm or neem seed kernel powder + sand (1: 2) @ 150 g/palm in the base of the 3 inner most leaves in the crown.

Natural enemies of rhinoceros beetle: Predator: Reduviid bug

Chemical Control:

The topmost three leaf axils around the spindle may be filled with any of the following mixtures as a prophylactic measure:

a) Carbaryl 10 D 50 g + fine sand 200 g, which is to be done thrice in a year in April-May, September-October and December-January.
b) For seedlings, apply Naphthalene balls 10.5 g (approx. three to four balls) covered with fine sand, once in 45 days.

Place phorate 10 G 5 g in perforated sachets in two inner most leaf axils for 2 times at 6 months intervals.

Treat manure pits and other possible breeding sites with 0.01% carbaryl (50 % WP) on w/w basis. Treatment will have to be repeated every six months.

2. Black headed caterpillar: *Opisina arenosella* Walker Cryptophasidae (Xylorictidae): Lepidoptera

Economic Importance: It is one of the most important lepidopterous pests attacking coconut palms in India. The outbreak of the pest occurs in the dry hot months.

Marks of Identification: Adult: Moth is medium sized greyish white and it's nocturnal in habit. Caterpillar: Slender, elongate, greenish brown with blackish head & 15mm long.

Host plant: Coconut and other palms.

Life History:

Eggs: 59-252, on tip of older leaves, I.P. 3-7 days.

Larva: L.P.: 32-55 days.

Pupa: Pupation inside the silken galleries of leaf, P.P. 8-14 days.

Life Cycle: 2 months.

Longetivity of adults is about 3-10 days. The moths do not migrate. However, they are introduced in to or spread to other areas by the larvae and pupae being carried along with coconut leaves.

S. O.: Pests is active in hot months i.e., from March to May.

Nature of Damage: Caterpillars feed on tender leaflets by remaining within the leaf folds or galleries made of silken threads & excreta. As a result, dried patches are seen on fronds & trees starts withering. In case of severe attack the whole plantation would have the appearance of having suffered from a bad fire. The productions of nuts get adversely affected as photosynethic activity of the palm is much reduced. The fronds become unsuitable for hatching and other purposes.

Management Practices:

Cultural control:

As a prophylactic measure, the first affected leaves may be cut and burnt during the beginning of the summer season.

Biological control:

Natural enemies of black headed caterpillars:

Parasitiods: *Bracon* spp., *Ichneumon* spp., *Goniozus nephantidis*, *Brachymeria* spp. etc.
Predators: Reduviid bug, spider, red ant, earwig, ground beetle etc.

Chemical control:

Root feeding: Cut sharply at an angle and insert the root in the insecticidal solution containing monocrotophos 36% WSC @ 10 ml + water 10 ml in a 7 x 10 cm polythene bag.

3. Red palm weevil: *Rhynchophorus ferrugineus* Olivier (Curculionidae: Coleoptera)

Economic Importance: Most destructive pest. It lives generally in living palms and often its attack is fatal common on matured palm.

Marks of Identification: Adult weevil: Reddish-brown, with 6 spots on thorax bigger sized with curved snout. Grubs: apodus light yellowish with red head and 5 cm long.

Host plant: Coconut and some ornamental palms.

Life History:

Eggs: 204, white oval shaped, in soft tissues at the base of leaf sheath or cuts of wounds on the trunk or injuries caused by man, rhinoceros beetle. I.P. 2-5 days.

Larva: L.P. 24-61 days.

Pupa: Pupation in cocoons in side the trunks of fibrous material P.P. 18-34 days.

Life Cycle: 50-90 days, **S.O.:** Pest is active throughout the year.

Nature of Damage: All the stages of the pest are passed on palm trees. Grubs bore into the trunk near the growing points and feed on soft tissues. The early indications of attack are the presence of a few small holes in the stem from which pieces of chewed fibers protrude and a thick brown liquid oozes out. In young palm the top wither while in older ones the top portion bends & breaks. Higher incidence of the beetle has been correlated with leaf rot disease.

Management Practices:

Cultural Control:

Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem in order to prevent successful inward movement of the grubs through the cut end.

Mechanical Control:

Set up pheromone trap for red palm weevil @ 1 trap/100 ha by fixing it to the plant at 0.6 to 1 m height to trap and kill the beetles.

