Karmaveer Kakasaheb Wagh Education Society's

K. K. Wagh College of Agriculture, Nashik

Saraswati Nagar, Panchavati, Nashik-3

AFFLIATED TO

MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI

(M.S.)

LECTURE NOTES

ON

CROP PESTS STORED GRAIN PESTS AND THEIR MANAGEMENT

COURSE NO. : ENT-353

Compiled by

Mr. T. B. UGALE

Mr. A. S. MOCHI

Assistant Professor

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY

Exercise No.1

STUDIES ON POLYPHAGOUS PESTS

Material : Preserve specimens and damaged plant parts.

1. White Grub : *Holotrichia serrata* F, *H. consanguinea* Bl.
Leucopholis lepidophora Burm.
Scarabaeidae : Coleoptera

Economic Importance : It is a cosmopoliatan and polyphagous species having been reported from most of the States of the country. Since last 10 to 15 years grub is posing a great threat to the cultivation in some pockets of Maharashtra State. It is in endemic form in some pockets of Ahmednagar, Buldhana, Dhule, Jalgaon, Kolhapur, Osmanabad, Parbhani, Sangli, Satara and Wardha districts.

Marks of Identification : **Adult** : Beetle is stoutly built, reddish brown 22-25 mm in length and head is oblique

Eggs : Creamy white, oval/spherical, 2mm diameter.

Grub : About 47 mm long, white in colour with dark brow head having power full mandibles and 3 pairs of prominent thoracic legs.

Host Plants : White grubs are polyphagous.

Larval Hosts : Attack number of crops like sugarcane, groundnut, jowar, maize, paddy, tobacco, vegetables etc. and grasses. Perennial trees like guava, citrus, peach etc. are also reported to be attacked by the grub.

Adult Host : The adult beetles feed on leaves of neem, shevaga, ber (Drumstic), tamarind, bel, acacia (Babhul), gulmohor.

Nature of Damage : The grubs feed on roots and rootlets of plant and infested plants become yellowish and dried up. The attacked plant can be easily pulled out from the soil. The adults feed on leaves of ber, neem, drumstick. etc.

Carry Over : Through the adult beetle. Newly formed beetle remains in quiescent stage in soil and emerges when cloudy weather and light showers prevail in the month of May/June.

Life History : The emergence of beetle begins after first pre-monsoon showers (May/June), emergence confined to early evening, after the sunset, mating takes place on neem and babhul trees. Beetles return to soil before sunrise and female start laying the eggs singly in earthen cells at the depth of 7-10 cm. soil. A female lays 50-70 eggs. Incunation period 9-24 days.

Grub : Grub moult twice and become full grown in 5-9 months.

Pupal stage : Pupation in soil. Pupal stage last for about 14-29 days.

Adult : Though adult are formed during November and December they don't emerge until the first pre-monsoon shower in May or June. The longevity of adult after emergence is 47-97 days. Only one generation in a year.

Seasonal Occurrence : The pest is active in *Kharif* season.

Management Practices :

1. Collection of beetles by shaking host trees (neem/babhul/ ber) at night hours and their destruction in kerosinized water.
2. Collection and destruction of grubs from the field at the time of weeding and interculturing.
3. Flooding of the fields.
   spray the host trees like neem, babhul and ber with 0.1 % carbaryl in monsoon on community basis. The emergence of beetles is observed immediately after the first pre-monsoon showers. (Mau/June)
   Note : Leaves of treated host trees should not be fed to animals upto 10 days after treatment.
5. Soil application with quinalphos 5G/phorate10G/ carbofuran3G @ 25 kg/ha. at the time of land preparation of application of FYM.

6. In case *L. lepidophorta* around kumbhi river in Kolhapur Dist. use rotavator in May, in whilte grub affected area for the destruction of different stages of white grub.

2. Termites or White ants : i) *Odontotermes obesus* R, ii) *Microtermes obesi* H.
Termitidae : Isoptera

Economic Importance : Termites are polyphagous insects, reported from many parts of Maharashtra. The infestation of termites is more in sandy loam soils. They inflict more serious damages in the unirrigated areas.

Marks of Identification : These are social insects living in a colony. Polymorphic forms are noticed.

A) Reproductive caste : (Winged) **:** They live in royal chambers.

Queen : Develop from fertilized eggs. It is much larger in size and has creamy white abdomen which is marked with transverse dark brown stripes. It lives for 5-10 years and lays thousands of eggs.

King : Develop from unfertilized eggs. It is much smaller than queen and slightly bigger than workers. It is secondarily wingsless insect.

B) Sterile caste : (Wingless) **:**

Workers : Develop from fertilized eggs. They are whitish yellow. Head wider than reproductive castes. Mandibles are stronger, meant for feeding on. They avoid light and need high humidity for their survival.

Soldiers : Develop from unfertilized eggs. They have large head and strongly chitinized sickle shaped mandibles, defend the colony by fighting. (Mandubulate type soldiers).

Host plants : Termites are polyphagous feeding on crops like wheat, sugarcane, groundnut, cotton, chillies, brinjal, fruit trees etc.

Nature of Damage : Workers of termites feed on the roots and stem parts of the plants. This results in drying of the plants. Other forms do not cause any direct damage to the crop.

Life History : Soon after, first monsoon showers, the sexual forms leave their colony for nuptial flight during evening. After a short flight mating takes place, they shed their wings and the queen and king settle down in the soil. The female burrows in the soil, lay eggs and establish new colony. The queen gradually grows in size and start egg laying very rapidly at the rate of one egg per second or 70,000 to 80,000 eggs in 24 hours. It lives for 5 to 10 years. It can live for several years also. There is only one queen in a colony. Incubation period is one week in summer and within 6 months larvae develop to form soldiers or workers. The reproductive castes when produced mature in 1-2 years.

Management Practices :

1. Locate termitoria (mounds) and destroy queen by digging out termitoria or fumigating with fumigants like CS_2/methyl bromide/CS_2 + chloroform mixture @ 250 ml/mound.
2. Termite damage in standing crop can be minimized by application of 5 lits. of lindane 20 EC/ha. into irrigation water or field spreading of 1 lit. of lindane or chlorpyriphos mixed with sand or soil, followed by light irrigation.
3. Keep the crop healthy and vigorous. Shortage or water leading to initial drying of the plant, may lead to termite infestation. Hence, it is very necessary to keep the crop healthy and vigorous.

3. Locust :

Species : Locust are those species of grasshoppers, which under certain favourable conditions, multiply, congregate, move together in their nymphal stages as band and the resultant swarms fly to distant areas in dense. Their epidemics occur in all continents. There are nine well recognized species. The following species occur in India.

1. The Bombay locust : *Patanga succincta* L.
2. The Migratory locust : *Locusta migratoria* L.
3. The Desert Locust : *Schistocerca gregaria.*Very common, most destructive.

Famity : Acrididae Order : Orthoptera

1. Bombay Locust : *Patanga succincta* L.

i) The area of distribution : India, Ceylon and Malaya. In India – area extending from Gujarat to Madras and in certain areas upto Bengal. Swarms 1835-45, 1864-66, 1901-1908 resulted in heavy damage to crops.

ii) Breeding grounds : Open areas of Western Ghats.

iii) No. of broods : 1 in a year (diapause in adult)
These hoppers do not congregate to form bands but remain scattered among crops or grasses.

2. Migratory Locust : *Locusta migratoria* L.

i) Distribution : Europe, Africa, East Asia and Australia. Swarms : In India they were observed in 1898 in Madras, and in Banglore 1954.

ii) Breeding grounds : Breeds in spring in Pakistan and resultant adults migrate into the desert area of India as individuals and breed during summer in Rajasthan –Gujarat areas of India. Scattered locust may gather in ecologically favourable pockets and lay eggs innumerably i.e. there are several broods in a year.

3. Desert Locust : *Schistocerca gregaria*

The desert locust is a pest of world wide importance as it is known to migrate in swarms from one country to another.

i) Distribution : It is an international pest affecting about 60 countries, mainly India, Pakistan, Afganistan, Arebia, Persia, Iraq and Africa.

ii) Breeding regions : The pest breeds during the spring season in costal and other areas of West African Countries like Persia where the winter rains bring about the required degree of soil moisture and vegetation. The adults emerging from this breeding stage migrate eastward to Pakistan and India by about the beginning of monsoon.

iii) The Phase Theory of Locust : The phase theory was first put forth by Uvarov on the basis of his studies on *Locusta* in Russia. Previously *L. Migratoria* and *L. danica* were recognized as two distinct species as they exhibited marked differences in colour, morphology, physiology and behaviour. Investigations by Uvarov, However, revealed that the *L. migratoria* and *L. danica* were the same species which existed in 2 phases.

Two forms gregarious and solitary are connected by intermediate from *transines.* This theory was subsequently confirmed for other species of locust also. Gregarious phase exhibit black colour pattern and same is absent in solitary. Solitory has uniform colour which resembles that of vegetation on which they live. Under laboratory condition the colour of the solitary phase hoppers can be changed into that of gregarious by breeding them under crowded conditions and vice-versa.

Reasons of out break : In breeding regions there are regular showers of rainfall in both the rain fall belts, which brings about the required degree of soil moisture and vegetation. However, strong winds do not scatter the swarms.

Nature of Damage : Locusts are voracious feeders, each adult, consuming its own weight of vegetation daily. It is estimated that 1 sq. km. settled swarm contain about 3000 quintales of locust. An average swarm is 10 sq.km.. Biggest 300 sq. Kilometer swarm is on record. Similarly, hoppers eat 6-8 times more than their own weight. It has been assessed that in India during 1926-31 plauge, the damage caused to crops, fodder etc., was about 10 crores of rupees and consequential loss to premature death of cattle and other livestock was in calculable.

Methods of Locust Control : The chief aim of locust control is to destroy the locust in all its stages.

1. Destruction of eggs : Locating the egg laid areas is almost importance, then trench them around so as to entrap the young hoppers as they move out after hatching. Even actual destruction of eggs on organized scale may be carried out by ploughing, harrowing and hand digging.

2. Hopper Control : The mechanical methods include entrapping the making hopper bands in 2' x 2' trenches and burying. The chemical method include use of poison baits and dusting of insecticides. Dusing of 2 % methyl parathion dust against hoppers @ @5 to 30 kg/ha. has been found to bring a complete control of these pests.
3. Control of adults or winged locust swarms : 2% methyl parathion may be carried out to achieve better control when swarms are resting on bare ground at night or in early morning can be beaten or swept up and destroyed. If they are resting on bushes or hedges, they can be easily burnt with help of flame throwers.

When flying locust are about to descend in large swarms in cultivation aeras, best way to tackle them is to prevent them by creating a cloud of smoke or by burning refuse etc. Spraying with neem kernel suspension as a deterent to the crop, has also been tried with success. Recently with the introduction 'aerial application' of insecticide the control of locust swarms has become easier. The advantage associated with aerial spraying are :

i) Vast areas can be treated in relatively short time.
ii) The swarm in flight can also be treated.
iii) When swarms settle down in a particular area that area can be quickly covered by aerial application.
iv) The moment of swarm can be watch with ease.

Locust control organizations, In India: Locust warning organization of the Govt. of India was established from April 1939. In 1942 a coordinated Anti locust scheme was put interaction. **In the World** : United Nations Special Fund Desert locust Project which was sponsored by the F.A.O. in 1960. This is being subscribed by several countries including India. Its purpose is to develop more effective and less expensive control of the desert locust.

4. Armyworm : *Mythimna separata* Walk. Noctuidae : Lepidoptera

Economic Importance : It is one of the cosmopolitan and polyphagous pests. It is sporadic in occurrence but sometimes breaks out in epidemic form especially when there is a good start of rains followed by a long dry spell. Complete failure of crops is also common in case of heavy attack.

Marks of Identification : Moth-medium sized, forewings grayish brown with prominent spots at the anterior margin. Hindwings pale white with dark borders. Caterpillar dull greenish, 4 cm in length, broad light colourted strips on the lateral side of the body.

Host Plants : Polyphagous attacking wide range of cereals and pulses.

Nature of Damage : The pest is nocturnal in habit. Caterpillars generally hide during day time in the soil or in leaf whorls. The larvae feed during night on the leaves from margin and in case of severe infestation defoliate the plants completely. On exhausting food from one field the caterpillars march like an army to neighbouring fields and hence the name army worm.

Life History : Eggs-are laid on central leaves. Incubatioon period- about a week. Larva – larva period 3-4 weeks. Pupa – pupation in soil. Pupal period 8 to 10 days. life cycle – completed in about 5-6 weeks. Generations : 5 generations every year. Carry over – Pest usually hibernates in pupal stage in soil. Seasonal occurrence : The pest is active from June to November

Management Practices :

1. Ploughing the field after harvest of the crop and burning plant debris helps in destroying the hibernating pupae.
2. Mechanical collection of larvae and their destruction.
3. Dusting methyl parathion 2D @ 20 kg/ha as soon as incidence is noticed.
4. Spraying with 0.05% endosulfan / 0.2% carbaryl.

Note : Dusting or spraying should be carried out during evening.

Practical Guidelines : Draw figures of caterpillar, moth and damaged leaves on plant.

5. Cutworm : *Agrotis ipsilon* Rott. Noctuidae : Lepidoptera

Economic Importance : Cosmopolitan pest, reported to occur throughout the country. It is serious in low lying areas which remain water logged for considerable time during the year. It causes severe damage in seedling stage. The damage to the crop varies from 12-35 %

Marks of Identification : Moth : Medium sized, stout with grayish brown wavy lines and spots on fore wings. The moths are active at dust and are attracted by light. Caterpillar: 4-5 cm long, dirty black in colour and have habit of coiling at slightest touch.

Host Plants : Potato, pulses, barley, oat, tobacco, peas, gram, cotton, tomato, Lucerne, chillies, brinjal and other vegetables.

Nature of Damage : The caterpillars hide during the day in cracks and crevices in soil or in debris around the plants and feed on tender leaves during night by cutting seedling near ground level. The destruction is much more than actual feeding.

Life History : Eggs : 300-350 in clusters laid on ventral leaf surface or moist soil.
I.P. : 4-5 days. Larva : L.P. 3-5 weeks. Pupa : Pupation in soil in earthen cacoons P.P.11-18 days.
Life Cycle : Completed in 5-9 weeks.

S.O. : It is a cool climate pest, active from October.

Management Practices :

1. Heaps of green grasses may be kept at suitable interval in infested field during evening and collected next day early in the morning along with caterpillars and destroy.
2. Clean cultivation and mechanical destruction of caterpillars also help in reducing pest infestation.
3. 5% carbaryl poison bait @ 25-60 kg/ha controls the pest effectively. (1kg carbaryl 50 WP + 10 kg wheat bran + 1 kg jaggery and sufficient water).
4. Apply lindane dust @ 125 kg/ha. or fenvalerate 2%@ 50 kg/ha or chlorpyriphos 20 EC 0.05% before planting of potato crop.

6. Tobacco leaf eating caterpillar (Spodoptera) : *Spodoptera litura* F.
Noctuidae : Lepidoptera

Economic Importance : The pest is cosmopolitan and polyphagous infesting various crops in the world.

Marks of Identification : Adults : Moths are medium sized stout with forewings grey to dark brown in colour with wavy marking. Hindwings are whitish .
Larva : Caterpillar are pale greenish brown and smooth, with dark marking and prothoracic plate.

Host Plants : Tobacco, peas, brinjal, banana etc.

Nature of Damage : The caterpillars, when young, feed gregariously on leaves and juicy stems and become isolated at later stage of growth.

Life History : Eggs : Laid in masses, covered with brown hairs on tender leaves I.P. : 4-5 days. Larva : Darkish in appearance. Initially, on hatching feed gregariously on soft tissue during night and become isolated when full grown. L.P. : 14-21 days. Pupa : Pupation in earthen cocoons P.P. : 9-14 days. Life cycle : completed in 30-60 days.

Management Practices :

1. Collection of eggs masses and caterpillars and their destruction.
2. Ploughing after harvest of the crop to destroy the pupa.
3. At the early stage of infestation, dusting with 10% carbaryl @ 20-25 kg/ha. controls the pest satisfactory.
4. Spraying of SINPV @ 250 LE.

5. Use of sex pheromone traps with spodolure.

7. American bollworm (Helicoverpa) : *Helicoverpa armigera* H.
Noctuidae : Lepidoptera

Economic Importance : It assumes epidemic proportion under favourable climatic conditions. The pest is common in localized areas of Maharashtra.

Marks of Identification : Moths stout, light yellowish to brown, forewings pale brownish with some black dots and hindwings lighter with smoky borders. Caterpillars greenish with dark broken grey lines along the sides of the body.

Host Plants : Infesting cotton, gram, tur, peas, tomato, tobacco, safflower, sunflower, jowar etc.

Nature of Damage : The caterpillars feed on tender foliage, squares, flowers and bolls/pods/fruits. While feeding, caterpillars insert the anterior half portion of their body inside the bolls. They feed on seeds and cause substantial damage.

Life History : Eggs – female lays 200 eggs singly on tender parts of the plant. Incubation period 6-7 days. Larva –larval period 2 weeks. Life cycle completed in 5-6 weeks. Several generations in a year.

Seasonal Occurrence : The pest is active from November to March.

Management Practices :

1. Ploughing the field after harvest of the crop would destroy the pupae, nearly by 70%.
2. Hand picking of caterpillars in the initial stage of attack.
3. NPV of *Helicoverpa armigera* @ 250 LE/ha (Prepare the stock solution of 250 LE and add it in 500 litres of water and spray for 1 ha.)
4. Spraying with 5 % NSKE.
5. Spraying the crop with 0.05% endosulfan/ formothion/ quinalphos / phosalone Or dusting with endosulfan 4D/ phenthoate 2D / quinalphos 1.5 D / phosalone 4D / malathion 5D / methyl parathion 2D @ 20 kg/ha as soon as 5 % pods/bolls / fruits are damaged, or 2 larvae per metre row are noticed. (ETL.)
6. Use of pheromone traps (Helilure) @ 5 /ha.

8. Mites :

Major species :

1. Two spotted spider mite : *Tetranychus urticae*, Tetranychidae : Aacarina
2.. Red or carmine spider mite: *Tetranychus cinnabarinus*, Tetranychidae : Aacarina
3. Sugarcane mite : *Oligonychus indicus H.*, Tetranychidae : Aacarina
4. Yellow mite : *Polyphagotarsonemus latus* B. Tarsonemidae : Aacarina
5. Woolly mite / Eriophyid mite : *Aceria* spp. Eriophyidae : Acarina.

Economic Importance : Mites are the most common non-insect pests associated to the diverse group of crops. Generally their incidence is more severe during warm climate and also on crops grown in green houses. Numerous species of different genera of mites are distributed throughout the world.

Marks of Identification : The morphological characters differ according to the species. In general, they are very small orthropods (1 to 3 mm long) the newly emerged larva is six legged, however, the nymphs (protonymphs, deutonymph) and adults have always eight legs. Exception to this is *Aceria* spp. (gall mites, eriophyid mites etc.) having only four legs and are elongated worm like very minute in size.

The body of mites is divisible in two regions – cephalothorax and abdomen and the colour varies according to species.

Host Plants : Highly polyphagous, damaging different field crops and horticultural crops.

Nature of Damage : Both nymphs and adults suck the cell sap from plant parts. Infested leaves turn chlorotic (yellow patches) and development of fine webbing and dust particles or well as brownish patches. Heavily infested leaves and fruits may drop down. Sometimes the leaves turn reddish colour and curling of the leaves is noticed.

Life History : Females lays about 50 to 80 eggs on under surface of leaves. Incubation period varies according to the species and climatic condition. Generally it ranges from 3 to 7 days. Nymphal period is 1 to 2 weeks. Adult longevity is 1 – 2 weeks. Like cycle is completed in 9 to 15 days.