Coconut log traps: Setting up of attractant traps (mud pots) containing sugarcane molasses 2½ Kg or toddy 2½ l (or pineapple or sugarcane activated with yeast or molasses) + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/ logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers.

Install pheromone trap @1/2 ha

Biological Control:

Natural Enemies: *Cheliosoches Mario* (Forficulidae: Dermapetra) is predaceous on eggs and early instar grubs.

Chemical Control:

In attacked palms, observe for the bore- holes and seal them except the top most one. Through the top most hole, pour 1% carbaryl 50% WP (20gm/lt) or 0.2% trichlorphon 50% EC @ one litre per palm using a funnel. Then plug this hole also. If needed repeat after one week.

When the pest infestation is through the crown, clean the crown and slowly pour the insecticidal suspension. In case of entry of weevil through the trunk, the hole in trunk may be plugged with cement / tar. A slanting hole is made with the aid of an auger and the insecticide solution is poured with funnel.

Setting up of attractant traps (mud pots) containing sugarcane molasses 2½ kg or toddy 2½ litres + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/logs of green

petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers.

Fill the crown and the axils of top most three leaves with a mixture of fine sand and neem seed powder or neem seed kernel powder (2:1) once in three months to prevent the attack of rhinoceros beetle damage in which the red palm weevil lays eggs.

Root feeding: Cut sharply at an angle and insert the root in the insecticidal solution containing monocrotophos 36% WSC @ 10 ml + water 10 ml in a 7 x 10 cm polythene bag.

4. Eriophyid mite: *Aceria guerreronis* Keifer (Eriophyidae: Acarina)

The Eriophyid Mite is one of the dreaded pests of coconut, and in recent years it has caused enormous damage to the palms.

Marks of Identification:

Nymph and Adult - Pale in colour with elongate body and worm like appearance

Life History:

Mites are usually found under the bracts of fertilized female flowers and do not infest the unfertilized flowers. This mite is very minute in size measuring 200 – 250 micron in length and 36 – 52 micron in width with two pairs of legs. Nymph and adult are pale in colour with elongate body and worm like appearance. The life cycle of this mite, which consists of egg, two larval instars and an adult stage, is completed in 7 -10 days.

The mites feed by piercing the superficial plant tissue and sucking the juices. A coconut mite develops from egg to adult in 10 days, so populations can build up rapidly, often producing thousands of mites in several aggregations on the same fruit. Massive populations of coconut mites may be present among the tepals and on the fruit surface beneath the perianth until about the sixth month of the coconut's development, after which populations decline.

Nature of damage:

Triangular pale or yellow patches close to perianth.
Necrotic tissues.
Brown colour patches, longitudinal fissures and splits on the husk.
Oozing of the gummy exudation from the affected surface.
Reduced size and copra content.
Malformed nuts with cracks and hardened husk.

Management Practices:

Cultural Control:

Grow intercrop (sun hemp, four crops/year) and shelter belt with Casuarina all around the coconut garden to check further entry.

Apply urea 1.3 Kg, super phosphate 2.0 Kg and muriate of potash 3.5 Kg/palm/year.

Increased quantity is recommended to increase the plant resistance to the mite.

Soil application of micro nutrients such as borax 50 g + gypsum 1.0 Kg + manganese sulphate 0.5 Kg/palm

Biological Control:

Predacious mites and insects and pathogenic fungus like ***Hirsutella thompsonii*** are effective.

Natural enemies of coconut eriophyid mite:

Predators: Phytoseiid mites, ladybug beetles, syrphid flies, minute pirate bug, *Oligota* spp., lacewing.

Spraying the affected palms with a mixture of 2 per cent neem oil, garlic and soap mixture has been found to be effective.

To prepare one litre of the above mixture 20 ml of neem oil, 20 g of cleaned garlic pearls and 5 g of washing soap are required. The soap should be dissolved in 500 ml of water and neem oil is added to it. The mixture is to be stirred well to form an emulsion.

Chemical Control:

Fenpyroximate 5%EC @ 10 ml/l (spray fluid volume as required).

Root feeding: Cut sharply at an angle and insert the root in the insecticidal solution containing monocrotophos 36% WSC @ 10 ml + water 10 ml or triazophos 40% EC @15 ml or carbosulfan 25% EC @ 15 ml / 15 ml of water in a 7 x 10 cm polythene bag.