Seasonal Occurrence : The pest is more active during summer months.

Management Practices :

A) Cultural practices :

1. Avoid monoculture practice.
2. Encourage intercropping with non host crops.
3. Destruction of mite infested plant parts.
4. Clean cultivation.

B) Chemical Control : Spraying of wettable sulphur 0.2 % or dicofol 0.03% or dusting of 300 mesh sulphur dust @ 25 kg/ha.

9. Rodents (Rats) : Muridae : Rodentia : Mammalia

Economic Importance : Rats are of great economic importance because of their variable role in problems of human food and health.

Marks of Identification :

1. **House Rat or Black Rat** : *Rattus rattus* Linn. Weight is between 120-125 g. length 35-38 cm.
2. **House mouse** : *Mus musculus* Linn. Weight is between 23-26 g. length 15-20 cm.
3. **Drain Rate or Brown rat** : *Rattus norvegicus* Birk. Weight is between 142-146 g. length 35-41 cm.
4. **Field Rats** : *Bandicota bengalensis* Gray. Weight is between 234-237 g. length 36-41 cm.
5. **Large bandicoot** : *Bandicota indica* Bech. Weight is between 370-414 g. length 38-45 cm.

Host Plants : Rats are highly polyphagous, feed on different stored grains and other food material and damages the different crops in field.

Nature of Damage : Rats damage (nibble) the earheads and feed on the developing grains of standing crop in the field. They also carry grains to their burrows. The damage is also equally serious on threshing yards and godowns. It has been noticed that a house rats eats 10 g of food grains/day, while bandicoot takes 15g. The damage to field crop may be from 5 to 25 per cent.

Life History : Rats are prolific breeders, they start breeding at the age of 3 to 4 months and breed throughout the year. A single female can liter as many as 10 young ones at a time with frequency of 10-12 times during a year under favourable conditions. Thus, one pair may give rise to about 800 young ones / year. Life period 3-5 years.

Management Practices :

I) Mechanical Control :

1. Hunting : It consists of engaging parties of persons who digout rat burrows and kill the rats.
2. Trapping : Trapping the rags and later disposing them off is one of the oldest methods of rat control. Good results of trapping the rats depend upon use of sufficient number of traps and their proper placement. They should be placed at right angle along walls or between objects.
3. Flooding : With powerful water supply. The flooding of burrows used to force the rats out during day time when they can be killed mechanically.
4. Guarding by rodent proof material:Specifically in fruit crops like coconut,etc.

5. Electronic rodent deterrent : In recent year, ultrasonic sounds have been used for repelling rats and mice from godown. Sound frequency of 20 Khz prevent rats from feeding and reproducing.

II) Biological Control : Cats, dogs, mongoose, snakes, birds, etc. play an important role in checking the build up of rat population.

III) Chemical Control : Chemicals used for the control of rodents are called rodenticides. They include.

1. Zinc phosphide : It is dull, black coloured pulvarised powder. It is soluble in water. After reaching in the stomach it reacts with acidic juices and produce phosphine (PH3) gas which is absorbed in the body and because of its toxicity rat is killed.

Zinc phosphide poison bait : (2% bait by wt.) The bait should be prepared by mixing 1 part zinc phosphide 80 % with 49 parts crushed grains and little quantity of any edible oil (sweet oil). A spoonful of bait wrapped in a paper packet should be inserted deep in every live burrow with the help of bamboo stick and the opening of the burrow should be closed with grass and mud. 1 kg of bat is sufficient for treating 200 burrows. The bait when consumed, the hydrochloric acid (HCL) present in the gastric juice reacts with it and phosphine gas is evolved which is rapidly absorbed in the system and cause death.

It is a single dose poison or Acute poison. Single dose sufficient to kill the rat. With continuous use of this poison the rats develop bat shyness and hence prebaiting (without poison) is required.

2. Warfarin : This is an anticoagulant type of rodenticide. In the market it is available as Rodafann 'C'. After entering into the body of rats it stops secretion of prothombin which is necessary for clotting of blood. Secondly, capillaries are damaged and lead to bleeding. In the absence of prothombin bleeding continues and rat dies slowly. The advantage is that rats do not get suspicious of the food, do not induce bait shyness and hence no prebaiting is required. It is chronic poison, kill the rats when taken in several doses. The baid should be prepared by mixing 1 part 0.5% warfarin with 19 parts of roasted and crushed gains of bajra or wheat and little quantity of edible oil. Ready to use baits are available.

3. Bromadiolone bait (Roban / Moosh-moosh) : Ready to use bait. Anticoagulant rodenticide. Single dose is sufficient to kill the rat. Death occurs slowly in 4-5 days. Do not develop bait shyness and hence, pre-baiting is not required. The bait is prepared by mixing 1 part 0.005% Bromadiolone 0.25% formulation with 40 parts of wheat flour/crushed wheat (carrier). Ready to use bromadiolone cakes are also available.

4. Aluminium phosphide : It is used for fumigation of rat burrows. It is sold as Celphos tablets. A ½ tablets of 3 g could be droopped in the burrow opening and holes closed by wet earh. The tablets in contact with moisture, liberates phosphine gas that kills the rats in burrows. It is very hazardous and highly inflammable and hence should be used carefully.

****

Exercise No. 2

STUDIES ON PESTS OF RICE

Material : Preserved specimens and affected plant parts.

The common pests infesting rice crop in Maharashtra state are as given below.

Major Pests :

1. Stem Borers :

a) Yellow Stem Borer : *Scirpophaga incertulas* Walk. Pyralidae : Lepidoptera

Economic Importance : It is one of the major pests of paddy. It is a specific pest of paddy and has world wide distribution. It is very serious in areas where more than one crops of paddy are taken in a year.

Marks of Identification :

Moths : Medium sized, 10-15 mm in length, forewings yellowish, hindwings whitish, black dot on each of the forewings and tuft of yellowish hairs on anal segments in female moth. Caterpillar – yellowiosh, 20 mm, yellowish brown head.

Host Plants : Rice only.

Nature of Damage : On hatching from the egg, the larva bores inside the stem of the paddy plant. As a result of feeding, the central shoot is killed causing "dead heart". The attack in the later stage results in yellowing of leaves and white earheads locally known as "Palinj.

Life History : Eggs-100-200 eggs are laid on upper surface of leaves near the tips. Incubation period 6-7 days. Larva-larval period 4-5 weeks (6 larval instars), before pupation larva construct an emergence hole on stem which is always located above the water level in fields. Pupa : Pupation in stem. Pupal period 8-10 days. Adult – adult longevity 5-7 days. Life cycle-completed in 2 months. 3 to 5 generations in a year.

Carryover : The pest hibernate in larval or pupal stage in the stubbles during winter season.

Seasonal Occurrence : Cold weather with high humidity and low temperature has been found conducive for the multiplication of the pest.

b) Stripped Stem Borer : *Chilo partellus* S. Pyralidae : Lepidoptera

Marks of Identification : Moths : Medium, 10 mm, forewings yellowish grey with small black spots at apical portion, hindwings are dirty white. Caterpillars : dirty white with brownish markings, 20-25 mm in length

Host Plants : Rice, paddy, jowar, maize, sugarcane, some hill millets and wild grasses.

Nature of Damage : Caterpillars initially feed on leaves and later bore inside the stem producing dead hearts or empty earheads depending upon the stage of the crop.

Life History : Eggs- average eggs laid by a female 200 on leaves, incubation period 6 days. Larva – larval period 15-26 days (5 moults). Pupa-pupation in stem. Pupal period 3-5 days. Life cycle – completed in 6-7 weeks.

Carryover : Pest hibernate as larva in stubbles in off season.

Seasonal Occurrence : The pest is active from July to November

Management Practices of Stem Borer Complex :

I) Cultural and Mechanical Measures :

1. Avoid late transplanting of the crop.
2. Grow high yielding midlate varieties like Ratna, EP-4-14, I.R.20, IET-3116, IET-3127, IET-9691 and IET-3093.
3. Remove affected tillers and destroy them.
4. Clipping of leaf tips at the time of transplanting to destroy the egg masses.
5. Plough the field immediately after harvest and destroy the stubbles.
6 Conservation of frogs to keep down the incidence of stem borer, army worm, crabs etc.

II) Chemical Control :

1. **Nursery Treatment :** Application of phorate 10 G @ 10 kg or quinalphos 5 G @ 15 kg or carbofuran 3 G @ 16.5 kg/ha in the soil under saturated moisture conditions. 15 days after sowing. If granular application is not possible due to inadequate soil moisture (sloppy or light type of soil) then spray with fenitrothion 0.08% or endosulfan 0.06 % or quinalphos 0.08% or phenthoate 0.08% when 1 moth or 1 egg mass/ sq.m. is noticed.
2. **Dipping of Seeding Roots :** Dip seedling roots for 12 hrs. in the solution prepared by mixing chlorpyriphos 20 EC, 500 ml. in 500 litres of water (0.02% solution). For this treatment the bed should be prepared by spreading plastic sheet and making ridges on all four sides for preparing the solution.
3. **Field Application :** When 5% dead hearts appear in the field or average 1 egg mass / sq.m., apply granules in the soil as given under nursery treatment. At the time of application, the field should have saturated moisture condition or maximum of 7-10 cm. of water level. Do not let in or drain out water for 4 days after application, Or spray the crop with insecticides given under nursery treatment or spraying of Bt @ 1 kg/ha. when 5% affected tillers sq.m. or 1 eggs mass/ sq. m. or 1 moth/sq.m. is noticed.

III) Biological Control : Release of laboratory based parasitoids, *Trichogramma japonicum* 4-5 times at weekly intervals @ 50,000/- parasitoids /ha on noticing stem borer moth activity.

Practical Guideline : Draw figures of adult stages of yellow and stripped stem borer.

2. Rice gall midge or gall fly : *Orseolia oryzae* W.M. Cecidomyidae : Diptera

Economic Importance : This pest is distributed throughout India. It has been found to be endemic in Bhandara, Chandrapur and Ratnagiri districts of Maharashtra State. The loss in yield in heavily infested crop may be to the extent of 50 per cent.

Marks of Identification : Adult fly-small, reddish brown, mosquito like having long slender legs, body length 4-5 mm. Maggot – pinkish, 2.5 - 3.00 mm in length.

Host Plants : Wild rice and grasses like *Panicum* spp., *Cynodon dactylon, Ischaeum cillare, Eleusine indica.*

Nature of Damage : The tiny maggot hatching out from the eggs creeps down between the leaf sheaths till it reaches the apical point of the central shoot or tillers as the case may be and then it enters the tissues and destroy the growing point. Due to the feeding normal growth of the plant stops and a small gall is produced. This gall gradually elongates and a long hollow silvery shoot emerges in place of normal stem bearing the earhead. The affected plants induces tillering but by the time, flies may emerge in successive generation and again attack the tillers and in case of severe infestation large percentage of plants yield no grains at all. The infestation is highest in tillering stage. The infested tillers do not bears ears.

Life History : Egg – average eggs laid by a female 100 on leaves singly or in clusters. Incubation period 3-5 days. Larva- larval period – 10 days. Pupa – pupation in galls or within the silver shoot. Pupal period 3-5 days. Life cycle : It is completed in 2-3 weeks and 5-8 generations in a year.

Carry Over : The pest probably overwinters in the larval stage in stubbles.

Seasonal Occurrence : Cloudy skies and drizzling rains are conducive to fast build up of pest. The favourable conditions for fly development is 26 to 30°C temperature and 82 - 86 % humidity. Heavy rains and low humidity cause high mortality.

Management Practices :

A) Cultural and Mechanical Measures :

1. Destroy all wild grasses and alternate hosts in and around the rice fields to prevent the infestation of this pest.
2. Grow resistant varieties viz., IET 7918, IET 6080, IET 7008, Pratap, Kunti, Suraksha, Vikram and Phalguna.

3. Removal of affected tillers showing silver shoots and their destruction will keep the pest under check..

B) Chemical Control :

1. **Nursery Treatment** : Give nursery treatment as stated under rice stem borer, when 1 silver shoot/sq.m. is noticed.
2. **Field Application** : When 1 silver shoot or gall/sq.m. in endemic area or 5% silver shoots/sq.m. in non-endemic area, apply phorate 10G @ 10 kg or quinalphos 5G @ 15 kg in soil control the pest effectively.

Note : Granules should be applied carefully and should not be handled by persons having wounds on feet or hands.

Practical Guideline : Draw the figures of adult fly and plant showing silver shoot.

3. Rice Jassids (Green Leaf Hoppers) : *Nephotettix nigropictus* Stal.
Nephotettix virescens Dist. Cicadellidae : Hemiptera.

Economic Importance : In the recent years, this pest appears in endemic forms in some part of Maharashtra. In addition to direct feeding damage, they are vectors of rike virus diseases and have almost the same overall economic significance as stem borers.

Marks of Identification : Adult greenish, wedge shaped, 4-5 mm in length, black spot on each forewing, Nymphs smaller, wingless and greenish.

Host Plants : Rice, wheat, barley and lemon grass.

Nature of Damage : Both nymphs and adults suck cell sap from the leaves. As a result the leaves turn yellowish and start drying from tip to downwards. Some species are known to be the vectors of virus diseases. The green leaf hoppers. *N. nigropictus* are reported to transmit 'rice transitory yellowing' and 'rice yellow dwarf'. Tungro virus disease transmitted by *N. virescens* is the most serious.

Life History : Eggs – about 25 per female within leaf tissues. Incubation period – 4-5 days. Nymph - nymphal period 10-15 days (five moults). Adult longevity 17-22 days in summer and 30-50 days in winter. Life cycle : Completed in about 5 weeks. Generations : Six overlapping generations in a season and several in a year.

Carry Over : Over wintering in adult stage, through alternate host plants.

Seasonal Occurrence : Pest is active during July-Sept. The abundance of the pest has been attributed to high temperature, low rainfall and abundant sunshine. Generally fields receiving large amounts of nitrogenous fertilizers are mostly infested. The pest population decreases after heavy rain. Incidence is more in ill drained fields.

Management Practices : Spray with dimethoate 0.05% or fenitrothion 0.05% or monocrotophos 0.05% or malathion 0.1% or phenthoate 0.05% or dusting carbaryl 10 D @ 20 kg/ha when 1-2 jassids / sq. m. in nursery and 5-10 or more jassids / hill in the field.

Note : Dusting should be undertaken in the evening or early in the morning when there is no wind.

Practical Guideline : Draw figures of adult stages of this pest.

4. Brown Plant Hoppers : *Nilparvata lugens* Stal. Delphacidae : Hemiptera

Economic Importance : Most destructive pest. It has become serious on high yielding varieties of paddy in many states.

Marks of Identification : Nymphs and adults are brown to brownish black, adults 4.5 mm in length.
Two types of adults are noticed - 1. Brachypterous – wings are not fully developed.
2. Macropterous – Wings development is complete.

Host Plants : paddy, sugarcane and some grasses.

Nature of Damage : Both nymphs and adults suck the cell sap from stem and leaves. As a result, the leaves become yellow, dry up and the whole plant dies after a few days. They are normally confined to the basal portion of rice plant. When the population is large, the crop dries up in

patches and this stage is called 'hopper burn'. They also transmit grassy stunt virus disease of paddy. Very high infestation causes lodging of the crop.

Life History : Eggs about 300 – 350 per female in leaf tissues on either side of midrib and the leaf sheath. Incubation period – 6-12 days. Nymph-nymphal period 15 days, 4 to 5 moults. Adult-lives for 10-20 days in summer and 30-50 days in atumn. Life Cycle : Several generations in a year.

Carry Over : It overwinters either as eggs or fifth in star nymphs through alternate host plants.

Seasonal Occurance : High nitrogen application, high humidity, optimum temperatures increases the population rapidly.

Management Practices : 1. Grow BPH resistant/tolerant varieties viz.,IET-7575, IET-7568, IET-7943 and IET-8115.

2. Spray the crop with insecticides given under the leaf hopper when 5-10 hoppers/hill are noticed.

Note : Insecticide should reach lower portion of the plant.

Practical Guideline : Draw the figures of adult and nymphal stages of this pest.

5. Swarming Caterpillar & Army Worm: *Spodoptera mauritia* B. *Mythimna separata;* Noctuidae : Lepidoptera. (Refer the polyphagous pests, Page No.).

Minor Pests :

6. Paddy Blue Beetle : *Leptisa pygmaea* B.; Chrysomelidae : Coleoptera.

7. Rice Hispa : *Dicladispa armigera* Oliv.; Chrysomelidae : Coleoptera.

8. Rice Case Worm : *Nymphula depunctalis* G. ; Pyralidae : Lepidoptera.

9. Paddy Grass Hopper : *Hieroglyphus banian* Fb.; Acridiidae : Orthoptera

10. Paddy Leaf Roller or Folder : *Cnaphalocrosis medinalis* G.; Pyralidae: Lepidoptera.

11. Rice Skipper : *Pelopidas mathias* Fab.; Hesperiidae : Lepidoptera

12. Rice Earhead Bug or Gundhi Bug : *Leptocorisa* spp.; Coreidae : Hemiptera.

13. Rice Butterfly (Rice Horned Caterpillar) : *Melanitis ismene* C. Satyridae : Lepidoptera.

14. Land Crabs : *Paratelphus* spp.

15. Snail and Slugs : Snail-*Helix* spp. Slug-*Limax* spp.; Gastropoda : Mollusca.

Exercise No. 3

STUDIES ON PESTS OF SORGHUM (JOWAR)

Material : Preserved specimens and affected plant parts.

Sorghum is attacked by about 150 pests. The common pests are given below.

Major Pests :

1. Jowar Shoot Fly (Stem Fly) : *Atherigona soccata* Rond. Anthomyidae : Diptera.

Economic Importance : It is one of the serious pests of sorghum in India. The pest attacks the crop only in early stage of growth and infestation goes up to 80%. The high yielding hybrids are more susceptible to the attack of this fly. The total loss in yield in sometimes as high as 60%. The pest is very serious on kharif and rabi crops in Maharashtra State.

Marks of Identification : Adult fly – dark grey, like the common house fly but much smaller in size, 6 to 4 dark spots on abdominal segments of female and male respectively (arranged in rows of two). Maggot-legless, tapering towards head, pale yellow, small (10-12 mm in length).

Host Plants : Jowar and grasses like *Andropogan sorghum*, *Cynodon dactylon* and *Panicum* spp., maize, wheat, some millets.

Nature of Damage : Maggots on hatching from the eggs bore into the central shoots of seedlings and kill the growing point, producing "dead hearts". They feed on the decaying core of the shoots. Subsequently on death of central shoot, plant gives out tillers and plant gets bushy appearance.

Life History : Eggs – average 40 eggs are laid by a female singly on lower surface of leaves and tender stem. Incubation period 2-3 days. Larva – larval period 10-12 days (4 larval instars) pupa-pupation in stem. Pupal period-about a week. Adult longevity -12-14 days. Life cycle – completed in 2-3 weeks. Several generations in a year. Carry over- The pest over winters in adult stage on grasses.

Seasonal Occurrence : The insect attacks the seedlings and late sown crops are attacked badly. The attack is severe during July to October. Cloudy weather favours multiplication of the insect. In rabi, early sown crop suffers more and hence, sowing should be delayed possibly.

Management Practices :

1. Sow the kharif crop as early as possible i.e. immediately after the onset of rains or within 15 days after receiving of rains. Increase the seed rate to make up the loss.
2. Use the seeds treated with carbofuran 50 SP @ 5% a.i. (100 g/kg) by wt. of seed (Gum arabic as sticker) or carbosulfan 25 STD (200 g/kg of seed) OR 3% carbofuran granuals @ 5 kgs/50 kgs of seed by using slurry of wheat flour as sticker. OR
3. Application of phorate 10G @ 10 kg/ha in soil at sowing OR
4. Spray the crop with 0.05% endosulfan as soon as 10% seedlings are infested or 1 egg /10 seedlings are noticed.
5. Removal and destruction of affected shoots alongwith the larvae.
6. Use resistant (Maldandi 35-1) or less susceptible varieties like R.S.V.9 R (Swati), S.P.V.86.