5. Rat:

Black Rat: *Rattus rattus* Linnaeus (Rodentia: Muridae)
Indian gerbil: *Tatera indica* Hardwicke (Rodentia: Muridae) (nursery/seedling)
The lesser bandicoot or Indian mole-rat: *Bandicota bengalensis* Hardwicke (Rodentia: Muridae)
M.I.- A slender rat with large hairless ears, the ship rat (*Rattus rattus*) may be greybrown on the back with either a similarly coloured or creamish-white belly, or it may be black all over. The uniformly-coloured tail is always longer than the head and body length combined. Its body weight is usually between 120 and 160 g but it can exceed 200 g.
Nature of Damage: Rats remain in the crowns of coconut palm and damage the tender nuts by forming characteristic holes. They make hole through the husk and drinks the sweet liquid. Shed nuts can be seen at the base of the palm.
Management Practices:
Cultural control:

Practice clean cultivation/maintain weed free fields which reduces the harbouring/hiding points for rodents.

Practice trapping with locally available traps using lure @ 8-10 traps/acre.

In areas, where *Rattus rattus* is a problem, wonder traps/multi-catch traps work better and enable to trap more animals into a single trap.

Identify live rodent burrows and smoke the burrows with burrow smoker for 2-3 minutes.

Erect owl perches @ 5-6/acre to promote natural control of rodents.

Chemical control:

A. In cases of high level of infestation (>50 live burrows/ac) practice poison baiting with zinc phosphide @ 2.0% on community approach.

PRACTICE PRE-BAITING TO AVOID BAIT SHYNESS

Day 1: Close all the burrows in the fields, orchidbunds, canal bunds and surrounding barren lands etc.

Day 2: Count the re-opened burrows and practice pre-baiting @ 20 g/burrow (98 parts of broken tomato + 2 parts of edible oil)

Day 4: Observe the re-opened burrows and treat the burrow with zinc phosphide poison bait (96 parts of broken tomato + 2 parts of edible oil + 2 parts of zinc phosphide) @ 10g/ burrow. Collect the dead rats, if found any outside and bury them.

B. Zinc phosphide is mixed of 1:49 ratio with food like popped rice or maize or cholam or coconut pieces.
C. Warfarin can be mixed at 1:19 ratio with food.
D. Ready to use cake formulation (Bromodiolone) is also available.

PESTS OF ARACANUT

1. Spindle bug: *Carvalhoia arecae* Miller & China (Miridae: Hemiptera)

Life History:

Egg: Eggs are laid singly between the leaflets of the spindle. The eggs hatch in 9 days.

Nymph: There are five nymphal stages and it is completed in 15-24 days. The light violet brown nymphs have greenish yellow border.

Adult: Adult bugs are brightly coloured (red and black)

Nature of Damage:

Inhabit the inner most leaf axils, usually below the spindle.

Both nymphs' andadults suck sap from tender leaflets and spindle. Infested portions develop necrotic patches leading to drying. Severe infestation - blackish brown linear lesions on the spindle leaf. Spindle fails to unfurl. Stunted growth and twisted, leaves become dried and shed. Severe infestation leads to stunting of the palm.

Management Practices:

Biological Control:

Natural enemies of spindle bug: Predators: Lacewing, Ladybird beetle, King crow, common mynah, wasp, dragonfly, spider, robber fly, reduviid bug, praying mantid, red ant, big eyed bug, pentatomid bug, earwig, ground beetle etc.

Chemical Control:

Spray application of dimethoate 0.05%

Filling the inner most leaf axils with phorate 10% G (10g/palm)

2. Inflorescence caterpillar: *Tirathaba mundella* Walker (Pyralidae: Lepidoptera)

Life History:

Egg: Eggs are white, circular and slightly flat and approximately 0.8 mm in diameter. Eggs are laid on flowers from emergence to the end of flowering. Egg period is 5 days.

Larva: Larvae complete their development within the fruit. The red coloured caterpillar penetrates the inflorescence and remains in the tissue for 15 days, tunnelling and destroying the tissue. After this phase it moves to the base of the peduncle changing into a pupa. As the caterpillar destroys the tissues of the inflorescence, a resin coloured liquid gum is exuded from the fruitlets, which upon exposure to air becomes reddish coloured and as it solidifies turns dark brown.

Pupa: Pupa 12 mm long and 5 mm wide with a brown color and a few dark spots. Moth emerges from pupa in 7-11 days.

Adult:

The adult moth has a greyish upper wing surface and a cream color underneath with a wingspan of 28-35 mm. The adult can be found during the day or night, flying in a rapid and haphazard fashion.

Nature of Damage:

The caterpillars feed on the inflorescences especially the tender female flowers and rachillae, web them into a wet mass with silken threads and take shelter in it.

Burrowing and feeding activities produce visible damage symptoms in the form of frass production and a sticky, gummy exudate.

Mature caterpillars can damage newly opened inflorescences also.

In severe cases, they bore into the tender buttons and tender nuts as well.

Delayed spathe opening, yellowing of spadices, presence of small holes with frass and drying patches on the spathe are the external symptoms of attack.

Management Practices:

Mechanical Control:

Affected spadices may be opened and if all the female flowers have been damaged the inflorescence should be removed and burnt.

Biological Control:

Natural enemies of inflorescence caterpillar:

Predators: Predatory ant, lacewings, ladybird beetles, King crow, common mynah, wasp, dragonfly, spider, robber fly, reduviid bug, praying mantis, red ants, big eyed bugs (*Geocoris* sp), pentatomid bug (*Eocanthecona furcellata*), earwigs, ground beetles, rove beetles etc.

Chemical Control:

Infected spadices may be forced open and sprayed with malathion 0.05%

PESTS OF CASHEWNUT

1. Mosquito bug (Capsid bugs): *Helopeltis antonii* Signoret Miridae: Hemiptera

The mosquito bug is considered to be the most serious pest of cashew in India, and causes more economic loss to the crop than any other pest. It is estimated that this pest alone is responsible for damage of nearly 25% of shoots, 30% of inflorescence and 15% of tender nuts. It causes more than 30% economic loss by inflorescence blight and immature nut fall.

Life History:

Egg: Female bug lays reniform and creamy white eggs singly by deeply inserting them into the tender tissues of new shoots, leaf petioles and veins. The presence of chorionic threads projecting outside the tissues is indicative of the presence of eggs inside. Each female bug lays, on an average, 50 eggs. The incubation period of the egg is on an average 5-7 days, at a temperature range of 24-32 oC and relative humidity of 50-100 per cent. About 60% of the eggs normally hatch out as nymphs.

Nymph: The nymphs go through 5 instars in 10-15 days. The first instar is completed in 1.9 days, second instar in 2.2 days, third in 2.8 days, fourth instar in 2.8 days and fifth instar in 3.2 days and thus nymphal period completes within 13-15 days. Nearly 60 per cent nymphs survive and moult as adults. The nymphs are wingless and smaller, but otherwise resemble the adults. The young nymphs are orange coloured and ant-like.

Adult: The female bug lives for about 7 days, while the longevity of male is 9-10 days. The adult bug is reddish-brown, about 6-8 mm long with a black head, red thorax, black and white abdomen. The pest can easily be recognized by its peculiar pin-like, knobbed process projecting on the dorsal side of its mid thorax. The adult usually feeds during early hours (6-10 am) and makes about 150 feeding punctures per day. The adults are poor flyers, generally fly below the bush and mating takes place mostly on the undersurface of cashew leaves. The life-cycle is completed in 25-32 days. The bug resembles mosquito in sitting position and hence this pest is known as 'mosquito bug'.

Nature of Damage:

Nymphs and adults of this mirid bug suck sap from the leaves, young shoots, inflorescence, developing young nuts and apples.

The injury made by the suctorial mouth parts of the insect results in exudation of a resinous gummy substance from the feeding punctures.

The tissues around the point of entry of stylets become necrotised and black scab formed, due to the action of the phytotoxin present in the saliva of the bug, infesting the tender shoots / inflorescences at the time of feeding. These lesions turn pinkish brown in 24 hours and become black in 2-3 days.

Feeding on tender leaves causes crinkling.

Affected shoots show long black lesions and may cause die-back in severe cases.

Infested inflorescence usually turns black and die, immature nuts may drop off.