Practical Guideline :

Draw figures of maggot, fly and plant showing dead hearts.

2. Jowar Stem Borer : *Chilo partellus* S. Pyralidae : Lepidoptera.

Economic Importance : It is one of the major pests of jowar and has a wide distribution. The infestation is noticed till harvest and the grown up plants when damaged loose their vigour and putforth weak ears. The infestation is more pronounced on rabi and hot weather crops.

Marks of Identification : Moths-medium sized, straw coloured, yellowish grey forewings. The hindwings are whitish. Caterpillar-dirty white, brown head, many dark spots on the body, 12-20 min in length.

Host Plants : Although principle hosts are jowar and maize, it has also been recorded on sugarcane, rabi and certain grasses.

Nature of Damage : On hatching from the eggs, the larvae initially feed on tender leaf whorls causing series of holes in the leaf lamina and later bore into the stems, feed on the central shoots causing their death, commonly known as "dead hearts".

Life History : Eggs-about 300 eggs are laid, on leaves in clusters, incubation period-about 6 days. larval period : 3-4 weeks. Pupa : pupation in stem. Pupal period 7-10 days. Before pupation larva prepare a hole on stem at ground level for the moth to escape/come out. Adult : Adult longevity 2-4 days. Life cycle : completed in 6-7 weeks. About 4-5 generations are completed in a year.

Carry Over : The pest hibernates in the larval stage in stubbles. Seasonal occurrence : The pest is generally active from July to November. The infestation is more on rabi and summer crops.

Management Practices : Preventive and curative measures.

Preventive :

1. Collection and destruction of stubbles after the harvest of crop to kill hibernating larvae.
2. Increase the seed rate to compensate the loss.
3. Follow proper crop rotation (with non host crop)
4. Use of light traps.

Curative :

5. Removal and destruction of affected shoots alongwith the larvae.
6. Spraying with 0.05% endosulfan or 0.2% carbaryl Or whorl application of endosulfan 4G @ 10 kg/ha, when 10% plants are infested.

Practical Guideline : Draw figures of caterpillar, moth and plant showing dead heart.

3. Aphids: i)*Rhophalosiphum maidis* F. ii) *Aphis sacchari* Z.; Aphididae: Hemiptera.

4. Delphacids : *Peregrinus maidis* A.; Delphacidae : Hemiptera

Economic Importance : These are the most important sucking pests of jowar. The infestation is usually high on rabi crop. The yield is adversely affected and the fodder quality also deteriorates.

Marks of Identification : **Aphids :** Adults-minute, soft bodied, oblong, light green or pale yellow. Cornicles are characterized by the presence of 2 tube like structures on the dorsal side of abdomen. Aphids are generally wingless but winged forms are often noticed usually in the beginning and towards end of season for migration to other crops. Nymphs : Smaller and greenish. Aphids are found in large numbers on lower surface of leaves and leaf whorls and do not move unless disturbed.

Delphacids : Adults : Wedge shaped, pale yellow, walk diagonally. Nymphs –like adults but wingless. Delphacids found mostly in the whorl of the plants.

Host Plants : Jowar, bajra, other cereals and sugarcane.

Nature of Damage : Both Nymphs and adults suck the sap from plant especially from the leaves. As a result the leaves turn yellow and in case of heavy infestation the plants remain stunted. Their injury causes oozing of sap which crystalises on evaporation forming sugary material called "*Chikta*" or "Sugary disease". Due to sugary material oozing out of the plant and honey due excreted by the insects, the sooty mould develops and the leaves turn blackish. The yield is adversely affected and the fodder quality also deteriorates.

Life History: Aphids- Only females are noticed in Maharashtra. Reproduction parthenogetically, on an average each female produce about 42 young ones within period of 5 days. Nymphs moults 4 times in a period of 5 days. A generation is completed in about 2 weeks.

Delphacids : Eggs-about 150 eggs are laid in leaf tissues, incubation period -7-8 days. Nymphs : nymphal period 15-19 days (moult 5 times). Life cycle completed in about a month's time.

Management Practices : Spraying with dimethoate / quinalphos at 0.03% or formothion/ monocrotophos/ methyl demeton at 0.02% or dusting the crop with endosulfan 4D / quinalphos 1.5D @ 20 kg/ha. Spraying is more effective than dusting.

Practical Guideline :

Draw figures of leaf showing aphid colonies and a typical aphid with cornicles.

5. Army Worms : *Mythimna separata* Walk. Noctuidae : Lepidoptea.
(Already described under Polyphagous Pests, Page No.).

6. Midge Fly : *Contarinia sorghicola* coq.; Cecidomyidae ; Diptera

Economic Importance : The insect has a world wide distribution and is considered to be one of the important pests of sorghum. The grain loss varies from 20-50%. The severity of infestation has significant effect of overall production of gratin.

Marks of Identification : Adult fly– very small, bright red, 2mm in length, wings transparent, slightly dusky, female posses fairly long ovipositor. Maggot-small, dark orange reddish, 2 mm long.

Host Plants : Besides, jowar the pest is reported to feed on several grasses such as sudan grass, Johnson grass, *Pankanis* etc.

Nature of Damage : Maggots on hatching from the eggs feed on the developing grains (ovary) in the spikelets resulting in partial or complete sterility. In case of severe infestation only empty earheads are noticed.

Life History : Eggs : 100-125 singly in spikelet just near the overy with the help of ovipositor, incubation period 2-4 days. larval period 7-11 days. Pupa-Pupation in spiklet. Pupal period 3-5 days. Adult fly longevity – 1-2 days. Generation – completed in 14-15 days. Overlapping of generations are common. Carryover : It is accomplished by larvae diapausing in soil debris or in panicle residues.

Seasonal Occurrence : The pest is active in the months of August to October. High humidity and low temperatures favours its multiplication. Sowing of early maturing high yielding varieties on different dates along with late maturing local varieties provides ideal conditions for rapid multiplication.

Management Practices :

1. Adopt zonal system : Sow only one variety in a group of 8-10 villages. Undertake sowing of jowar as early as possible and complete the operation within a week. If possible hybrid varieties should be sown from 20^{th} to 30^{th} July.
2. Destruction of panicle residues prior to onset of monsoon i.e. before May-June by feeding to cattle or by burning before 15^{th} May, to kill hibernating larvae & prevent carry over of pest.
3. Destroy the alternate host plants before flowering.
4. Spraying with 0.1% malathion /0.2% carbaryl/0.05% endosulfan or dusting with malathion 5D/carbaryl 10D/edosulfan 4D @ 20 kg/ha when 1-2 flies /earhead are noticed. Dusting / Spraying should be undertaken early in the morning.

Practical Guideline : Draw figures of maggot and adult fly.

Minor Pests :

7. Grass Hopper : 1. Deccan wingless grass hopper : *Colemenia sphenerioides* B.
2. Surface grass hopper: *Chrotogonus* spp. Acrididae : Orthoptera.

8. Web Worms or Earhead Webber : *Stenachroia* HMP. Pyralidea : Lepidoptera

9. Hairy Caterpillar *Amsacta moorei* Bull-Arctiidae : Lepidoptera ;
Eurproctis subnotata W.; Lymantriidae : Lepidoptera.

10. Earhead Caterpillar : *Helicoverpa armigera* H.; Noctuidae : Lepidoptera

11. Mites : *Oligonychus indicus* H. & Tetranychidae : Acarina.

****

Exercise No. 4

STUDIES ON PESTS OF WHEAT, MAIZE , BAJRA AND RAGI

Material : Preserved specimens and affected plant parts.

I) PESTS OF WHEAT : The common pests infesting wheat crop in Maharashtra State are given below :

Major Pests :

1. Pink borer : *Sesamia inferens* Wlk. Noctuidae : Lepidoptera

Economic Importance : This is widely distributed species and is a common pest of wheat in India. It is sporadic in occurrence. It occasionally attacks maize crop also.

Marks of Identification : Moths – small, straw coloured, forewings with faint longitudinal band in the middle while hindwings are pale. Caterpillars – 22 - 25 mm long, pink coloured, smooth with dark spots on the body. Each spot bears a hair.

Host Plants : Wheat, maize, sugarcane, jowar, paddy, rabi, barley, oats and guinea grass, etc.

Nature of Damage : The young larva hatching from the egg, bores into stem, resulting into the death of the central shoot, commonly known as 'dead heart' in early stage of the crop. In the later stage of the crop, this damage results into the formation of empty white earheads. The larva migrates from one plant to another, thereby causing injury to many plants in its life.

Life History : Eggs – eggs are laid within leaf sheath or on leaf in clusters. Incubation period 4-9 days. Larva – larval period 3-4 weeks. Pupa-pupation in stem. Pupal period 5-12 days. Life cycle-completed in about 6-7 weeks.

Carry Over : The pest hibernate in larval stage in stubbles.

Management Practices :

1. Removal and destruction of stubbles after harvest of the crop to kill hibernating larval stages.
2. Remove affected shoots/dead hearts and burn them.
3. Spraying with 0.2% carbaryl immediately after the incidence is noticed.

Practical Guideline : Draw the figures of adult and larval stage of this pest.

2. Wheat aphid : *Macrosiphum miscanthi* (T.) Aphididae : Hemiptera

Economic Importance : Wheat aphid is widely distributed in India and sometime causes heavy losses.

Marks of Identification : Nymphs are greenish in colour while the adults are greenish – brown in colour with cornicles and winged forms appear in early summer.

Host Plants : wheat, barley, oats etc.

Nature of Damage : The nymphs and adult suck cell-sap from leaves and ear-heads development of black sooty mould on plant is common feature. Yield is decreased considerably

Life History : The female give birth to young ones. Life cycle is completed withing 7-9 days.

Management Practices : Spraying of dimethoate or monocrotophos or methyl demeton at 0.03%.

3. Termites or White ants : i) *Odontoterms obesus* R. ii) *Microtermes obsesi* H. Termitidae : Isoptera (Described under Polyphagous Pests, Page No.).

4. Rats : Muridae : Rodentia. (Refer Polyphagous Pests Page No.).

Minor Pests :

5. Jassids : i) *Typhlocyba maculifrons* M. ii) *Amrasca* spp. Cicadellidae : Hemiptera.

II) PESTS OF MAIZE : The Maize crop is infested by the following important pests:

1. Stem Borer : *Chilo partellus* S.
2. Pink Borer : *Sesamia inferens* Wlk.

3. Army Worm : *Mythimna separata* Wlk.
4. Surface Grasshopper : *Chrotogonus* spp.
5. Deccan wingless Grasshopper : *Colemania sphenarioides* B.
6. Aphids : *Rhophalosiphum maidis* F.
7. Delphacids : *Peregrinus maidis* A.

The details of the above pests are given under jowar and wheat.

III) PESTS OF BAJRA :

Major Pests :

1. Blister Beetle : i) *Lyttya spp.* ii) *Mylabris pustulata Th.;*Meloidae : Coleoptera.

Economic Importance : It is the only important pests of bajra, which occasionally breaks out in epidemic form in some localities. The grubs feed on the eggs of grasshoppers in soil and are thus beneficial.

Marks of Identification : *Lytta* spp. : Adults medium sized, light brown or greenish blue, soft body. *M. pustulata* : Adults – bigger sized, yellowish brown stripes across their forewings, soft body. These beetles secretes acidic substance called 'Cantharidin' from their body and when crushed on human body cause blisters and hence, they are called 'Blister beetle'.

Host Plants : Bajra, jowar, paddy, cucurbits and beans.

Nature of Damage : Beetles attack inflorescence and feed on pollens and petals of flowers and thus adversely affecting grain setting. In case of severe infestation earheads remain without grains (empty earheads). The grubs are harmless to the crop.

Life History : Whitish eggs are laid in soil which hatch in about 15 days. The larva feed on eggs of grasshopper and are thus beneficial. Pupation in soil. The beetles emerge from the pupae and remain active from August to December.

Management Practices :

1. Collection of beetles by hand net.
2. Dusting the crop with methyl parathion 2D or Endosulfan 4D @ 20 kg/ha as soon as the pest is observed.

Practical Guideline : Draw the figures of adult stage of two species of this pest.

Besides the above pest, bajra crop is also attacked by the following pests.

2. Army Worm : Refer Polyphagous Pests Page No. …..

Minor Pests :

3. Deccan Wingless Grasshopper:*Colemenia sphenerioides* B.; Acrididae: Orthoptera.

4. Surface Grasshopper : *Chrotogonus* spp.; Acrididae : Orthoptera

5. Hairy Caterpillars : *Amsacta moorei;* Arctiidae : Lepidoptera.

IV) PESTS OF RAGI (FINGER MILLET):

1. Pink borer : *Sesamia inferens* Wlk; Noctuidae : Lepidoptera
(Refer the pests of Wheat).

2. Jassids : *Amrasca* spp.; Cicaddlidae : Hemiptera
(Refer the pests of Cotton).

3. Aphids : *Rhopalosiphum maidis* F.; Aphididae : Hemiptera.
(Refer the pests of Jawar)

****

Exercise No. 5

STUDIES ON PESTS OF SUGARCANE

Material : Preserved specimens and affected plant parts.

About 125 insect and non-insect species have been recorded to infest the sugarcane crop in the country. Of these, about 20 are recorded in the State of Maharashtra. The pests which are commonly found to infest this crop are given below.

Borers are the most noxious pests of sugarcane crop and are responsible for heavy losses. Four types of borers viz., early shoot borer, top borer, internode borer and root borers are commonly noticed.

Major Pests :

1. Early Shoot Borer : *Chilo infuscatellus* Snell; Pyralidae : Lepidoptera.

Economic Importance : This pest is widespread in all the cane growing areas of the State. However, heavy incidence is noticed in the crop of light soil and where there is shortage of irrigation water especially in the summer months. Heavy losses to the extent of 22 to 33 per cent in yield and 12 per cent in recovery have been noticed.

Marks of Identification : Moth-greyish brown or straw coloured, males are smaller than the females. Larva – newly hatched larva is grayish in colour having a dark head and translucent body with spot and hairs. Full grown larva 20-25 mm in length.

Host Plants : Besides sugarcane, the pest attack jowar, maize, bajra, hill millets and grasses.

Nature of Damage : The pest is mainly injurious to young cane upto 8 weeks after planting. The caterpillars that hatch out from the eggs get scattered and enters into the young shoots by making the hole just above the ground level and tunnels downwards. The central shoots dries up causing 'dead hearts'. It is a characteristic sign of the presence of the pest within the plants. The dead heart can be easily pulled out. The central shoot dries, rots inside the stem and emits an offensive smell on being pulled out.

Life History : Eggs are laid along the sides of midrib on the leaves. About 11-20 egg masses with 16-65 eggs in each cluster are laid by a single female. Incubation period 3-6 days. Larva-larval period 22-31 days. Pupa-pupation inside the stem. Pupal period 5-9 days. Life cycle –completed 34-51 days, No.of generations – 8/year. Carryover : pest hibernates in larval stage in stubbles. Seasonal occurrence : It is active from July to September in adsali planting, November and December in preseasonal planting and January to March in Suru planting. Moderately high temperature with light rains and low humidity increases the early shoot borer activity.

2. Top Borer or Top Shoot Borer : *Scirpophaga excerptalis* Wlk (= *nivella* Fab).
Pyralidae : Lepidoptera.

Economic Importance : It is a cosmopolitan species and is considered to be a serious menace to the sugarcane cultivation in India, however, mild infestation of the pest is noticed in Maharashtra as compared to other borers. Maximum loss to the extent of 18.5 to 55% in yield have been reported in the State.

Marks of Identification : Moth : creamy white, female possess orange coloured tuft of hairs at the tip of abdomen. In males each of the fore wing has a black spot. Caterpillars –yellowish, 25-35 mm in length.

Host Plants : In addition to sugarcane it feeds on jowar, rice, maize and some grasses.

Nature of Damage : The pest is injurious to the cane in latter stage and persists till havest. The newly hatched caterpillar makes number of small holes on leaves (Shot holes on leaves), enters into

midrib of the leaf producing galleries in the midribs. Latters, bores downward into the shoot from the top causing death of central shoot. As a result of such damage the top portion gradually dries up and few internodes already formed mostly go waste. In such cases one or two buds just below the dried top portion sprout and develop into small sized, side canes or side shoots forming a 'bunchy top' i.e., bushy appearance.

Life History : Eggs-35-216 eggs are laid on underside of leaves. Incubation period 6-7 days. Larva – larval period 3-6 weeks. Pupa-pupation inside the stem in the larval tunnels, pupal period 7-10 days. Life cycle –completed in 5-9 weeks. With 6 generations in a year. Carryover : Full grown caterpillars hibernate in cane tops throughout winter.

Seasonal Occurrence : The maximum activity of the pest is observed mostly in October and November in adsali planted cane. High humidity and late rains appeared conducive for the increase in pest population.

3. Internode Borer : *Sesamia inferens* Walk.; Noctuidae : Lepidoptera.

Economic Importance : Though this pest was recorded to be of minor importance in the State of Maharashtra, it is now becoming a serious menace to the cultivation of sugarcane crop. It causes 8 to 34 per cent reduction in yield and 0.06 to 4.20 per cent in recovery.

Marks of Identification : Moths – small, 10-12 mm in length, straw coloured. Forewings have marginal dark lines and the hind wings are white. Caterpillars 20-23 mm in length, brownish in colour.

Host Plants : Sugarcane, wheat, paddy, maize, jowar and some grasses.

Nature of Damage : Infestation of the pest is noticed in all stages of crop growth. Firstly it act as an early shoot borer causing 'dead hearts' and latter as an internode borer. The activity as an internode borer starts 3 to 4 months after planting and continues till the harvest. The caterpillar borers at the nodal region and enters into the cane (stem). The hole is usually plugged with excreta. Due to feeding 'galleries' are formed inside the cane, the tissues turn red leading to reddish appearance and cane become hard. The larva may attack a number of nodes, habit of boring into one internode after another.

Life History : Eggs-are laid between leaf sheath and the stem in clusters. Incubation period 4-9 days. Larva – larval period 31-38 days. Pupa – Pupation inside the stem in the larval tunnels, pupal period 5-12 days. Life cycle : Completed in 6 to 8 weeks, with 5-6 generations in a year. Carryover : Larva overwinters in canes or stubbles from November to February. Seasonai Occurrence : The pest is found throughout the year and infestation is noticed from May to September. High temperature associated with light showers and low humidity helps in rapid multiplication of the pest. This pest is mostly active during dry and warm conditions.

4. Root Borer : *Emmalocera depressella* S.; Pyralidae : Lepidoptera.

Economic Importance : It is one of the minor pests of sugarcane and attack the underground portion of the stem. It is therefore, not a true root pest but in usage, it has been named as root borer.

Marks of Identification : Larva creamy white, 30 mm, the adult is yellow brown with white hind wings.

Host Plants : Sugarcane and jowar.

Nature of Damage : On hatching caterpillar enters the stem near the root zone through a fine hole and feeds on inner contents. Cenral leaf whorl dies and forms a 'dead heart'. It is not easily pulled out like that of early shoot borer.

Life History : Oviposition –on leaves/stem/ground. Incubation period 5-8 days. Larval period – 4 weeks. Pupation takes place inside the cane, pupal stage lasts for 9-14 days. Life cycle is completed in 6-7 weeks. Pupation inside canes.