Heavily infested trees show scorched appearance, leading to the death of shoots and growing tips

Management Practices:

Culturcal Control:

Remove alternate hosts such as neem, guava, cocoa, mahogany, cinchona, cotton, apples, grapes, drumstick, black pepper, jamun etc.

Remove the volunteer (self-sown) neem plants in and around cashew plantations.

At the out-break situation, the management programme against this pest should be launched on large scale community basis as the efforts made by an individual farmer may not be of much use.

Monitor crop regularly for signs of damage

Avoid interplanting cashew with other crops which are hosts for *Helopeltis* bugs such as and cotton

Mechanical Control:

Remove the volunteer (self-sown) neem plants and other weeds in and around cashew plantations.

Biological Control:

Natural enemies of mosquito bug:

Parasitoids: *Trichogramma* spp., *Telenomus* spp., *Chaetostricha* sp, *Erythmelus helopeltidis*.

Predators: Red ant, dragon fly, ladybird beetle, spider, praying mantis, black ant, anthocorid bug

Chemical Control:

Spray application of followed by carbaryl 50% WP @ 2g/l followed by monocrotophos @ 2ml/l at vegetative flush stage, panicle initiation stage and nut formation stage respectively are recommended for the management of tea mosquito bug.

Spray schedule involving three rounds of spray *viz*., first spraying with Profenophos (0.05%) at flushing stage, second spraying with Chlorpyriphos (0.05%) at flowering and third spraying with Carbaryl (0.1%) at fruit set stage is most effective.

2. Stem and root borer: *Plocaederus ferrugenius* L. Cerambycidae: Coleoptera

The stem and root borer is the most serious pest of cashew as its damage results in death of trees. It is an internal tissue borer and hidden dreaded enemy of cashew tree as it is capable of killing the tree outright. The infestation by the pest is more severe in neglected plantations.

Life History:

Egg: The female beetle lays 60-90 eggs. The eggs are whitish, ovoid in shape measuring about 3 mm in length (looks like rice grain) and these eggs are inserted into the live tissues in the crevices of the bark at the collar region and exposed roots above the soil. The egg period varies from 4-7 days.

Grub: The eggs hatch out as tiny grubs, which bore into the fresh tissues of the bark, feed on the sapwood tissues and make tunnels in broad and in irregular directions. The tunnels are deepest in the middle and shallow at the sides. The grubs feed inside the tissues for 4-7 months. The grown up grubs are off-white in colour measuring about 7-10 cm in length. The fully fed grubs descends to root zone through tunnels, bores into the heartwood and forms an oval shaped chamber with a circular exit hole for the emergence of adult beetles. The chamber is tightly packed with fibrous tissues and frass, providing protection to the calcarious cocoon within which the grub undergoes pupation.

Pupa: The pupal period lasts for 2-4 months. Adult emergence occurs from November – June coinciding with monsoon rains. The adult beetle lives for 1-3 months. Pest infestation has been found to be heavier in summer than in the rainy season.

Adult: The adult is a medium sized (25-40 mm long), reddish-brown longicorn beetle. In the male, antennae are twice as long as the body, but in the female, they do not surpass the body length. The adult makes an indignant squeaking sound by rubbing the prothorax and mesothorax together.

Nature of Damage:

Stem borer infestation could be identified by the presence of small holes at the collar region, gummosis, extrusion of frass through the holes at the collar region, yellowing and shedding of leaves, drying up of twigs and gradual death of the tree.

Adult beetles lay eggs in the crevices of bark on the trunk. The grubs that hatch out, bore into the bark and feed on the sub-epidermal and vascular tissues and the tissues are tunneled in irregular

fashion. As a result of the injury to the bark tissues, gum oozes out and gets hardened subsequently resulting in gummosis.

When the vascular tissues are damaged the ascent of plant sap is arrested and the leaves become yellow and start shedding. In the advanced stages of infestation twigs dry up and the tree dies.

Cashew trees more than two years of age are prone to be attacked by this pest. However, the infestation is severe in older and neglected plantations. Even though the infestation is noticed throughout the year, the peak period of infestation was observed during summer months.

Management Practices:

Culturcal Control:

Removal of dead trees and trees with advanced stages of infestation at least once in 6 months.

Avoid injuring the plants by sickle and other garden tools, which otherwise will attract the adult for egg laying.