Management Practices : **(Borer Complex)** Borers being an internal feeders are extremely difficult to control. Both preventive and curative measures are necessary to keep them under check. Since

most of the borers occur together and the type of damages caused by them is more or less common, the measures for their control are also given together.

1. Collection and destruction of egg masses.
2. Removal of dead hearts.
3. Early earthing up of canes, usually a month after planting helps in minimizing the damage of early shoot borer and root borer.
4. Timely planting of cane – Adsali in July-August, Preseasonal in October and Suru in December – January. Late planted crops (apart from giving lower yields) are badly attacked by the shoot borer, causes gaps in the stand of cane and set – back to growth and yield.
5. Profuse and timely irrigation, mulching with trash at planting or germination for early shoot borer.
6. Digging out the clumps (stubbles) after harvest to kill hibernating larvae of root borers, early shoot and internode borers.
7. Burning of trash at harvest to prevent carry-over of internode borer infestation to the succeeding crops.
8. Biological control :
   Release of eggs parasitoid, *Trichogramma chilonis* Ish. @ 50,000 Adults/ha/week in 6-8 instalments. Trichocards (*Corcyra* eggs parasitized by *Trichogramma*) are commercially available.

Chemical Control : (For Early Shoot Borer) : Drenching the soil with 0.1% lindane 20 EC or Cholrpyriphos 20 EC (i.e. 5 litres in 1000 litres of water/ha.) immediately after planting in the furrow by using water can/sprayer. Spraying the crop with 0.05% endosulfan as soon as incidence is noticed. (ETL- 15-22% incidence in top shoot borer.).

5. Sugarcane Pyrilla or Leaf Hopper : *Pyrilla perpusilla* Walk; Fulgoridae: Hemiptera.

Economic Importance : It is a major pest of sugarcane and breeds practically throughout the year. It is distributed throughout India. Since 1950, the pest is noticed in the endemic form in the area of Deccan canals of Maharashtra State. Due to constant sucking of the cell sap, losses to the extent of 26 to 35 % in yield and 2 to 5% in sucrose has been recorded. Besides, 2.25 to 4.5 per cent decrease in production of gur has been reported. Under epidemic conditions nearly 50% decrease in recovery occurs and gur will not set.

Marks of Identification : Adults- straw coloured, 2 pairs of wings folded like a roof on the back, head extended like a pointed beak. Nymphs-newly hatched ones are milky white with a pair of characteristic processes/filaments covered by wax, very active and found in large numbers on cane.

Host Plants : Besides sugarcane, it also feeds on wheat, barley, jowar, maize, bajra etc.

Nature of Damage : Both nymphs and adults suck the cell sap from the lower surface of leaves. As a result plant loose turgidity, begin to wither and get dried up. The sucrose % of the juice is adversely affected. They also excrete honeydew like substance, that spreads on the leaves on which black fungus (*Capnodium* spp.) develop, which adversely affect the photosynthesis and the yield.

Life History : Eggs are pale greenish yellow, single female lays about 400 eggs on lower surface of leaves and also between the detached leaf sheath and the stem, covered with white, cottony waxy filaments. Incubation period 7-14 days in summer and 30-40 days in winter. Nymphs – nymphal period 50-60 days (5 instars) in summer and 50-80 days in winter. Life cycle : completed in 60 days in summer and 120 days in winter, 3-5 generations in a year.

Carry Over : Through alternate host plants, overwinters mostly in adult stage.

Seasonal occurrence : Cold winds and high humidity help in rapid multiplication. Low rain fall or prolonged dry spell and low temperature during monsoon also seem to be conducive for its

profuse multiplication. Severe infestation of the pest is noticed during July and August in the endemic area.

Management Practices :

1. Collection and destruction of egg masses.
2. Removal of 5-6 lower most leaves helps in reduction of pyrilla population as maximum egg laying takes place on such leaves.
3. Biological control : Release of lepidopterous nymphal parasitoids viz., *Epiricania melanoleuca* F. @ 5000 cocoons/ha or 5,00,000 eggs/ha effectively control the pyrilla. After establishment of parasitoids, insecticides should not be used and avoid trash burning to prevent destruction of hibernating eggs of parasitoids on dry leaves. Use of *Metarrhizium anisopliae* M. and *Aspergillus flavus* L. fungi are also effective against the pest (nymphs and adults).
4. Chemical control: Hand spraying of 0.035% endosulfan / 0.03% quinalphos/0.03% fenitrothion/0.05% malathion/0.03% monocroto-phos /0.03% dimethoate as soon as 3-5 individual eggs or nymphs or adults/leaf are noticed in May/June. Aerial spraying of malathion ULV/endosulfan 35 EC/fenitrothion 100 EC is also recommended.

6. Sugarcane Woolly Aphids: *Ceratovacuna lanigera* Zehnter; Aphididae: Hemiptera.

Economic Importance : Sporadic occurrence of this pest is observe in some sugarcane growing pockets of Maharashtra from last few years.

Marks of Identification : Nymphs have elongate, ovoid body with pale yellowish white colour. As nymphs develop, gradually covered with white powdery secretion which covers body segments. The adults are apterous or alate (winged) forms, about 1 to 2 mm in length and covered with white cotton like secretion.

Host Plants : Wild and cultivated sugarcane species.

Nature of Damage : The aphids form a colony on the under surface of sugarcane leaves. Both nymphs and adult suck the cell sap from leaves and excrete honey dew resulting subsequent development of black sooty mould on plant resulting adversely on photosynthesis. It affect adversely on growth, sugar content and yield of crop. The fodder quality of leaves (tops) is also adversely affected. The incidence of the pest is most severe from June to September when the humidity is high.

Life History : The woolly aphid is an viviparous insect reproduce parthenogenetically with 10 to 60 offsprings per female on ventral surface of leaf. The nymphal period is 23-40 days. Adult period 8 to 36 days. Life cycle is completed within 4 to 6 weeks.

Management Practices :

1. Adoption of strip planting method so as to wide space between the paired rows.
2. Mechanical measures like collection and destruction of the infested leaves as soon as localized infestation is noticed.
3. Release of lepidopterous predator *Dipha* (*Conobathra*) *aphidivora* or other predators like *Micromus, Chrysoperla* spp.
4. Spraying of dimethoate, endosulfan, malathion or methyl demeton at 0.05% or dusting of methyl parathion 2D @ 25 kg/ha.

7. White Grub : *Holotrichia serrata* F.; *H. consanguinea* Bl.
Leucopholis lepidophora Burm. Scarabaeidae : Coleoptera.
(Refer the Polyphagous Pests Page No. ……)

8. Termites or White Ants : *Odontotermes* spp. *Microtermes* spp.
(Refer Polyphagous Pests Page No. ……)

9. Sugarcane Mites : *Oligonychus indicus* Hirts.; Tertranychidae : Acarina.
(Refer the Polyphagous Pests Page No.)

Minor Pests :

10. Scale Insects : *Melanaspis glomerata* Green, Coccidae : Hemiptera.

11. Mealy Bugs : *Saccharicoccus sacchari* Ckll.; Pseudococcidae : Hemiptera.

12. White Fly or Mealy Wings : *Aleurolobus barodensis* Mask.;
Aleyrodidae : Hemiptera.

13. Grasshopper : *Hieroglyphus banian* Fab.; Acrididae : Orthoptera

14. Rats : *Rattus rattus Linn.* & *R. norvergicus* Birk.

15. Aphids : *Melanaphis sacchari Z.; A. maidis* F. and *A. sacchari* Z.
Aphididae : Hemiptera.

Exercise No. 6

STUDIES ON PESTS OF COTTON, SUNNHEMP AND AMBADI

Material : Preserved specimens and affected plant parts.

I) PESTS OF COTTON : Of the 134 pests recorded on cotton, 25 pests have been reported in the State of Maharashtra infesting the crop and the important pests are described below :

Major Pests :

1. Jassid or Leaf Hopper : *Amrasca biguttula* Ishida; Cicadellidae : Hempitera

Economic Importance : It is a cosmopolitan and polyphagous species widely distributed in the Indian Union. It occurs in all the cotton growing areas of the State. Heavy incidence of the pest is noticed in irrigated cotton.

Marks of Identification : Adult-wedge shaped, 3.5 mm in length, pale green, black spot on each of the fore wings and 2 spots on vertex. Nymph –wingless, pale greenish, walk diagonally.

Host Plants : It is polyphagous species infesting cotton, bhendi, potato, brinjal, sunflower etc.

Nature of Damage : Both nymphs and adults suck the cell sap from the lower surface of the leaves and inject their toxic saliva into the plant tissues and produce a characteristic "Hopper Burn" symptoms on leaves wherein the margins turn yellowish initially and subsequently turn reddish and curl. In case of heavy infestation, the leaves show brown necrotic patches and the growth of the plant remains stunted thereby affecting the yield adversely.

Life History : Eggs-female lays 30 eggs in leaf tissues singly inside the leaf veins which hatch in 4-11 days depending upon the climatic conditions. Nymphs - nymphal stage 7-21 days (moult 5 times). Life cycle-completed in 2 to 4 weeks. Generation – several overlapping generations in a years. Seasonal occurrence : Active during July to September. Excessive rainfall and irrigated conditions are conducive for the multiplication of the pest and the incidence is observed to be more pronounced in irrigated cotton as compared to rainfed cotton.

Practical Guideline : Draw fugures of adult jassids and the plan showing "Hopper Burn" Symptoms.

2. Aphids : *Aphis gossypii* Glover; Aphididae : Hemiptera

Economic Importance : It is a cosmopolitan and polyphagous species noticed in all the cotton growing areas of the state.

Marks of Identification : Adult – oblong, 2 mm long, yellowish to dark green or black in colour, cornicles on abdomen, mostly wingless, winged forms are noticed mostly in the beginning and towards the end of the season, wings are thin, transparent and held like a roof of the body

Host Plants : Cotton, brinjal, bhendi, chillies, potato, pomegranate, etc.

Nature of Damage : Nymphs as well as adults suck the cell sap by remaining on the lower surface of leaves and impair the vitality of the plants. In severe infestation the leaves curl badly and growth of the plant remain stunted. Besides sucking the sap from the leaves, these insects also excrete a honey-dew like substance which attracts the black sooty mould (*Capnodium* spp.) which adversely affect the photosynthesis.

Life History : They reproduce viviparously and parthenogenetically. A single female produces 8-20 nymphs/day. Nymphs moult 4 times. The life cycle completed in 7-9 days, there are many generations in a year.

Seasonal occurrence: The pest is very active during early part of rainy season and in the later period of winter season.

Natural Enemies: Predators – Ladybird beetle, *Coccinella septumpunctata* and green lacewing *Chrysoperla carnea.*

Practical Guideline : Draw the figure of aphid.

3. Thrips : *Thrips tabaci* Lind, *Scirtothrips dorsalis*, Hood.; Thripidae : Thysanoptera.

Economic Importance : It is a consmopolitan and polyphagous species distributed all over the state wherever cotton is grown. It breaks out in serious form especially in early stage of the crop growth.

Marks of Identification : Adults – minute, delicate insects (about 1 mm long), light yellow, the wings have a fringe of hairs, Nymphs – very minute, whitish yellow.

Host Plants : Cotton, mango, tondli, bottle gourd and guava.

Nature of Damage : Both nymphs and adults with their rasping and sucking type of mouth parts scrap the epidermal tissues of leaves and suck the oozing cell sap. As a result of their feeding, leaves become brownish. Excessive feeding on leaves lead to their curling and the plants remain stunted.

Life History : Female breeds sexually as well as parthenogenetically. Eggs : female can lay 30-50 eggs during her life time in leaf tissues of veins on lower surface of leaves. Incubation period 2-5 days. Nymph-nymphal period 7 days (moult 3 times) Life cycle completed in 4 weeks Adult female lives for 10-15 days. Parthenogenesis is common and progeny produced in this way consists of females only. Seasonal occurrence – Pest is active in post – monsoon period or in dry spell during monsoon.

Practical Guideline : Draw figure of adult thrips.

Management Practices : (Aphid, Jassid and Thrips).

1. Seed treatment with imadacloprid @ 5 g/kg seed or granular application at the time of sowing with phorate 10G @ 1-1.5g at each spot, Or spraying with 0.03% dimethoate./methyl demeton. Spraying should be undertaken when ETL reaches to : Aphids – 10 aphids / plant or 15-20% plants are infested. Jassids- 2 jassids/leaf. Thrips – 10 thrips/leaf or 15-20% plants are infested.

4. Bollworms :

a) Spotted or spiny bollworms (SBW) : i) *Earias vittella* Fb.; ii) *E. insulana* B.
Noctuidae : Lepidoptera.

Economic Importance : It is a cosmopolitan species and is distributed throughout the cotton growing areas of the State. In Maharashtra, shoot damage to the extent of 30% has been reported. The shedding of squares and bolls to the extent of 50-60% has been recorded. Similarly, the loss in yield of kapas (seed cotton) has been estimated to be around 20 per cent.

Marks of Identification : *E. vittella* adults have pale white upper wings with a broad greenish band in the middle, 10 mm in length. *E. insulana* adults have completely green upper wings. Caterpillars – brownish white with number of black and brown spots on the body and hence the name 'spotted bollworm', 19 mm long.

Host Plants : Oligophagous, infesting cotton, bhendi, ambadi, holly hock, mudrika and other malvaceous plants.

Nature of Damage : In early stage of the crop growth the larvae bore into the growing tender shoots and feed internally, resulting into drooping and drying of such shoots. With the onset of flowering, the larvae bore into the bunds and flowers and make them drop down on ground. Latter, when the bolls are formed, they attack them. The infested bolls show holes plugged with the excreta. The infested buds and bolls are mostly shed but if they remain on the plant they open prematurely and the lint obtained from them is of inferior quality.

Life History : Eggs – A female lays 200 – 400 eggs in 5-23 days on top tender leaves, floral buds, bracts and bolls singly or in batches, eggs hatch within a week and tiny larva move freely for some time on the plant and then bore. Larva : They become full grown in 2-3 weeks depending upon climatic conditions. Pupa : pupation in the soil or on plant in squares or bracts in silken cacoons. Pupal period lasts for 1-2 weeks. Generation – life cycle completed in 18-46 days and there are several generations in a year, Carryover : summer bhendi is one of the important source

of carryover of the pest and hence avoid growing of bhendi and other malvaceous crops during off season. (i.e. summer season), which serve as alternate host for spotted bollworm.

Practical Guideline : Draw the figures of larva, moth, damaged shoot and boll.

b) Pink bollworm (PBW) : *Pectinophora gossypiella* S.; Gelechidae : Lepidoptera

Economic Importance : This is one of the most destructive pests of cotton having been reported from almost all countries of the world. In Maharashtra it is distributed in all the cotton growing areas. Shedding of bolls to the extent of 60% (Marathwada), while infestation of bolls to the extent of 50% (Jalgaon) has been reported.

Marks of Identification : Moth- small, 3-6 mm in length, brown with numerous black spots on the wings. Caterpillar pinkish, 18-19 mm in length.

Host Plants : Oligophagous, infesting cotton, bhendi, ambadi, hollyhock, mudrika and other malvaceous plants.

Nature of Damage : Unlike the spotted bollworm, the pink bollworm never attacks the shoots; but infest floral buds, flowers and bolls. In the beginning; the caterpillars feed on floral buds and flowers and cause their shedding. Later on they bore into the bolls and feed on inner contents. Caterpillar feeds on the seeds and moves to adjacent locule by making hole through the septum. Ginning percentage of seeds and spinning qualities of kapas are adversely affected. As caterpillars enter the bolls, their entry holes which are very minute, get closed and it becomes extremely difficult to locate the infested bolls until they drop down on the ground.

Life History : Eggs : female lays about 100-150 eggs in 3-5 days singly on underside of leaves, floral buds, bracts and bolls. Eggs hatch within a week but hatching delays under severe cold conditions. Larva : full grown in 9-21 days and pupates by spinning cacoon on the bract or in falien leaves, flowers or even in soil. Pupa : pupal stage last for 6-20 days. Generation. There are two types of generations viz. short cycle and long cycle. The life history mentioned above is in the case of "short cycle generation". In the "long cycle generation" the full grown larva without undergoing pupation remains in hibernating stage in seed even up to 2 years. As many as 9 generations are completed in a year. Carryover : Through seed in the form of hibernating larva, but quite negligible in over state. Majority of them hibernate in pupal stage (cacoons) among the shed bolls, other plant debris or in cracks in soil.

Practical Guideline : Draw the figures of caterpillar, moth and attacked bolls.

c) American bollworms : *Helicoverpa armigera* H.; Noctuidae : Lepidoptera.

(Refer Polyphagous Pests Page No……..).

Management Practices : (Bollworm Complex)

Preventive Measures :

1) Clean-Up Campaign : Immediately after harvesting is over, the stalks, leaves, infested bolls on the plants and those lying on the soil should be collected and burnt.
2) Fumigation of Seeds In Storage : Seed fumigation should be done with Alluminium phosphide @500 g/100cu.m. of space for 24 hrs. to kill hibernating larvae of PBW. Fumigation should be carried out carefully and strictly under expert supervision.

Mechanical Measures :

1) If the infestation of SBW is observed, remove and destroy the affected shoots along with larvae or the affected shoots should be pressed to kill the larvae inside.

Biological Control :

1) Field releases of following parasitoids @ 50,000 parasitized eggs of corcyra/ha. *Trichogramma chilonis* (an exotic egg parasitoid) *Chelonus blackburni* Cam. (an exotic egg-larval parasitoid) 50,000 adults/ha. *Bracon kirkpatrickii*, W. (an exotic larval parasitoid) *Apanteles angaleti* M. (an indigenous larval parasitoid).

Chemical Control

1) Spraying the crop with 0.0075% cypermethrin/0.0025% decamethrin / 0.0125 % fenvalerqte / 0.0092 % fluvalinate or 0.2 % carbaryl / 0.06 % endosulfan / monocrotophos / 0.05 % quinalphos / phosalone or dusting the crop with carbaryl 10D@ 20 kg/ha at 5% infestation on squares, flowers and bolls (ETL).
2) Spraying with Bt/HaNPV for American bollworm.

5. Mites : 1. Red mite – (Tetranichid mite); *Tetranychus* spp. Teranychidae : Acarina
2. Woolly mite – (Eriophyid mite); *Aceria gossypii* B; Eriophyidae: Acarina

In recent years, the problem of phytophagous mites is assuming serious form. One of the reason for this is the intensive and indiscriminate use of chlorinated hydrocarbon and carbamate insecticides in plant protection work which are reported to be ineffective against mites but are responsible for destruction of their natural enemies. Red mites are common in Maharashtra infesting variety of crops.

Biology – Red Mites : Adults are extremely small, 0.6 x 0.2 mm, Body unsegmented not divided into cephalothorax and abdomen. 4 Pairs of legs (in larvae 3 pairs only), life cycle consists of an egg, 3 nymphal and adult stages. The nymphal stage are called protonymph (larva), deutonymph and tritonymph. Larva, in most cases resembles the adult.

Woolly Mites : They are different from all other Acarina. They have vermiform body, distinctly divisible into a cephalothorax and a long tapering abdomen and only 2 pairs of legs situated near the anterior end of the body. Both in the adult and immature stages, mouthparts are adopted for biting, piercing and sucking. Life cycle consists only two nymphal instars which are not very different from the adult.

Nature of Damage : Red mites are abundant on lower surface of leaves. The nymphs and adults suck the cell sap from the leaves which as a result turn reddish brown and ultimately dry and drop down. The woolly mites feed on epidermal tissues of leaf and cause irritation due to which a growth of dense whitish hairs arises on both surfaces of leaves as well as on the infested shoots. Heavily infested plants shed their bolls. In Maharashtra, red mites are more common than woolly mites.