The affected bark should be removed along with the grubs.

Mechanical Control:

Mechanical removal of the immature stages (grubs) of the pest during initial stages of infestation.

Identify the borer hole (alive) and extract mechanically by chiseling out the damaged area of the tree and swab neem oil (50 ml neem oil + 1 liter water + 0.5 ml teepol/5 gm of soap) on the trunk up to a height of 1 meter.

Biological Control:

Natural enemies of mosquito bug:

Parasitoids: *Trichogramma* spp., *Telenomus* spp., *Chaetostricha* sp, *Erythmelus helopeltidis*.

Predators: Red ant, dragon fly, ladybird beetle, spider, praying mantis, black ant, anthocorid bug

Chemical Control:

1. Swabbing the bark of exposed roots and shoots with Carbaryl 50 WP 2 g/lit. Twice a year before the onset of South West Monsoon (March – April) and after cessation of monsoon (November) painting of coal tar + kerosene mixture (1:2) or swabbing with a suspension of Carbaryl 50 WP (4 g/lit) can be done up to one metre length in the exposed trunk region after shaving the bark or swab the tree trunk with neem oil 5% thrice during JanuaryFebruary, May-June, and September-October.
2. Root feeding with Monocrotophos 36% WSC 10 ml + 10 ml of water kept in a polythene bag on one side of the tree and keep the same amount on the other side of the tree (Total 20 ml/tree) divided into two equal halves will give protection when there is moderate incidence.
3. Remove grubs from early stage infested trees and drench the damage portion with Chlorpyriphos 0.2% @ 10 ml/lit or Neem Oil 5%.

3. Flower thrips: *Rhynchothrips raoensis* Ramakrishna Ayyar (Thripidae: Thysanoptera)

Thrips is attack cashew inflorescence. The rasping and feeding injury made by these thrips results in scab on floral branches, apples and nuts, forms corky layers on the affected parts and subsequent shedding of flowers, improper filling of kernel, malformation of nuts and even immature fruit drop. It is reported that the infestation of flower thrips alone accounts for 16 % fruit drop (2% in mustard stage, 12 % in peanut stage and 2 % in later stages) in cashew.

Life History:

Eggs: The eggs are inserted singly in the epidermis of the leaf. The nymphs emerge in about 10 days.

Nymph: The nymphs of red-banded thrips S. rubrocinctus can be distinguished by their greenish yellow colour and red bands across the first and last abdominal segments.

Adult: They are minute, slender, fragile, soft bodied, fast moving insects and adults have fringed wings.

Nature of Damage:

Adults and nymphs are seen in colonies on the lower surface of leaves and suck the sap from leaves, inflorescence and apples and nuts.

As a result of their rasping and sucking activity the leaves become pale brown, scab on floral branches, apples and nuts, forms corky layers on the affected parts.

In severe cases there will be shedding of leaves and stunting of growth of trees.

Management Practices:

Culturcal Control:

Inter crop with Sesbania grandiflora, to provide barrier which regulate the thrips population.

Do not follow chilli or onion intercrop crop – both the crops attacked by thrips.

Sprinkle water over the seedlings to check the multiplication of thrips.

Mechanical Control:

Blue sticky traps:

Set up blue sticky traps for flower and leaf thrips @ 4-5 traps/acre. Locally available empty tins can be painted blue coated with grease/Vaseline/castor oil on outer surface may also be used.

Biological Control:

Natural enemies of flower thrips:

Predators: Predatory mite (Amblyseius swirskii), predatory thrips (Aeolothirps spp.), insidious flower bugs (Orius insidiosus), ant lion, lygaeids, ladybird beetle, anthocorids etc.

Chemical Control:

Spray spinosad 45% SC @ 0.5 ml/l of water, dichlorvos 76% EC @ 1 ml/l of water.

EXERCISE NO. 9
STUDIES ON PESTS OF APPLE, FIG, BER AND AONLA

PESTS OF APPLE

1. Mites: *Panonychus ulmi* Tetranychidae: Acarina

Life History:

European red mites overwinter as eggs; eggs hatch in spring when trees bloom. Overwintering eggs in roughened bark at bases of buds and spurs on smaller branches and twigs, or in wounds. Globular, red eggs with a slender stalk (stipe) are laid on leaves.