Life History : Eggs : female lays 33-90 eggs on leaves which hatch in 4-6 days. Larva : larval period 4-7 days. Nymph : nymphal period 7-16 days. Life cycle: completed in 15-29 days depending upon climatic conditions. Generation : several generations in a season.

Management Practices : Dusting of sulphur @20 kg/ha or spraying with 0.2% wettable sulphur control the mites effectively.

Practical Guideline : Draw the figure of mites.

6. Red Cotton Bug : *Dysdercus cingulatus* Fb.; Pyrrhocoridae : Hemiptera

Marks of Identification : Adult bug : small (12-13 mm in length), red in colour (except eyes, scutellum and antennae which are black coloured.), black spot on each of the forewings and white bands on the abdomen. Nymphs : red, smaller and wingless.

Host Plants : Oligophagous, infesting cotton, bhendi, ambadi, holly hock and other malvaceous plants.

Nature of Damage : Both nymphs and adults suck the cell sap from the leaves, tender shoots and tender bolls and impair the vitality of plant. The attacked bolls open badly and produces a lint of poor quality. In addition, they also feed on the seed and lower their oil content. The infested seeds become unfit for sowing. Due to excreta of the insect and the crushing of the nymphs during ginning the lint gets stained and hence it is commonly called cotton stainer. The insect is reported to introduce a bacterium, *Nematosopora gossypii* into the bolls which also stains the cotton fibre.

Life History : Eggs – femal lays 100-130 eggs in soil near the plant. Nymph-nymphal period 30-35 days (4 moults). Life cycle – completed in 6-8 weeks.

Management Practices : Dusting with methyl parathion 2 D/endosulfan 4 D @ 20kg/ha. immediately after the appearance of the pest. Dusting should be done both on the crop and on soil.

Practical Guideline : Draw the figures of nymph and adult.

7. Dusky Cotton Bug : *Oxycaraenus hyalipennis* K; Lygaeidae : Hemiptera.

Marks of Identification : Adults : small (6 mm long), dusky in colour : Nymphs :reddish brown, turn into dusky brown.

Host Plants : Cotton, bhendi and other malvaceous plants.

Nature of Damage : Pest attacks open bolls and those damaged by bollworms. Nymphs and adults suck the sap from immature seeds in open bolls, as a result seeds do not develop properly. Besides, due to their crushing in ginning the lint gets stained.

Life History : Eggs : The cigar shaped whitish eggs are laid in cluster in the lint of half opened bolls. Hatch in 5-6 days. Nymph : nymphal period 2 weeks (moult 6 times). Seasonal occurrence : the pest is active from November to February.

Management Practices : Given under red cotton bug.

8. Cotton Leaf Roller : *Sylepta derogate* Fb.; Pyradidae : Lepidoptera.

Host Plants : Cotton, bhendi, etc.

Nature of Damage : The caterpillars roll-up the cotton leaves and feed on them from margin by remaining inside such rolls.

Life History : Eggs laid on surface of tender leaves. Pupation takes place within.leaf rolls. Leaf cycle completed in 4 weeks.

Management Practices :

1) Removal and destruction of rolled-up leaves.
2) Dusting the crop with methyl parathion 2D or endosulfan 4D @ 20-25 kg/ha or spraying of carbaryl 50 WDP 0.2%.

9. Cotton mealy bug : *Phenaccocus solenapsis* Tin. Peudococcidae : Hemiptera.

Economical Important : Recently the species *P. solenapsis* is predominantly observe on cotton.

Marks of Identification : Body oval (5 mm), somewhat rounded in lateral view, dark green almost black, cover with white, thin mealy wax, a pair of dark longitudinal lines on dorsum, ovisac absent from dorsum, but well developed ventrally with 18 pairs of lateral wax filaments, posterior pair longest.

Host Plants : Highly polyphagous, feeding on cotton, other crops and weeds, atleast 14 host families.

Nature of Damage : Both nymps and adult females suck the cell-sap from the leaves, flowers and bolls. Excretion of honeydew and development of sooty mould dropping of flowers and bolls and adversely effect on growth of plant. Drying of soots in case of severe infestation.

Life History : The eggs are not detectable. There are three nymphal and adult stage. The stages last with an average of 6, 8, 10 and 13 days respectively. The adult stage lasts 10 to 30 days.

Management Practices :

1. Collection of severely infested twigs and their distraction
2. Spraying of *Verticillium leccanii* @ 0.2 % or monocrotophos or diamethoate or qunalphos or clorpyriphos @ 0.05%
3. Use of cryptolaemus predators.

Minor pests :

10. White Fly : *Bemisia tabaci* G.; Aleyrodidae : Hemiptera

11. Scale Insects : *Pulvinaria maxima G.;* Coccidae : Hemiptera

12. Cotton Ash Weevil : *Myllocerus maculosus* D.; Curculionidae : Coleoptera.

13. Reniform Nematode : *Rotylenchulus reniformis;* Hoplolaimidae : Tylenchida.

II) PESTS OF SUNNHEMP AND AMBADI :

Major Pests :

1. Hairy Caterpillars : *Argina* spp.; Arctiidae : Lepidoptera

Marks of Identification : Black hairs all over the body of caterpillar. Moths are pale, whitish with red black soots on upper wings and black marginal blatches on lower wings.

Host Plants : Polyphagous pest feeding on sunnhemp, ambadi, grasses etc.

Nature of Damage : The caterpillars feed on leaves and occasionally also bore into seed capsules.

Life History : The moths lay small whitish eggs on the tender leaves and shoots. Incubation period 6-9 days, larval period 2-3 weeks pupal period 1 week. Total life cycle is completed within 4 to 7 weeks. Pupation takes place either in the leaf folds or in the soil.

Management Practices :

1) Clean cultivation
2) Handipicking of caterpillars in the early stage of infestation, alongwith leaves.
3) Dusting with endosulfan 4 D or methyl parathion 2D @ 20 kg/ha as soon as incidence is noticed. Or spraying with 0.05% endosulfan or 0.1% carbaryl 50 WDP.

Practical Guideline : Draw the figures of moth and caterpillar.

2. Spiral Borer of Mesta / Stem Borer : *Agrilus acutus* Thumb.;
Buprestidae : Coleoptera.

Economic Importance : This pest is commonly observed in Bihar, Uttar Pradesh and Madhya Pradesh.

Marks of Identification : It is a minute bronzy or metallic blue coloured beetle with cylindrical body. The grubs are brownish pinkish.

Host Plants : Mesta (Ambadi).

Nature of Damage : The damage is caused by the grubs by feeding inside the stem on woody tissue. During feeding the grub travels throughout the entire length of the stem in a spiral manner. A portion of the infested region swells-up considerably to form an elongated gall, the portion above the gall dries up and breaks.

Life History : The eggs are laid on stem preferably on the nodal region below the leaf – base. Pupation takes place inside the stem. Incubation period 1 to 2 weeks. Larval period 25 – 30 days. Pupal period 8-10 days. Total life cycle – 5 to 6 weeks.

Management Practices :

1. Collection and destruction of infested plants.
2. Swabbing the stem with 2.5 % methyl demeton 25 EC or dusting with endosulfan 4D or Methy parathion 2D @ 20 kg/ha.

Minor Pest :

3. Jassids : *Amrasca biguttula* Ishida; Given under cotton.

4. Aphids : *Aphis gossypii* G.; Given under cotton.

5. Flea Beetle : *Longitarsus* spp.; Chrysomelidae : Coleoptera.

6. Capsid Bug : *Ragmus importunitas D.*; Miridae : Hemiptera

****

Exercise No. 7

STUDIES ON PESTS OF OILSEED CROPS

Material : Preserved specimens and affected plant parts.

I) PESTS OF GROUNDNUT : Groundnut is one of the major oilseed crops of the State, which is attacked by about a dozen insect and non-insect pests. The more important are aphids, leaf miner, pod sucking bug, white grub and termites.

Major Pests :

1. Groundnut Leaf Roller or Groundnut Leaf Miner: *Aproaerema modicella* Devant
Gelechidae : Lepidoptera.

Economic Importance : Though the pest was recorded to infest the crop in Nagpur area, it has been assuming serious form in the State only during last 10 years. Though polyphagous, considered to be serious only on groundnut.

Marks of Identification : Moth-small, 8-10 mm in length, wings are grayish with a pale white dot on each of the forewings. Caterpillar – small, 6-8 mm long, cylindrical tapering posteriorly, brown or light green in colour.

Host Plants : Polyphagous infesting groundnut, soybeans, red gram (tur) etc.

Nature of Damage : The larva mines the upper epidermis of the leaves during early stage of their growth. The mined leaves within a few days show brown streaks. Later the larvae bite their way out from the mines and fold the leaves or bring two adjacent leaves together and feed on them. As a result, leaves dry and the plant wither adversely affecting the yield.

Life History : Eggs are laid on leaves and tender shoots. Incubation period 3-4 days. Larva-larval period 9-17 days. Pupa – pupation in leaf folds or in leaf mines. Pupal period – 7days. Life cycle : Completed in 15-28 days, with many generations in a year.

Management Practices : Spraying the crop with 0.01 % cypermethrin / 0.01 % fenvalerate / 0.0025% decamethrin/0.2% carbaryl/ 0.05% monocrotophos/ 0.05% quinalphos or dusting the crop with quinalphos 1.5 D/ methyl parathion 2 D/ phosalone 4D / malathion 5 D @ 20 kg/ha as soon as 2 live larvae/ plant or 10 % mined leaves are noticed.

Practical Guideline : Draw the figure of adult moth of this pest.

2. Groundnut Aphids : *Aphis craccivora* Koch.; Aphididae : Hemiptera.

Economic Importance : This is a cosmopolitan and polyphagous species breaks out in an epidemic form almost every year in all the groundnut growing areas of the State and causes heavy losses.

Marks of Identification : Adult –dark olive brown to black with dark medium bars on the abdomen. Wlinged forms have black wings. The aphid colonies are noticed on underside of leaves, top shoots and stem.

Host Plants : Tur, wal, cowpea, beans, pulses etc.

Nature of Damage : Both nymphs and adults suck the sap from tender leaves and shoots. As a result, the vitality of the crop is reduced which adversely affects the yield. It also excrete honeydew like substance on which develops a black saprophytic fungus which interferes with the photosynthetic activities of the plants. Besides, the pest is also known to serve as a vector of virus disease, commonly known as "rosette" of groundnut.

Life History : Both winged and wingless forms reproduce viviparously and parthenogenetically. On an average single apterous and alate female produces 54 and 47 young ones in 8 to 17 and 14-18 days, respectively.

Management Practices : Spraying with 0.02% methyl demeton / formothion / 0.05 % monocrotophos or dusting with malathion 5 D / quinalphos 1.5 D / endosulfan 4 D / phosalone 4 D @ 20 kg/ha as soon as incidence is noticed.

Practical Guideline : Draw the figure of winged and wingless aphids.

3. Thrips : *Caliothrips indicus* Bagn.; Thripidae : Thysanoptera.

Economic Importance : It is responsible for transmitting "Tomato spotted wilt virus" in groundnut and cause "bud necrosis" disease. The loss in yield may extend upto 80 per cent.

Nature of Damage : Nymphs and adults suck the cell sap from the leaves. The infested leaves turn yellow and margins curl up. Often there is leaf shedding. Severely infested plants appear blighted and dried up.

Management Practices :

1. Spraying with 0.05% monocroptophos as soon as incidence of the pest is noticed.
2. Groundnut crop should be sown in last week of December in south Konkan and between last week of December to first fortnight of January in North Konkan in bud necrosis affected area to minimize the incidence.

4. White Grub : *Lachnosterna consanguinea* Bl.; *Holotrichia serrata* F.*;* Scarabaeidae : Coleoptera.
(Refer Polyphagous Pests Page No. …)

5. Pod Sucking Bug : *Elasmolemus sordidus* Fb., Lygaeidae : Hemiptera.

Nature of Damage : Both nymphs and adults suck the sap from the developing seeds. As a result the seeds get shriveled, become rancid and give bitter taste. The oil content and germination percentage of infested seeds are also adversely affected. Besides, causing damage in the field it continues to infest the pods in threshing yard and even in storage.

Management Practices : Spraying the crop with 0.05% malathion.

Practical Guideline : Draw the figures of nymph and adult stages of this pest.

Minor Pests :

6. Termites : *Odontotermes obesus Ramb.;* Termitidae : Isoptera.

7. Jassids : *Empoasca kerri;* Jassidae : Hemiptera.

8. Hairy Caterpillars :
Red Hairy Caterpillar : *Amsacta moorei* Butler
& Bihar Hairy Caterpillar : *Spilosoma obliqua* Walk.; Arctiidae ; Lepidoptera.

II) PESTS OF SAFFLOWER : It is another major oilseed crop of the State. The crop suffers badly from the ravages of few pests which cause considerable losses every year.

Major Pests :

1. Safflower Aphids : *Uroleucon compositae* Th.; Aphididae : Hemiptera.

Economic Importance : It is the most notorious pest of safflower having been reported from all areas of the State, wherever the crops is grown. Heavy infestation of the pest is noticed in late sown crops.

Marks of Identification : Adult – small, 2 mm in length, shining black, soft bodied insect. Nymphs – reddish brown in colour.

Host Plants : Safflower, niger, sesamum, citrus, ornamental plants like dahlia, cornflower, caliopsis etc.

Nature of Damage : Nymphs and adults suck the cell sap from the leaves and tender shoots, impaire the vitality of plant. In case of severe infestation entire plant may be covered by pest, showing blackish appearance. Besides sucking the sap from the plant, they also excrete a honey dew like substance which attract the black sooty mould adversely affecting photosynthesis.

Life History : Aphids reproduce viviparously and parthenogenetically. Single female produces 30 youngones. A generation completed in 7-9 days.

Seasonal Occurrence : The pest is active in November and December.

Management Practices :

1. Early sowing in the first week of October. In drought prone areas sowing of crop second week of September is recommended.
2. Spraying the crop with 0.03% methyl demeton / dimethoate / thiometon or 0.05% endosulfan/ quinalphos/ fenthion or 0.1% carbaryl/ malathion or dusting phosalone 4 D / methyl parathion 2 D @ 20 kg/ha as soon as incidence is noticed.

Practical Guideline : Draw the figures of wingless and alate forms of this pest.

2. Leaf Eating Caterpillar: *Prospalta* (*Perigaea*) *capensis* G. Noctuidae: Lepidoptera

Economic Importance : The pest is sporadic in occurrence but occasionally assume serious form and cause considerably losses.

Marks of Identification : Moth – medium, dark brown in colour with blackish brown forewings and light brown hindwings. Caterpillar – greenish, become dark brown, 25 mm long.

Host Plants : Safflower, niger, jute, etc.

Nature of Damage : Larvae feed voraciously on the leaves and in case of severe infestation completely defoliate the plants.

Life History : Eggs are laid on leaves and tender shoots. Incubation period 4 days Larva : larval period 15-20 days. Pupa : Pupation in soil. Pupal period 8 days. Life cycle : completed in 4 weeks.

Management Practices : Dusting of insecticides as given under aphids.

Practical Guideline : Draw the figure of adult stage of the pest.

III) PESTS OF SESAMUM : The Important pest infesting the crop in the State are sesamum gall fly, leaf eating caterpillar, pod sucking bug and leaf roller.

Major Pests :

1. Sesamum Gall Fly : *Asphondylia sesami* Felt.; Cecidomyidae : Diptera.

Economic Importance : It is the most noxious pest of sesamum and may cause heavy losses. It is serious in Nagpur region and incidence to the extent of 20 % has been reported.

Marks of Identification : Adult fly – small 2.5 mm in length, mosquito like fly, ashy colour. Maggot – small, dirty white.

Host Plants : Cluster beans and sesamum.

Nature of Damage : The maggots feed on buds and cause gall formation in place of pod.

Life History : Eggs – are laid on floral buds, flowers and developing capsules. Incubation period 3 to 4 days. Larval period 15-20 days. Pupa – pupation in galls. Pupal period 6-10 days. Life cycle completed in 3 - 4 weeks.

Management Practices :

1. Removal and destruction of infested buds with maggots.
2. Do not allow to grow stray plants in off season.
3. Grow resistant variety – N-166-5.
4. Spray with endosulfan or dimethoate at 0.05%.

Practical Guideline : Draw the figure of adult of this pest.

2. Seasmum Leaf Eating Caterpillar or Til hawk moth : *Acherontia styx* West; Sphingidae : Lepidoptera.

Economic Importance : Though the pest is sporadic in occurrence, it occasionally assumes serious form and cause considerable losses.

Marks of Identification : Moth – fairly large, stoutly built with dark grey bluish thorax, abdomen yellowish with black transverse bands, forewings dark brown. Caterpillar – stoutly built with horn like process at the anal end and 8 strips on the body, greenish brown in colour.

Host Plants : Sesamum, Dolichos spp and Jasminum spp.

Nature of Damage : Caterpillars feed voraciously on leaves and defoliate the plants.

Life History : Eggs – are laid on leaves. Incubation period 8-10 days. Larva-larval period 2 months. Pupa-pupation in soil. Pupal period 1-2 months. Life cycle : completed in 3-5 months.

Management Practices : Spraying the crop with 0.05% endosulfan / quinalphos / fenthion / 0.2% carbaryl/ 0.01% fenvalerate as soon as incidence is noticed.

Practical Guideline : Draw the figures of adult and caterpillar of this pest.

Minor Pests :

3. Pod Sucking Bug : *Elasmolomus sordidus* Fb.; Lygaeidae : Hemiptera.

IV) PESTS OF SOYBEAN :

Major Pests :

1. Girdle Beetle : *Obereopsis brevis* G.; Cerambycidae : Coleoptera

Marks of Identification : The adult are small brownish black beetles with long antennae. The maggots are whitish.

Host Plants : Soybean, cowpea and lablab.

Nature of Damage : The female feeds on xylem of stem and lays eggs inside. The larvae further damage the stem and make a tunnel inside and fill up with excreta. The leaves and growing point dries. Broken stem can be seen in the field. ETL = 2% infested plants.

Life History : The female lays the eggs in stem pith after girdling it. Incubation period 4-5 days, larval period 34 - 47 days. The pupal period 8-11 days in larval tunnels. Over winter in full grown larva within the feeding tunnel.

Pest Management :

1) Collect and destroy infested plants.
2) Apply phorate granule @ 10 kg/ha or carbofuran granules 30 kg/ha at the time of sowing or spray endosulfan, dimethoate or quinalphos at 0.05%.

2. Stem Fly : *Ophiomyia phaseoli* Coq.; *Melanagromyza sojae;* Agrocmyzidae : Diptera

Marks of Identification : The maggots are small and white coloured while the adults are tiny black fly.

Host Plants : Beans and peas.

Nature of Damage : The damage is caused by maggots causing swollen petioles. The maggot feed inside the stem and produce long slits in the stem. If cut open the stem, tunnel may be seen. The insects attack right from two-leaf stage of crop and the damaged plants dry up. ETL = 2 % infested plants.

Life History : Female fly lay eggs on upper surface of leaf near petiole singly. Incubation period 3-4 days, larval period 8-10 days pupal period 5-6 days. Pupation takes place inside the stem. Total life cycle takes 2-3 weeks.

Pest Management : Similar to Girdle beetle.

3. Tobacco Leaf Eating Caterpillar : *Spodoptera litura* F.; Noctuidae : Lepidoptera
(Refer the polyphagous pests, Page No……).

Minor Pests :

4. Hairy Caterpillar : *Spilosoma obliqua* Walk.; Arctiidae : Lepidoptera

5. Aphids : *Aphis* spp.; Aphididae : Hemiptera.

6. Thrips : *Thrips Tabaci* Lind.; Thripidae : Thysanoptera.

7. Jassids : *Apheliona maculosa;* Jassidae : Hemiptera.

8. White Fly : *Bemsia tabaci* G.; Aleyrodidae : Hemiptera.

It is a vector of virus MBYMV (Mung bean yellow mosaic virus).