Immature mites bright red, undergo three instars.

Adults dark red with six to eight white spots at the base of hairs on the back.

Distribution and status: Though distributed widely in apple growing regions it is occasional pest

Nature of Damage:

Severe mite infestations can cause bronzing of leaves. Damage is relatively less severe on wide leaf varieties such as Yellow Newton and more severe on narrow leaf varieties such as Red Delicious.

Management Practice:

Biological control:

Conserve predators such as *Chrysoperla zastrowi* sillemi, anthocorid bug, predatory mite (*Amblyseius fallacis*), coccinellid (*Stethorus punctum*) etc.

Chemical control:

Spray bifenthrin 8% SC @ 2ml / l of water or fenazaquin 10% EC @ 0.5 ml / l of water or hexythiozox 5.45% W/W EC @ 0.4 ml/l of water and use spray fluid of 10 l/tree or malathion 50% EC @ 1 ml/l of water or propargite 57% EC @ 0.5-1 ml/l of water and use spray fl uid of 10 l/tree or spiromesifen 22.9% SC @ 0.3 ml/l of water.

2. Apple Codling Moth: *Cydia pomonella* Tortricidae: Lepidoptera

Distribution and status: Kashmir, Himachal Pradesh and Tamil Nadu

Host range: Apple

Life History:

Egg: Female lays 100 white coloured, oval, flat eggs, singly on developing fruits, leaves and twigs. Egg period 4-12 days, larval period 21-30 days and pupal period 8-14 days. Grown up larvae comes out of the fruit and falls on ground and reach the bark of the tree for shelter in cracks and crevices to construct a silken cocoon and transforms to a yellowish brown pupa.

Nature of Damage:

It causes two types of fruit damage: stings and deep entries. Stings are entries where larvae bore into the flesh a short distance before dying. Deep entries occur when larvae penetrate the fruit skin, bore to the core, and feed in the seed cavity. Young larvae enters the fruit thorugh calyx penetrates and attacks the core and flesh. Larvae may enter through the sides, stem end, or calyx end of the fruit. One or more holes plugged with frass on the fruit's surface are a characteristic sign of codling moth infestation. Calyx entries are difficult to detect without cutting the fruit.

Management Practice:

Mechanical Control:

Kill larvae by mopping up with a pole and some rags dipped in kerosene tied on its end. Place kerosenized water in an open vessel below the tree so that the larave that fall may also be killed.

Chemical Control:

Spray carbaryl 50 WP 2 g/l of water, flubendiamide 0.5 ml/l of water.

PESTS OF FIG

1. Leafhopper: *Velu caricae* G. Cicadellidae (Jassidae): Hemiptera

It is one of the most destructive pests of fig.

Marks of Identification:

Adults : Small, wedge shaped, reddish brown with blackish compound eyes, walk diagonally.

Host plants: It is specific pests of fig only.

Life History :

Eggs : 36, singly inside the leaf tissues, I.P.: 6-13 days.

Nymph :N.P.: 9-12 days. .

S.O.: The activity of pests coincides with the period when young foliage is produced, i.e. the first week of Oct.

Nature of Damage: Both nymph & adult suck the cell sap from ventral side of leaves. As a result leaf margins turn yellow, curl & becomes reddish brown producing typical "**hopper burn**" symptoms. Fruiting capacity is adversely affected.

Management Practices:

Biological Control:

Various biological control agents, including *minute pirate bugs*, *Orius* spp. (Hemiptera: Anthocoridae)

Chemical Control:

Spray with 0.1% carbaryl or o.o2% phosphamidon or 0.03% dimethoate. First spray should be given in the first week of October when new flush appears & subsequent sprays as & when infestation noticed.

2. Fig spider mite: *Eotetranychus hirsti* Pritchard and Baker Tetranychidae: Acarina

Economic Importance:

Eotetranychus hirsti is is a serious pest of fig in India and Pakistan. In India, it is reported from Delhi, Punjab, West Bengal and Uttar Pradesh. This mite is host specific, hence known as fig spider mite.

Life History:

It is greenish yellow in colour with black blotches all over dorsum.