V) PESTS OF CASTOR : Castor crop is infested by the following pests :

Major Pests :

1. Castor Semilooper : *Achoea janata* Linn.; Noctuidae : Lepidoptera.

Economic Importance : It is the most destructive pest of castor reported from almost all states of the country wherever this crop is cultivated.

Marks of Identification : Adult moth-stoutly built, forewings brown, hind wings dark with a white band in the middle and 3-4 white spots at the anal marging. Body length 60-65 mm. Larva semilooper, grey or black with red or whitish side stripes, 60-70 mm in length.

Host Plants : Larval host : castor, pomegranate, rose, cotton etc.
Adult host : citrus, pomegranate, mango etc.

Nature of Damage : Larva feeds voraciously on leaves usually from the lower side. In case of severe infestation, leaves are completely skeletonized. The adult moth do not cause damage to castor. Moth damages the fruits of above mentioned host plants.

Life History : Eggs – are laid on lower surface of leaves. Incubation period 3-4 days. Larva : larval period 2 weeks. Pupa : pupation in dried leaves. Pupal period 11-27 days. Life cycle completed in 4-6 weeks. Generations 5 to 6 in a year.

Management Practices : Spraying with 0.05% endosulfan or carbary 50 WDP 0.2 % or quinalphos 0.05% as soon as incidence is noticed.

Practical Guideline : Draw the figures of adult moth and larval stage of pest.

2. Castor Capsul Borer : *Conogethes:(=Dichocrocis)punctiferalis* G.;
Pyralidae : Lepidoptera.

Economic Importance : It is also important pest of castor found all over the State of Maharashtra. Damage to the capsule to the extent of 23 % has been recorded.

Marks of Identification : Moth – small, bright yellow with numerous black spots. Larva small, 24 mm in length, brownish with pink tinge.

Host Plants : Castor, guava and pomegranate.

Nature of Damage : Larvae bore into the shoots and capsules and destroy them.

Life History : Eggs are laid on tender shoots and capsules. Incubation period 6-7 days. Larva : larval period 12-16 days. Pupa : pupation in stem or capsules. Pupal period 7-10 days. Life cycle completed in 25-30 days.

Management Practices :

1. Removal and destruction of infested shoots and capsules.
2. Spraying 0.1% malathion or 0.2% carbaryl 50 WDP.

Practical Guideline : Draw the figure of adult stage of this pest.

3. Castor Jassids : *Empoasca flavescens* P.*;* Cicadellidae : Hemiptera

Nature of Damage : Both nymphs and adults suck the cell sap from lower surface of leaves. As a result, margins of leaf turn pale initially, later on becoming yellowish and ultimately dry. In case of severe infestation leaves curl badly and show brown necrotic patches.

Management Practices : Spraying with 0.02% fenthion / thiometon / phosalone / quinalphos / 0.1 % carbaryl as soon as incidence is noticed.

Practical Guideline : Draw the figures of nymph and adult of this pest.

In addition to the pests mentioned above, Serpentine leaf miner (*Liriomyza trifolii*) leaf eating caterpillars (*Spodoptera litura*) and hairy caterpillars (*Spilosoma obliqua* and *Euproctis fraterna*) are also found to infest the crop. These are described under tobacco and groundnut.

VI) PESTS OF MUSTARD :

Major Pests :

1. Mustard Sawfly : *Athalia lugens* (Klug); Tenthredinidae ; Hymenoptera.

Economic Importance : The mustard sawfly is widely distributed in the Indian Sub-continent.

Marks of Identification : The larva is dark green and have 8 pairs of abdominal prolegs. There are five black stripes on the back and the body has wrinkled appearance. A full grown larva measures 16-18 mm in length. The adults are small orange yellow insects with black marking on the body and have smoky wings with black veins.

Host Plants : It feeds on various cruciferous plants like mustard, rapeseed, cabbage, cauliflower, knol-knol, turnip, radish, etc.

Nature of Damage : Damage is done by larvae. They bites into leaves preferring the young growth and skeletonize the leaves completely.

Life History : The flies lay the eggs singly by making slits in the leaves. The eggs hatch in 4-8 days. The larvae are full grown by 16-35 days. Pupation takes place in soil. The pupal period is 11-31 days. The life cycle is completed in 31-34 days.

Seasonal Occurrence : October to March.

Carry Over : Pupal cocoons in the ground during summer.

Management Practices :

1. Collection and destruction of larvae.
2. Spraying of quinalphos or endosulfan or malathion at 0.05%

2. Mustard Aphid : *Lipaphis erysimi* K.; Aphididae : Hemiptera.

Economic Importance : The mustard aphid is worldwide and is serious pest of cruciferous oilseeds.

Marks of Identification : The nymphs and adults are louse like, pale greenish insects. They are seen feeding in large numbers, often covering the entire surface of flower- buds, shoots, pods etc.

Host Plants : Mustard, cabbage, cauliflower, knol-knol, etc.

Nature of Damage : Both the nymphs and adults suck cell-sap from leaves, stems, inflorescence or the developing pods. The leaves look curly, flower fail to form pods and the developing pods do not produce healthy seeds affecting adversely on yield.

Life History : The pest breeds parthenogenetically and the female gives birth to 26-133 nymphs. Life cycle completed in 7-10 days. About 45 generations are completed in a year.

Seasonal Occurrence : This insect is most abundant from December to March.

Carry Over : Through stray plants of cabbage, cruciferous weeds etc.

Pest Management :

1. Early sowing of crop preferably upto third week of October.
2. Spraying of methyl demeton or dimethoate or quinalphos at 0.03% or malathion or endosulfan 0.05%.
3. Predators of aphids are ladybird beetles (*Coccinella septumpunctata*) and *Chrysoperla carnea*.

Minor Pests :

1. Painted Bug : *Bagrada* spp. ; Pentatomidae : Hemiptera.

VII) PESTS OF SUNFLOWER :

The crop is attacked by number of pests but are of minor importance in the State. These pests are described under other crops.

1. American bollworm : *Helicoverpa armigera* Hub.
2. Tobacco caterpillar : *Spodoptera litura*
3. Hairy caterprillar : *Spilosoma* spp.
4. Jassids : *Amrasca biguttula*
5. Aphids : *Aphis gossypii*
6. White Fly : *Bemisia tabaci.*

****

Exercise No. 8

STUDIES ON PESTS OF PULSE CROPS

Material : Preserved specimens and affected plant parts.

I) PESTS OF GRAM :

Major Pests :

1. Gram Pod Borer : *Helicoverpa armigera* Hub.; Noctuidae : Lepidoptera.
(Described under Polyphagous Pests Page No……..)

II) PESTS OF TUR (RED GRAM OR PIGEONPEA) :

1. Tur Plume Moth or Pod Caterpillar : *Exelastis atomosa* Wal.
Pterophoridae ; Lepidoptera.

Economic Importance : It is a common pest on pods of red gram causing considerable losses. It is a specific pest of tur in many parts of India.

Marks of Identification : Moth – slender, 12 mm in length, grey coloured with long narrow wings. Forewings cut into two parts and the hindwings into three parts with fringe like border. Caterpillar 12 mm long, greenish brown, fringed with short hairs and spines.

Host Plants : Tur and wal.

Nature of Damage : The caterpillar makes a hole into the pod opposite to seed developing inside and then insert it's head into the pod and feeds on the developing seed. When one seed is finished, the larva cuts another hole opposite to another seed and damage the seed. The larvae also feed on flower buds.

Life History : Eggs are laid on tender shoots, leaves, flowers or pods. Incubation period 5 days. Larva : larval period 4 weeks. Pupa : pupation on pod surface or in pod burrows. Pupal period 2 weeks. Adult period is 1 to 2 weeks. Life cycle : completed within 7 weeks.

Practical Guideline : Draw the figures of adults and caterpillar of this pest.

2. Tur Pod Fly : *Melanagromyza obtusa* Mall.; Agromyzidae : Diptera.

Economic Importance : This pest is considered to be one of the important pests of tur as it is widely distributed throughout India, causing 80% loss in yield of seed.

Marks of Identification : Adult flies – small, black fly. Maggot – creamy white, 4.00 mm in length.

Host Plants : Tur, soybean and cowpea.

Nature of Damage : The maggots after hatching from the eggs enter into the soft seeds and feed on them. At first the damage resembles to that of leaf miner as their galleries run just under the epidermis of seed. Later, they burrow deep down resulting in decaying of the grain, which become unfit for either consumption or germination. In severe cases of damage, the pods present twisted appearance.

Life History : Eggs – about 38 eggs are laid in pods by a female with the help of ovipositor. Incubation period 3 – 4 days. Larva : larval period 6-21 days. Pupa : pupation in larval burrows inside the pod, pupal period 1-4 weeks. Adult – live for 5 to 12 days. Life cycle completed in 3 weeks. Seasonal occurrence : Adult flies are noticed in October and there are 2 – 3 broods on tur until harvest. Development of pest slows down during winter.

3. Pod Borer : *H. armigera* Hub. Noctuidae:Lepideptora
(Described under Polyphagous Pests Page No……)

4. Spotted Pod Borer Or Maruca : *Maruca vitreta* G.; Pyralidae : Lepidoptera

Economic Importance : This pest is wide-spread in tropical and sub-tropical regions of the world.

Marks of Identification : The moth has a white cross band on the dark brown forewings and a dark border on the white hind wings. The larva is green with a brown head, short dark hairs and black wrats on the body.

Host Plants : It is an important pest of pigeonpea, cowpea, green gram, black gram, soybean etc.

Nature of Damage : The lara webs together the flowers and feed on them and also bore into pods and feed on the seeds resulting in appreciable loss in yield of seeds.

Life History : The eggs are laid singly in the flowers or buds or on the pods of the host plants. Pupation takes place in the plant debris on the surface of ground. The total life cycle is completed within 4 to 6 weeks. Incubation period : 6 – 8 days, Larval period : 2 – 4 weeks, Pupal period 1-2 weeks.

5. Tur Pod Bug : *Clavigralla gibbosa* S.; Coreidae : Hemiptera.

Marks of Identification : Adult bugs are greenish brown, 20 mm long, femurs swollen at aphical end, nymphs are reddish.

Host Plants : Tur and Wal.

Nature of Damage : Both nymphs and adults suck the sap from the pod and cause infested pod to shrivel. The pest however, become rarely serious.

Life History : Eggs are laid on pods, leaves, buds in cluster. The incubation period is 8 days, nymphal period is 17 days, the adult period is 2 to 3 weeks. Total life cycle is about 4-6 weeks.

Management Practices : (Pod borer complex including above pests)

1) Collection and destruction of infested pods along with caterpillars during early stage of infestation.
2) Application of pesticide at initiation of flowering with NSKE 5% or 0.05% endosulfan/ phenthoate/ phosalone or 0.04% quinalphos/ monocrotophos or dusting with quinalphos 1.5 D/methyl parathion 2 D @ 20 kg/ha. For *H. armigera*, first spray of HaNPV @ 250 L.E./ha use of pheromone traps, tricho cards in addition to above measures.

Practical Guideline : Draw the figures of above pest.

III) PESTS OF PEA :

1. Pea pod borer : *Helicoverpa armigera* Hub.; Noctuidae : Lepidoptera
(Described under Polyphagous Pests Page No……..).

Practical Guideline : Draw the figure of larva and adult of this pest.

2. Pea Aphids : *Aphis craccivora* Koch. and *Macrosiphum pisi* K.;
Aphididae : Hemiptera.
(Described under groundnut page No……).

3. Pulse Beetle : *Callosobruchus chinensis* Lin.; Bruchidae : Coleoptera

Marks of Identification : Adults are 3-4 mm in length, oval, chocolate or reddish brown in colour, larva is creamy white.

Host Plants : In field – Pea, tur, gram, cowpea, lablab etc. The infestation may, however, originate in the field and be carried into the store.

Nature of Damage : It is a major pest of pulses in storage. However, field infestation is also common. The young grubs burrow into the pods and feed on developing seed/grain. The holes seen on the pulses are the exit holes from where the adults have emerged. Such grains are unsuitable for sowing.

Life History : Eggs are laid on surface of grains. Incubation period 5 days, larval period 30-50 days. Pupation takes place inside the infested grain. Pupal period 5-8 days. Life cycle is completed within 45 days.

Management Practices : Spraying with 0.05% malathion or endosulfan 0.05%.

Practical Guideline : Draw the figure of adult beetle.

4. Cutworm : *Agrotis ipsilon* Hufn.; Noctuidae : Lepidoptera.

This pest is described under Polyphagous Pests, Page No……. .

In addition to the pests mentioned above, leaf miner and thrips are also found to infest the crop but are of very minor importance in the State.

IV) PESTS OF MUG : (Green Gram), *Udid* (Black Gram), *Chavali* (Cowpea) & *Wal*:

1. Aphid : *Aphis craccivora* Koch.; Aphididae : Hemiptera.

The pest is described under Groundnut, Page No……. .

Minor Pests :

1. Leaf Miner : *Liriomyza* spp.; Agromyzidae : Diptera

2. Leaf Eating Caterpillar : *Spodoptera exigua* Hub.; Noctuidae : Lepidoptera.

3. Pod Borer : *Helicoverpa armigera Hub.*; Noctuidae : Lepidoptera.

****

Exercise No. 9

STUDIES ON PESTS OF FORAGE CROPS

I) PESTS OF LUCERNE :

Major Pests :

1. Cut Worm : *Agrotis spinifera* Hub. ; Noctuidae : Lepidoptera.
(Refer Polyphagous Pests Page No……..)

2. Army Worm : *Mythimna separata* Walk.*;* Noctuidae : Lepidoptera.
(Refer Polyphagous Pests Page No……..)

3. Tobacco Caterpillar : *Spodoptera exigua* Hub; *S. mauritia* G.
Noctuidae : Lepidoptera. (Refer Polyphagous Pests Page No……..)

4. Gram Pod Borer : *Helicoverpa armigera* Hub.; Noctuidae : Lepidoptera.
(Refer Polyphagous Pests Page No……..)

5. Leaf Roller or Leaf Miner : *Aproaerema modicella* D. Gelechidae : Lepidoptera.
(Refer Pests of Groundnut, Page No……..)

6. Red Hairy Caterpillars : *Amsacta lineola* Fab.; *A. moorei;* Arctiidae : Lepidoptera.

Marks of Identification : The full grown caterpillar is about 25 mm long, with reddish brown to olive green in colour and the body is covered with numerous long hairs. The moths are stoutly built and have white wings with black spots.

Host Plants : Maize, jowar, lucerne, cowpea, mung etc.

Nature of Damage : The young caterpillars feed on growing points gregariously scrap the leaf surface, the older larvae feed voraciously and defoliate the plant.

Life History : The female lays eggs in clusters on the under surface of leaf. Incubation period 2-3 days. The caterpillars complete their development in 15-23 days. Pupation takes place in soil. Pupal period is 12-15 days or during adverse condition remains in hibernation for pretty longer period. In general, the life cycle is completed in 23-55 days. The pest is more active from June to end of August.

Management Practices :

1) Use of light traps.
2) Collection of larvae at their gregarious stage of feeding alongwith infested leaves and their destruction.
3) Spraying of NSKE 5%.

7. Aphids : *Aphis craccivora* Koch.; Aphididae : Hemiptera.
(Refer the pests of groundnut page No. ……).

8. Stem Fly : *Ophiomyia phaseoli* Trayon.: Agromyzidae : Diptera
(Refer the pests of Soybean page No. ……).

II) PESTS OF MAIZE AND SORGHUM :

Major Pests :

1. Stem Borer : *Chilo partellus* S.; Pyralidae : Lepidoptera.
(Refer Pests of Sorghum Page No……..)

2. Shoot Fly : *Atherigona soccata* Rond; Anthomyidae : Diptera.
(Refer the Pests of Sorghum Page No……..)

Minor Pests :

3. Leaf Roller : *Marasmia trapezalis* Guen.; Pyralidae : Lepidoptera.

4. Termites : *Odontotermes obesus* Ram.; Termitidae : Isoptera

5. Delphacid : *Perigrinus maidis* A.; Delphacidae : Hemiptera.

6. Aphids : *Aphis sacchari;* Aphididae : Hemiptera.

III) PESTS OF PASTURES :

Grasshoppers : (Acrididae : Orthoptera) :

Different species of grasshoppers infest the pastures and causes major damage. They should be managed by different mechanical and biological control measures.

****

Exercise No. 10

STUDIES ON PESTS OF STORED GRAINS AND GRAIN PRODUCTS

Material : Preserved insect specimens and damaged grain commodities.

A) PRIMARY PESTS : Capable of causing damage to sound grains.

I. Internal Feeders : The larvae feed entirely within the kernels or grains or stored material.

1. Rice Weevil : *Sitophilus oryzae* Linn.; Curculionidae : Coleoptera.
2. Granary Weevil : *Sitophilus granarius* Linn.; Curculionidae : Coleoptera
3. Lesser Grain Borer : *Rhizopertha dominica* Fab.; Bostrychidae : Coleoptera
4. Pulse Beetle : *Callosobruchus chinensis* Linn.; Bruchidae : Coleoptera.
5. Angoumois Grain Moth : *Sitotroga cerealella* Oliv.; Gelechidae : Lepidoptera

II. External Feeders : Larvae and adults feed on grains from outside.

6. Khapra Beetle : *Trogoderma granarium* Everts; Dermestidae : Coleoptera
7. Indian Meal Moth : *Plodia interpunctella* Hubm.; Phycitidae : Lepidoptera
8. Rice Moth : *Corcyra cephalonica* St.; Galleridae : Lepidoptera
9. Fig Moth : *Ephestia (Cadra) cautella* Walk.; Phycitidae : Lepidoptera

B) SECONDARY PESTS: Feeds on broken grains or milled products.

10. Rust Red Flour Beetle : *Tribolium castaneum* Herb.; Tenebrionidae : Coleoptera.
11. Saw Toothed Grain Beetle : *Oryzaephilus surinamensis* Linn.; Cucujidae: Coleoptera
12. Long Headed Flour Beetle : *Latheticus oryzae* W.; Tenebrionidae : Coleoptera.
13. Flat Grain Beetle : *Laemophloeus minutus* Oliver; Cucujidae : Coleoptera
14. Cadelle or Yellow Meal Worm : *Tenebrioides mauritanicus* Linn. Ostomatidae : Coleoptera.

C) NON-INSECT PESTS :

15. Mites: *Tyroglyphus* spp.; *Acarus siro* Linn.; Acaridae: Acarina (Class : Arachinida)
16. Rats: *Rattus rattus* Linn.; *R. norvegicus* B.; Muridae : Rodentia (Class : Mammalia)

A) PRIMARY PESTS : Internal feeders.

1. Rice Weevil : *Sitophilus oryzae* Linn.; Curculionidae : Coleoptera

Economic Importance : It is cosmopolitan and polyphagous species and found to cause considerable damage to rice. Besides rice, it also cause damage to several other cereals and their products.

Marks of Identification : Adult : Tiny weevil, 3 mm in length with a head produced into a snout like structure. Body reddish brown to dark brown or almost black in colour. Fore wings with four light reddish or yellowish spots. The insect is able to fly. Grubs : whitish, often found inside kernels, small and legless.

Nature of Damage : Both adults and larvae feed on the sound grains of wheat, rice, maize, jowar, barely, bajri, etc. as a result, they are rendered unfit for human consumption. The adult damage a small portion of grain and feeds on inner content. Though the grains are mostly damaged in storage, the infestation is carried from the field also.

Life History : Eggs : The adult female make holes in the soft portion of the grain with the help of its mount parts and lays eggs singly. Each female can lay 350-400 eggs during her life time. The incubation period is about 4 days. Larva : The grub stage lasts for 19 to 34 days. Pupa : The pupation inside the grain and the pupal period 3 to 6 days. Life cycle completed within 26-28 days.

2. Granary Weevil : *Sitophilus granarius* Linn.; Curculionidae : Coleoptera

Economic Importance : It is also an important pest of cereals having been reported from most of the countries of the world. However, it is reported to be relatively less important in tropical compared to the temperate ones.

Marks of Identification : Adult : Small, reddish, brown to dark brown weevil, 3.5 mm in length. It resembles rice weevil so closely that it is difficult to distinguish. However, it is larger than rice weevil, uniformly brown with smooth elytra and larger punctures on thorax. It is incapable of flight and as such its infestation in restricted to granaries only.

Nature of Damage : Both grubs and adults cause damage to grains as in case of rice weevil.

Life History : Similar to that of *Sitophilus oryzae*.

3. Lesser Grain Borer : *Rhizopertha dominica* Fab.; Bostrychidae : Coleoptera

Economic Importance : It is considered to be second in importance to rice weevil. It is a major pest of most of the cereals. Though usually the attack is noticed in storage, the infestation is carried from field also.

Marks of Identification : Adult- slender, cylindrical and small in size (3 mm) with dark brown or black colour, elytra with slightly roughed surface. Head is turned somewhat downwards, so that it is scarcely visible from above. Larva : dirty white and has a light brown head. It's body is clothed with tiny hairs.

Nature of Damage : Both beetles and larvae cause serious damage in warm climate, attacking variety of grains like wheat, rice, jowar, bajri, maize, pulses, paddy etc. They completely hollow out the grain kernels and only the bran coat is left. The grub stage can feed inside the grain or on flour or on grains destroyed by adults.

Life History : Eggs : A single female can lay 300 to 500 eggs, droping them singly or in clusters in loose among the grains or sometimes on wall, on bags or in crevices in godowns. Eggs small, whitish. Larva : grubs after hatching from the eggs crawl actively about the grains, feeding on the flour produced by boring of the beetles or bore directly into slightly damaged grains. The larval period about 44 days. Pupa : The pupation is either inside or outside the grain. Pupal period lasts for about 7 days. Life cycle is completed within 2 months.

4. Pulse Beetle : *Callosobruchus chinensis* Linn.; Bruchidae : Coleoptera.

Marks of Identification : Adult small 3-4 mm in length, oval, chocolate or reddish brown, active with long serrate antennae, brownish grey, elevated ivory like spots near the middle of dorsal side, elyctra do not cover the abdomen completely. Larva is creamy white.

Nature of Damage : It is a major pest of pulses like mug, gram, tur, bean, masor and udid and causes heavy damage during monsoon season. Though the pest attack is commonly noticed in storage, the infestation sometimes is carried from the field where the eggs are laid on green pods. The young grub burrows into the pod or grain, feed on inner contents and pupate inside the grain and later emerges as an adult through the exit hole prepared by the full grown grub before pupation.

Life History : Eggs : Incubation period - 5 days. Larva : Larval period 30-50 days. Pupa : Pupal period 5-8 days. Life cycle completed in 45 days.

5. Angoumois Grain Moth : *Sitotroga cerealella* Oliv.; Gelechidae : Lepidoptera

Marks of Identification : Moth – small, dirty yellowish brown with wings completely folded over black in a sloping manner, with long fring of hairs at anal margin of hind wing. Larva 15 mm, whitish.

Nature of Damage : Larvae feed on the endosperm of grain leaving other part untouched. The damage to the grain is not noticed until full grown larva bores hole for moth to escape. Hole is circular with characteristic 'flap' or 'trap door' The infested grains are hollowed out by the larvae and filled up by the excreta and webbing.

Life History : The eggs are laid on grains or near grains singly or in batches. Egg period is 4-8 days. Larval period 3 weeks. Pupation takes place in the cavities of grain. Pupal period 1 to 2 weeks. Life cycle completed within 50-55 days.

II. <u>External Feeders</u> :

6. Khapra Beetle : *Trogoderma granarium* E.; Dermestidae : Coleoptera

Economic Importance : It is a cosmopolitan species and observed to thrive well under climatic conditions where temperature ranges between 92° F to 110° F. In the Indian Union it has been reported as one of the most destructive pests from all the States. Though it is a serious pest of wheat, it is found to attack other cereals like rice, oat, maize, jowar etc.

Marks of Identification : Adult : About 2-3 mm long, convex, oval in shape with grey and light brown markings and emerginate eyes. Grubs – brownish white in colour, 4 mm long and body covered with long reddish brown hairs, which are usually directed backward and form a sort of thick tail at the anal end.

Nature of Damage : The infestation generally occurs at superficial layers of grains as they are not able to penetrate beyond certain depth. However, in case of heavy infestation, it may destroy the entire lot. Only larvae are harmful, usually feed voraciously on embryo of grains thus adversely affecting their germination but can destroy the entire grains. Adults are harmless.

Life History : Eggs : A female lays about 125 eggs, loosely among the grains in her life time. They hatch in 6 to 26 days. Larva : Larvae become full grown in about 50 days. Pupation : on the surface of grain in bulk or edges of bags. The pupal stage lasts for 6 to 17 days. The adults are ready for egg laying in 2 to 3 days after emergence and live for 10 to 32 days. Under unfavourable conditions of climate and shortage of food the larval period may be prolonged upto 200 days or even upto 4 years.

7. Indian Meal Moth : *Plodia interpunctella* Hubm.; Phycitidae : Lepidoptera

Economic Importance : The pest is cosmopolitan in distribution and feeds on a variety of food articles and grains. It is a major pest of wheat.

Marks of Identification : The moth : wing expanse of 12 mm to 18 mm, the forewings lustrous brown with yellowish or whitish bands across the basal half. Larva : greyish white in colour, 23 mm long when full grown. It's body is covered with fine hairs and the skin is granular.

Nature of Damage : The larva feeds on germ portion of wheat. During the process, tubular webbing is formed by it either on bags or on the bulk of the food material. In serious cases the bag or flooring is completely covered with silken sheets.

Life History : Eggs : A female lays on an average 200 eggs singly or in groups on the food material. The egg and larval periods lasts for 5 to 7 and 30-40 days respectively. Pupa : Pupation takes place inside the silken cocoons attached to he bags or sometimes naked. The pupal period is 12 to 25 days. An adult lives for 2 to 25 days. Generation completed in about 60 days.

8. Rice Moth : *Corcyra cephalonica* Staint.; Galleridae : Lepidoptera

Economic Importance : The pest occurs in almost all the parts of the world. It is considered to be one of the most destructive pests of stored paddy, rice and other cereals in many parts of India. Besides cereals, legumes, oil cakes, dried fruits, suji, atta, etc. are also damaged by this insect.

Marks of Identification : Moth : pale greyish brown in colour with a wing expanse of about 12 mm. Larva : Creamy white in colour with a prominent broad, yellowish head, 25 mm when full grown.

Nature of Damage : Larva alone feeds under silken webs on broken grains but later instar can attack sound grains.

Life History : Eggs : Female lays about 90-200 eggs on bags, walls of godown etc. The egg is white, oval or elliptical in shape. Incubation period lasts for about 5 days. Larva : The larval period lasts

for 15 to 40 days Pupa : Pupation takes place inside the silken galleries. The pupal period 12 to 15 days. An adult lives for 4 to 6 days. Life cycle completed in 50 days.

9. Fig Moth : *Ephestia cautella* W.; Phycitidae : Lepidoptera

Marks of Identification : Moth – small, wings dirty white to greyish with black bands.

Nature of Damage : The larva feeds on dried fruits such as dried apples, dates, berries, fig and so also cereals and their products. The caterpillars web together the grains and feed on them.

Life History : The female lays whitis eggs in cracks and crevices of the receptacles or on the food stuff. Incubation period 8-12 days. Larval period 40-50 days. Larva pupates inside the cocoon in infested material. Pupal state lasts for 12 days. Life cycle is completed in about 2 months.

B) SECONDARY PESTS :

10. Rust Red Flour Beetle : *Tribolium castaneum* H.; Tenebrionidae : Coleoptera

Marks of Identification : Beetle small, 3-4 mm, oblong, flat, brown in colour.

Nature of Damage : Both the larva and adult feeds on grains which are already broken or damaged. The pest is more damaging to milled cereals, like atta, maida, suji which become mouldy and emit a pungent smell. It is secondary pest of all grains and primary pest of flour and other milled products. In grains, embryo or germs portion is preferred.

Life History : The female lays eggs in the flour or frassy material among the grains and other food stuff. The incubation period lasts 4-10 days. Larval period 22-25 days. Pupation takes place in the flour. Pupal stage lasts 5-9 days. Life cycle completed in 26-30 days.

11. Saw Toothed Grain Beetle : *Oryzaephilus surinamensis* L.; Cucujidae: Coleoptera

Marks of Identification : Beetle narrow, flattened, thorax having six teeth like serrations on each side.

Nature of Damage : The larva feeds mostly on flour, 'maida' or the grain dust produced by the infestation of other primary pests. The damaged grains are attacked by the adults. Excessive infestation of the pest on the food products makes them unpalatable and unsalable.

12. Long Headed Flour Beetle : *Latheticus oryzae* W. ; Tenebrionidae : Coleoptera.

Marks of Identification : Beetle small, light brown with elongated body, head is longer.

Nature of Damage : It is an important pest of milled products. Beetles feed on grains damaged by the primary pests. Both larvae and adults feed on cereal flours, and rice products.

13. Flat Grain Beetle : *Laemophloeus minutus* O. ; Cucujidae : Coleoptera

Marks of Identification : Smallest amongst the stored grain insect pests, 1.5 – 2.0 mm, light to dark reddish brown.

Nature of Damage : It prefers broken and powdered grains as a food. The larva feeds mostly on wheat embryo and on account of scavenging habits adult feeds on grains spoiled by primary pests.

14. Cigarette Beetle / Tobacco Beetle : *Lasioderma serricorne* Fabr.;
Anobiidae : Coleoptera.

Marks of Identification : Rounded, light brown, 3-4 mm beetle.

Hosts : Tobacco products.

Nature of Damage : Larva and beetle bore hole to the tobacco product and feed within it.

Life History : Eggs are laid on surface of produce. Life cycle completes within 4-6 week.

C) NON-INSECT PESTS :

15. Mites : 1) *Tyroglyphus* spp.; 2) *Acarus siro* Linn.; Acaridae : Acarina

(Class : Arachnida)

Marks of Identification : Very small, pale, straw to dark reddish brown.

Nature of Damage : It is an important pest of mills. The mites are reported to damage germ portions of wheat and when present in large number, they promote sweating, impart objectionable smell to the gains. Besides, they also cause damage due to their feeding.

16. Rats : 1) *Rattus rattus* Linn.; 2) *R. norvegicus* B.; Muridae : Rodentia (Class : Mammalia)

Economic Importance : Annually 2.5% losses are caused due to rodents in storage. As it is responsible for plague, it is considered as the most expensive rat of India.

Nature of Damage : Rats cause heavy damage to stored grains. The daily consumption of a rat is about 10 g of grains apart from other damage and 100 rats excluding their progeny can damage about one tonne of grains in a year.

****

Exercise No. 11

STUDIES ON MANAGEMENT OF STORED GRAIN PESTS

Sources of Infestation : Following are the main source of infestation.

a) Field Infestation : Pests like pulse beetle, rice weevil, grain moth etc. lay eggs on grains or pods in the field. The infestation is noticed in the grains when they are stored in stores.

b) Cross Infestation : Through old bags, godown, trucks, bullock carts etc. when godown or bags are empty then pests may remain in cracks, crevices of godown, on bags etc and when they get food supply can multiply.

The measures adopted for the control of stored grain pests are of two types :

I) Preventive : Measures which are employed to protect fresh stock of grains from the attack of pests.

II) Curative : Measures employed to control the pests when infestation noticed in the grains.

I) Preventive Measure :

1. **Sundrying** : Threshing yard should be away from granaries and should be clean. It is very essential to reduce moisture content of grains. When the grain has moisture content below 8% most of the insect spp. do not survive/ multiply. The grains are dried by spreading a thin layer in the sun heat. Dryers are also used now a days.
2. **Mixing of Inert Dust For Seed Purpose :**
   This method is used by many farmers in villages. The inert dust such as clay, ash etc causes physical injuires to insect. The dust causes laceration on the cuticle, resulting in desiccation and death of the insect.
3. **Bagging :** When grains are properly dried and ready for storage it should be bagged in gunnies free from pest infestation. As far as possible use new bags. But when it is not possible, the old bags should be fumigated or treat them with 0.1 % malathion or DDVP to avoid cross infestation.
4. **Godown Hygiene :** Before storing the grains in bags in godown. i) All the cracks, crevices, hole existing in the floor should be closed with cement. ii) All dirt, rubbish, webbing should be removed from the store and destroyed, iii) All the rat burrows should be closed with cement iv) It should be white washed v) Before storing grains, the godown should be disinfected by spraying malathion 0.1%.
5. **Care While Storing :** Proper storage is also necessary to protect grains from moisture damage which usually occurs at the bottom layers of bags due to seepage of water from the floor. Wooden crate dunnage is necessary. It helps free circulation of air, and prevent losses due to moisture accumulation.
6. Proper stocking of bags is necessary to facilitate the inspection and treatment of grains.

II) Curative Measures : Most practicable and useful curative method is the fumigation. Fumigation may be defined as the treatment of commodity or a space with a gaseous material to kill the insect pest present. They are highly volatile and able to penetrate deep and kill insect within a large mass of food stuff. In case of small scale storage, first to sieve the grains and remove different stages of pests. But in large scale storage, it is not possible to sieve and clean the grains and hence direct fumigation has to be carried out. Fumigation is possible only under air tight conditions. For small scale fumigation Metal bins or 'Kothis' can be made air tight. For large scale fumigation, however, the dump method is used.

Dump Method of Fumigation : The grains are enveloped in air proof cover. The covers for dump method are prepared from balloon fabrics or rubberised cloth or polythene sheet of varying sizes. The standard size of cover being 20' x 15' which can accommodate about 500 bags at a time. Put the cover over the grains to be fumigated and the sides touching the ground are covered with dry earth to prevent the leakage. The fumigant should be introduced (poured) from the opening at the top which should subsequently be closed. After the expiry of exposure time, the cover should be gradually opened from the sides so that the operator should not exposed to the fumes for a longer

period. The bags should not be disturbed for at least 24 hours to allow the enclosed gases to escape. After which the grains can safely be used. The grains required to be stored for longer period should at least be fumigated three times in a year. One after winter, second before monsoon and third at the end of monsoon. The commonly used fumigants for grains storage are given in the table along with the rate, time of exposure and the precautions to be taken while using particular fumigant.

Cntd…..

Optimum Doses of Pesticides Recommended by the Storage and Research Division of Ministry of Food .

Sr. No.	Name of the pesticide	Dose of pesticide	Method of application	Against	Remarks
1.	Malathion 50% EC	0.1%	Spray on grain bags, walls, floors etc. Should not be sprayed on food grains directly.	As prophylactic treatment against insect pests.	Forthightly spraying.
2	Ethylene Dibromide (EDB)	3 ml/quintal for small storage 22 gms/cu.m. for large storage.	The ampules are inserted in storage structures after breaking and making the structure airtight.	As fumigant against insect pests (except for oilseeds/ flour)	7 days exposure period.
3.	EDCT mixture	30-40 kg per 100 cu. m. in large scale storage. For small storage 55 ml. per qtl.	Fumigation in airtight condition on bags/ in bulk.	As fumigant against insect pests (except for oilseeds/flour)	7 days exposure period.
4.	Alluminium phosphide	a) 2-3 tablets of 3 gms / metric tonne. b) Amorphos powder 50% 10 g pkt /metric tonne. c) 2 tablets of 0.5 gms per rat live burrow.	For fumigation of grains in bag/bulk storage under sufficient airtight condition. 2 tablets of 0.5 gms each are inserted in living burrow and the burrows are sealed with mud.	For insect control For field rat control	7 days exposure period, should be done by trained person under, sufficient air tight condition. ---
5.	Zinc phosphide	Preparation of bait : Pure zinc phosphide:2 parts. Food grains as base: 96 parts. Any edible oil:2 parts.	Mix them thoroughly and place in paper cones	For House, Field Rat control	Application after prebaiting.
6.	Anticoagulants (Rodafarin, warfarin, Ratafin etc.)	I part rodenticide + 19 parts bait material. For 500 gms bait : i) Flour (cereals/ millets) 450 gms. ii)Any edible oil : 10 gms. iii)Sugar or jaggary:15gms. iv)Anticoagulant: 25gms.	The four constituents are mixed thoroughly and prepared bait material is kept in shallow vessel at places visited by rats.	For control of house rats.	Continuous baiting for 10-15 days.

****

Exercise No.12.

STUDIES ON PESTS OF BRINJAL

Material : Preserved pests specimens and affected plant parts.

Major pests :

1. Brinjal Shoot and Fruit Borer:*Leucinodes orbanalis* Guen.; Pyralidae: Lepidoptera

Economic Importance : It is one of the most serious pests of brinjal fruits and plants. Long and narrow fruits are less susceptible to attack. 21% fruits are found damaged by this pest.

Marks of Identification : Moth : Medium size, the forewings are whitish with large black and brown patches and dots all over. Caterpillar: Small, light pink in colour.

Host Plants : Polyphagous brinjal, potato, bitter gourd, pea pods, cucurbits etc.

Nature of Damage : Infestation starts few weeks after transplanting. The caterpillars bore into the growing shoots, midribs and petioles of large leaves and feed on internal tissues. As a result of damage, affected shoots wither and dry up and plants exhibit the symptoms of drooping. After fruit formation, larvae makes their entry under the calyx, when they are young. The holes, later plugged with excreta leaving no visible sign of infestation. Large circular holes seen on the fruits are the exit holes. Such fruits loose market value and are unfit for human consumption.

Life History: Eggs: 250, laid singly on ventral side of leaves, shoots, flower buds or sometimes on fruits, I.P.: 3-5 days in summer and 7 days in winter. Larva : L.P. : 12-15 days in summer and 22 days in winter. Pupa: Pupation in boat shaped cocoons on plant. P.P.7-10 days. Adult: Life span : 2-3 days. The pest is active throughout the year.

Management Practices :

1. Continuous cropping of brinjal and potato should be avoided.
2. Removal and destruction of affected shoots and fruits alongwith larvae.
3. Nursery treatment : Soil application of phorate 10 G @ 70 g/m^2 at the time of sowing.
4. Spray with 0.05% monocrotophos or 0.2% carbaryl or dusting 10% carbaryl dust @ 20 kg/ha. 3-4 weeks after transplanting and second application 15 days thereafter controls the pest effectively or NSKE 5%.
5. Use of sex pheromone traps with leucinolure.

2. Jassids : *Amarasca biguttula* Ishida. The pest is discussed under potato.

3. Aphids : *M. persicae* Sulz. The pest is discussed under potato.

4. White fly : *Bemisia tabaci* Genn.; *Bemisia argentifolii* Belows; Aleyrodidae : Hemiptera

Economic Importance : It is serious pest of brinjal now a days.

Marks of Identification : Adult : Fly is small, delicate insect with yellow body and haylineings dusted with waxy powder.
Nymphs : Is small, sluggish and pale yellow, oval in shape.

Host Plants: Polyphagous, feeds on brinjal, cotton, okra, potato, cabbage, cauliflower, tomato, melon and some weeds.