Nature of Damege:

Due to feeding of fig spider mite, transparent green patches are produced on the under surface of leaves when viewed across light. The patches turn yellowish green, then brown with rough and dry texture. Such leaves along with fruits drop prematurely, often resulting in complete defoliation of plants. This mite normally colonizes under surface of the leaves but in case of heavy infestation,

they may move to the upper surface of the leaves and fruits as well. The infested fruits get shriveled, fail to ripe and ultimately fall off.

Hibernation:

During November, the mites migrate to the terminal buds where they hibernate till February or early March.

Management Practice:

Biological control:

Conserve predators such as *Chrysoperla zastrowi* sillemi, anthocorid bug, predatory mite (*Amblyseius fallacis*), coccinellid (*Stethorus punctum*) etc.

Chemical control:

Spray bifenthrin 8% SC @ 2ml / l of water or fenazaquin 10% EC @ 0.5 ml / l of water or hexythiozox 5.45% W/W EC @ 0.4 ml/l of water and use spray fluid of 10 l/tree or malathion 50% EC @ 1 ml/l of water or propargite 57% EC @ 0.5-1 ml/l of water and use spray fl uid of 10 l/tree or spiromesifen 22.9% SC @ 0.3 ml/l of water.

PESTS OF BER

1. Ber fruit borer: *Meridarchis scyrodes M*. Carposynidae: Lepidoptera

Economic Importance: Most destructive pest of ber. Losses to the extent of 70% are noticed in susceptible varieties.

Distribution and status: Countrywide distribution

Host range: Ber, jammun and olive.

Life History :

Adult lays eggs flowers and tender fruits. Adult is small dark brown moth and larva reddish in colour. Fecundity of adult female 14 eggs. Egg, larval and pupal stages are 4-5, 14-18 and 8-9 days respectively. Adult longevity 3-5 days.

S.O.: Activity of the pest is in fruiting season from September to January and infestationreaches at its peak in middle of November.

Nature of Damage:

I and II instar yellow larvae feed superficially on the fruit while red third – fifth instar larvae bore deep into the fruit feeding on pulp and accumulate faecal frass.

Management Practices:

Cultural Control:

Collect and destroy the damaged fruits.

Rake the soil periodically.

Chemical Control:

Apply chlorpyriphos 1.5 D at 40 kg per ha around the trees before the fruits attain marble stage.

Spray malathion 1.0 L or dimethoate 750 ml L at the time of fruit set, two rounds at 15 days/interval.

2. Ber fruit fly : *Carpomyia vesuviana* C Tephritidae (Trypetidae): Diptera

Economic Importance: It causes severe damage to fruits to the extent of 73% has been noticed. It is active early in spring and again in autumn i.e. incidence is serious during February to March. Fleshy and late maturing varieties are more susceptible.

Marks of Identification: Adult flies : Small, brownish yellow, longitudinal strips on thorax and wings transparent. Maggot: Creamy white in colour.

Life History:

Female lays 22 eggs in cavities made on the fruit by ovipositor, egg period 2-3 days.

Maggot- maggot period, 7-10 days.

Pupa- Fully grown maggot falls to ground and pupates in soil with pupal period of 5-30 days Usually 2-3 generations completed in a year.

Adults - Adult is small fly with black spots on the thorax and dark spots on the wings.

Nature of Damage: Maggots feed on fruit pulp that results in fruit rotting and fruit drop.

Management Practices:

Cultural Control:

Cultivate fruit fly resistant varieties such as Safeda Ilaichi, Chinese, sanaur-1, Mirchia, Tikadi and Umran

Mechanical Control:

Collect and destroy fallen and infested fruits by dumping in a pit and covering with a thick layer of soil.

Plough interspaces to expose pupae.

Conserve parasitoids Opius compensates and Spalangia philippinensis

Chemical Control:

Use methyl eugenol lure trap (25/ha) to monitor and kill adults of fruit flies or prepare methyl eugenol and malathion 50 EC mixture at 1:1 ratio and take 10 ml mixture/trap.

Use bait spray combining molasses or jaggery 10 g/l and one of the insecticides, fenthion 100 EC 1ml/l, malathion 50 EC 2 ml/l, dimethoate 30 EC 1ml/l, carbaryl 50 WP 4g/l, two rounds at fortnight interval before ripening of the fruits.

Spray malathion 50 EC 1.0 l or dimethoate 30 EC 1.0 l or dichlorvos 700 ml at the time of flower formation and fruit set.