Nature of Damage: Both nymphs and adults suck the cell sap from the underside of the leaves. In case of severe infestation the vitality of the plant is lowered and vegetative growth is checked. This result in shedding of flower buds and fruits. The insects also excretes honey dew on the leaves which encourages the development of black sooty mould, adversely affecting the photosynthesis. The attacked crop gives sickly appearance. Besides, the pest is known to transmit virus diseases in many crops.

Life History : Eggs : 119, laid singly on the underside of leaves. I.P. : 3-5 days in summer and 5-33 days in winter. Nymphs : N.P. 9-14 days in summer and 17-81 days in winter. Pupa : P.P. : 2-8 days,

Pupation : On Leaves. Adult: Fly longevity: 2-5 days in summer and 24 days in winter. Life cycle: Completed in 14-122 days. No. of generations 10-12/year

Management Practices: Spray the crop with 0.1% methyl dematon or 0.05% triazophos /monocrotophos /dimethoate/ fenpropathrin as soon as incidence is noticed.

5. Mites : *Tetranychus telarius* L.; Tetranychidae : Acarina; Ref. Pests of grapevine.

Nature of Damage : They are found in large colonies on underside of leaves covered with fine silky webs. As a result of their feeding, white specks appear on leaves. These later enlarge and leaf become discoloured and dries away.

Management Practices : Spray with 0.2% sulphur or dicofol 0.03% control the mites effectively.

Minor pests :

6. Leaf roller : *Antoba olivacea* M.; Pyralidae : Lepidoptera

7. Epilachna beetle : *Epilachna* spp.; Coccinellidae : Coleoptera.
The pest is described under cucurbits.

8. Tingid Bug (Brinjal lace wing) : *Urentius* spp.; Tingidae : Hemiptera.

9. Root-knot Nematode: *Meloidogyne* spp.; Heteroderidae : Tylenchida; It is described under Tomato (Page No. ….).

10. Grey weevil (Ash weevil): *Myllocerus* spp.; Curculionidae : Coleoptera.

****

Exercise No.13

STUDIES ON PESTS OF TOMATO AND BHENDI (OKRA)

Material : Preserved pest specimens and affected plant parts.

I) PESTS OF TOMATO :

1. Fruit Borer : *Helicoverpa amigera* (Hub.); Noctuidae : Lepidoptera

Economic Importance : It is a major pest of tomato, widely distributed in the tropics, subtropics and warmer temperature region of the world. It is a serious pest of gram and tur.

Marks of Identification : Moth : Medium sized stout, light yellowish brown. Forewing are pale brown with a dark brown circular spot in the center. Hindwings are pale smokywhite with a blackish outer border.

Caterpillar : 3 to 5 cm long, greenish with dark broken grey lines along the sides of the body.

Host Plants : Highly polyphagous pest damaging crops like cotton, gram, tomato, peas, sunflower, bean, pigeon pea etc.

Nature of Damage: On hatching, young larvae feed on tender foliage. Full grown larvae attack the fruits. They bore circular holes and thrust only a part of their body inside the fruits and eat the inner contents. If the fruit is bigger in size, it is only partly damaged by the caterpillar but latter it is invariably invaded by fungi and bacteria and spoiled completely. The larvae move from one fruit to another and a single caterpillar may damage and destroy 2 to 8 fruits.

Life History : Eggs – female lays 200 eggs singly on tender parts of the plant. Incubation period 6-7 days. Larva –larval period 2 weeks. Life cycle completed in 5-6 weeks. Several generations in a year.

Management Practices :

1. In early stage of attack, handpicking of caterpillars and their destruction help in reducing the intensity of infestation.
2. Ploughing the field after harvest of the crop would expose the pupae which would be destroyed by birds.
3. Use of *Trichogramma chelonus* 50000 eggs/ha.
4. Spraying the crop with 0.05% quinalphos or fenitrothion, HaNPV 250 LE, NSKE 5%.

2. Cutworm : *Agrotis ypsilon* Rott.; Noctuidae : Lepidoptera

Described under polyphagous pests page no. …….. .

3. Leaf Eating Caterpillar: *Spodoptera litura* Fab.; Noctuidae : Lepidoptera; Described under polyphagous pests page no. …….. .

4. White Fly : *Bemisia tabaci* Gen.; *B. argentifolii* Below; Aleyrodidae : Hemiptera; Pest has been described under Brinjal page no. ……. .

5. Serpentine Leaf Miner : *Liriomyza trifolii* Burg.; Agromyziae : Diptera

This American serpentine leaf miner has entered in India with severe incidence in Maharashtra, Karnataka, A.P., Gujarat etc.

Economic Importance : *L. trifolii* which is known as American serpentine leaf miner due to its origine from Southern United States of America and spread to other countries during 1970. It entered in India along with plant material during 1990-91 and spread to the different states.

Marks of Identification : Adult fly : 1.5 - 2.0 mm long, grayish black with yellow spot on top of thorax and has plum red eyes. Larva : Legless, orange yellow, about 2 mm long.

Host Plants : Polyphagous pests feeding on different vegetable, ornamental, fibre and pulse crops.

Nature of Damage: Maggots feed in between two layers of leaf on mesophyle making narrow serpentine mine that appears whitish when seen from upper surface, ultimately causing blotches and holes.

Life History : Eggs : Laid singly in small incisions in the leaf with ovipositor. Pupation takes place in soil.

Management Practices : Monitoring the presence of flies by yellow sticky traps and spray crop with insecticides like NSKE 5%, monocrotophos 0.05%, cypermethrin 0.01%.

Assignment : Describe the IPM Programme for tomato crop.

6. Root-Knot Nematode : *Meloidogyne incognita;* Heteroderidae : Tylenchida.

Economic Importance : It causes severe damage to the crops like tomato, brinjal, bitter gourd, okra, bottle gourd, pomegranate, grape vine etc.

Marks of Identification : Full grown female is microscopic, lemon shaped and 0.5 to 0.7 mm long 0.3 to 0.5 mm broad. While the juveniles (larvae) and the males are thread like and full grown males are about 1 mm long.

Host Plants : Highly polyphagous, non-insect pest damaging different vegetable and fruit crops as well as pulses, ornamental and flower plants.

Nature of Damage : After hatching the juveniles (larvae) enters into the roots and feed within the roots by sucking cell sap. This is endoparasitic nematode causing formation of root galls. It affect adversely on the absorption of nutrition by the roots and hence the symptoms like stunting growth, yellowing and wilting of the plants is observed. The damage by this nematode also encourages the root-rot disease.

Life History : The females lay the eggs on surface of feeder roots in masses in gelatine matrix. The life cycle is completed within 3-5 weeks depending on climatic conditions.

Management Practices :

A) Cultural methods : 1) Summer follow and ploughing, 2) Crop rotation with non-host plants, 3) Soil solarization before sowing seed of vegetable crops, 4) Intercropping by sowing the crops like tagetes, sunnhemp, mustard, fenugreek etc., 5) Application of F.Y.M., organic amendments oil cakes like neemcake, caranj kake etc. @ 2 t/ha., 6) Discoiuraging the planting seedlings of vegetables or fruit crops from nematode infested fields.

B) Biological control: Use of fungal biopesticidal formulations comprising Trichoderma and paecalomyces.

C) Chemical Control : Application of granular insecticides like carbofuran 3G or phorate 10G @ 1 to 2 kg a.i./ha for vegetables and other seasonal crops and 4 kg a.i./ha for grown-up fruit crops.

Minor Pests :

7. Mealy bugs: *Ferrisia virgata* Ckll.; *Phenococcus solanapsi;* Pseudococcidae : Hemiptera.

8. Aphids : *Aphids gossypii* G.; *Myzus persicae S.*

9. Leaf hopers : *Amrasca biguttula biguttula* Ishida.

10. Thrips : *Thrips tabaci* Lind.; *Caliothrpis indicus* B.

11. Mites : *Teranychus* spp – Red spider mite; *Aceria spp. – Eiophied mite*

II) PESTS OF OKRA (BHENDI) :

Major Pests :

1. Shoot & fruit borer: *Earias vitella* Fab.; *E. insulana* Boised; Arctiidae : Lepidoptera.

Economic Importance : Serious pest of bhendi and cotton.

Marks of Identification : Moth : *E. vitella* – moths having small pale white fore wings with broad greenish band in the middle. *E. insulana* : the forewings are completely greenish. Caterpillars of both species are brownish white with number of black and brown spots on the body and hence also called spotted bollworm. Larval length is 18 mm.

Host Plants : Cotton, Okra, ambadi, holly hock and several other malvaceous plants.

Nature of Damage : Caterpillars bore into the tender shoots, flower buds and fruits. As a result, the shoots dry, flower buds and fruits drop prematurely. Fruits remaining on the plants get deformed and often show exit holes of the larvae.

Life History : Eggs : 60-432, laid on tender shoots, flower buds and young fruits, I.P. 3-7 days. Larva : L.P. 9-11 days in summer and 20 days in winter. Pupa: Pupation in the tough silken cocoons either on plant or in soil or among the fallen leaves and rubbish. P.P. 5-7 days in summer and 8-9 days in winter. Life cycle: Completed in 3 weeks in summer and 4 weeks in winter and there are 12 generations in a year.

Management Practices :

1. Removal and destruction of infested shoots, fruits and shed material helps in reducing the intensity of infestation.
2. Spraying with 0.2% carbaryl or 0.1% malathion or 0.06% endosulfan or 0.01% cypermethrin/fenvalerate, profenophos 0.05%.
3. Use of *T. chelonis* @ 4 to 5 trichocards/ha.

2. Jassids : *A. biguttula biguttula Ishida;* Described under potato.

3. Aphids : *Aphis gossypii* Glover; *Myzus persicae* S. Describe under Potato

4. White fly : *Bemisia tabaci* G.; The adults of white fly are also responsible for transmitting the virus disease 'Yellow vein mosaic'. Described under Brinjal (page no. ……) .

5. Mites : *Tetranychus* spp.; Described under brinjal (page no. ……).

6. Root knot nematode : *Meloidogyne* spp.; Described under pests of tomato (page no. ……).

Minor Pests :

7. Leaf roller : *Sylepta derogata Fb.*

****

Exercise No.14

STUDIES ON PESTS OF CRUCIFEROUS VEGETABLES

Material : Preserved pest specimens and affected plant parts.

Major Pests :

1. Diamond back moth : *Plutella xylostella* L.; Plutellidae : Lepidoptera.

Economic Importance : It is one of the serious pests of cruciferous crops throughout the world. It is cosmopolitan in distribution.

Marks of Identification : Moth : Small, brownish grey in colour, have three pale whitish triangular spots on their hind margins of forewings which form a diamond pattern when the insect is at rest with wings folded along the body. Hence, the name "diamond back moth". Caterpillar : Small, greenish, smooth with some scattered hairs and tapering at both the ends.

Host Plants : Cabbage, cauliflower, knolkhol, mustard, radish, etc.

Nature of Damage : Young larvae feed on epidermis of leaves while full grown larvae bore inside the heads. Round transparent patches appear on leaves due to feeding. In case of sever infestation the plants may be completely skelotonized.

Life History : Eggs : 57, singly along the veins on lower surface of leaves at night. I.P. : 7 days. Larva : L.P. 2 weeks. Pupa : Pupation on the leaves in thin silken cocoons,
P.P.: 1 week. No. of generations : 5-7 /year. Pest is active throughout the winter season.

Management Practices:

1. Spraying with 0.05% malathion or quinalphs or fenitrothion control the pest effectively.
2. Spraying with Bt (*Bacillus thuringiensis*) @ 1 to 1.5 kg/ha, Abamectin 1.8 EC 0.001%.
3. Spraying with 4% NSKE. It is necessary to add wetting and spreading agent viz; teepol / sandovit @ 1 ml/lit.
4. Trap cropping with mustard, the crop attracts 80-90 % moths for colonization.
5. Tomato, when intercropped with cabbage reduces egg laying by diamond back moth.

2. Mustard sawfly : *Athalia proxima* Klug.; Tenthredinidae : Hymenoptera.

Economic Importance : Most destructive pest of cruciferous crops and is especially serious on raddish and mustard.

Marks of Identification : Adult : Flies are small, black in colour, with wings having black veins. They have two pairs of wings.
Larva : Small, black and smooth, have a tendency to curl up and drop on the ground when disturbed

Host Plants : Cabbage, cauliflower, knolkhol, mustard, raddish and turnip.

Nature of Damage: Larvae feed on leaves from margin inward, mostly during morning and evening. They cut small holes into the leaves and skeletonize the plant. Frequently large number of larvae can be found on each leaf.

Life History : Eggs : 30-35, singly in the leaf tissues on the lower surface close to the margins with the help of saw like ovipositor. I.P.: 4-6 days. Larva: L.P. -2 weeks. Pupa: Pupation in soil in earthen cocoons. P.P.: 10-12 days. Adult : Lives for 3-5 days. The pest remain active throughout the year except April and May in which remain in aestivation. The peak period of activity is during Sept. to Dec. after which the activity declines.

Management Practices :

1. Hand picking of larvae.
2. Spray with 0.05% malathion or 0.1% carbaryl or endosulfan 0.05% controls the pest effectively.

3. Cabbage butterfly : *Pieris brassicae* Linn.; Pieridae : Lepidoptera

Economic Importance : Very common and regular pest of cruciferous crops and having wide range of host plants.

Marks of Identification : The butterflies have pale white or snow white wings and smoky shade on the dorsal side of body. The young larvae are pale yellow and become greenish yellow later on.

Host Plants : Cabbage, cauliflower, knol-knol, turnip, radish and other cruciferous crops.

Nature of Damage: The first instars caterpillars just scrap the leaf surface, whereas the subsequent instars eat up leaves from the margins inwards, leaving intact the main veins.

Life History : The butterflies lay on an average 164 yellowish conical eggs in clusters of 50-90 on the upper or lower side of leaves. The egg hatch in 11-17 days in winter and 3-7 days in summer. The larval period is of 15-40 days while the pupal stage lasts for 7 to 28 days depending upon climatic conditions. The butterflies live for 3-13 days.

Management Practices : 1. Hand picking and mechanical destruction of larvae during early stage of damage.
2. Spraying of 0.2% carbaryl or 0.05 % malathion or endosulfan.

4. Aphids : *Brevicoryne brassicae* Linn.; Aphididae : Hemiptera.

Economic Importance : It cause considerable damage in case of severe infestation.

Marks of Identification : Adult aphids are very small, soft bodied insects, yellowish green in colour. They have cornicles on abdomen.

Host Plants : Cruiferous crops, brinjal, potato, chillies, tomato, shepu, sunhemp, sweet potato, chakwat, geranium, fennel etc.

Nature of Damage : Nymphs and adults suck the cell sap from lower surface of leaves. Their continuous feeding lead to general yellowing of leaves and subsequent drying. Besides, the pest excrete sugary substance which spread on leaf surface and attract the black fungus, that hampers the photosynthetic activities of plant.

Life History: Only female are noticed in Maharashtra State. They reproduce parthenogenetically and single female produces 12-24 young ones (nymphs). The nymphs become mature within 7-9 days and start reproducing.

Management Practices: Nursery spray with 0.04% endosulfan/ 0.03% dimethoate / 0.05% malathion. Field application with 0.05% malathion as soon as infestation noticed.

Minor Pests :

5. Leaf miner : *Liriomyza brassicae* R.; Agromyzidae : Diptera

6. Flea beetles : *Phyllotreta cruciferae* G.; Chrysomelidae : Coleoptera.

7. Painted bug : *Bagrada cruciferarum* K.; Pentatomidae : Hemiptera.

8. Tobacco leaf eating caterpillar : *Spodoptera litura*; Noctuidae : Lepidoptera.

****

Exercise No.15

STUDIES ON PESTS OF CUCURBITS

Material : Preserved pest specimens and affected plant parts.

Major Pests :

1. Fruit Fly: *Bactrocera cucurbitae* C. (Melon fruit fly); *B. dorsalis* H. (Oriental fruit fly); Trypetidae : Diptera.

Economic Importance : These are cosmopolitan species causing huge annual losses to several vegetable and fruit crops. More than 50% fruits are damaged by fruit flies. Among the various species, *B. cucurbitae* is most common and destructive on vegetables.

Marks of Identification : Adult fly : Resemble common house fly but has conical, yellowish brown abdomen and transparent wings with grey spots and bands.
Maggot : Small, direty white, legless, tapering at one end.

Host Plants : Gourds, melons, tondali, guava, mango, ber and other fruits.

Nature of Damage : Maggots feed on pulp of the fruits. Infested fruits start rotting and rendered them unfit for human consumption.

Life History : Eggs : 200, laid just under the skin (epidermis) of the fruits, I.P. : 3-5 days. Larva : L.P. : 2-3 weeks. Pupa : Pupation in soil. P.P.8-10 days. These species breed almost throughout the year except winter during which they hibernate as pupae or adults. During rainy season the activity of melon fruit fly is at its peak while heavy rain stop breeding of fruit fly.

Management Practices :

1. Clean cultivation – Removal and destruction of fallen fruits and infested fruits daily to minimize the intensity.
2. Use of Rakshak traps with methyl eugenol as attractant.
3. Deep ploughing to expose hibernating stages.
4. Application of spray bait containing 20 ml malathion + 200g jaggry + 20 lit. of water.
5. Spraying with 0.05% malathion or 0.2% carbaryl at flowering reduce the intensity of infestation.

2. Pumpkin beetles : Red Pumpkin beetle : *Raphidopalpa foveicollis* L.;
Black pumpkin beetle : *R. intermedia* J.
Yellow pumpkin beetle : *Ceratia cincta* F.
Chrysomelidae : Coleoptera.

Economic Importance : The red pumpkin beetle is the most destructive species, damage the young seedling and kill the same.

Marks of Identification : Adults : Small, the elytra of red pumpkin beetle is pale orange yellow to deep pale brown while in case of black pumpkin beetle, it is black and it is yellowish in yellow pumpkin beetle. Grub : Small, slender, elongate, creamy yellow with brown head and legs.

Host Plants : All cucurbits. Bottle gourd, red pumpkin and cucumber are heavily damaged by red pumpkin beetle.

Nature of Damage : Beetles are mainly responsible for the damage of the plant above ground. They damage the leaves, flowers and fruits making irregular holes and causing death or retardation of growth. Incase of heavy infestation resowing is also required to be done. The grub live in the soil and feed on roots and stem of the plant. Fruits and leaves also get damaged when comes in contact with the soil. Damaged roots, stems start rooting.

Life History : Eggs : 150-300, laid in moist soil to a depth of 2.5 cm, near the plant. I.P.:5-27 days depending on temp. and moisture content of soil. Larva : L.P. 12-34 days. Pupa : Pupation in soil. P.P. : 15-35 days. Adult : Live for 20-197 days. Life cycle : Completed in 52-270 days. The maximum activity of the pest is observed during hot weather, (Mar.-May), reaching its peak in middle of April.

Management Practices :

1. Preventive measures-burning of old creepers, ploughing and harrowing of field after harvest of the crops to destroy the stages of the pest.
2. Collection and destruction of beetles in early stage of infestation.
3. Spraying with 0.05% malathion or dusting with 5% malathion dust @ 10 kg/ha gives satisfactory control of the pest.

3. Blister beetle : *Mylabris pustulata* Th.; *Lytta* spp.; Meloidae : Coleoptera.

Economic Importance : Major pest causing considerable damage.

Marks of Identification : Beetles : Medium sized, having 3 black and 3 yellowish orange bands running vertically and alternately on elytra. When disturbed these beetles exude an acidic yellow fluid which contains cantharidin and causes blisters on human skin and hence the common name.

Host Plants : Polyphagous, infesting cucurbits, cotton, groundnut, millets, rose and okra.

Nature of Damage : Beetles feed on pollens and petals of flowers and flower buds as a result fruit setting is adversely affected.

Life History : Life cycle : Life cycle has not been fully worked out.

Eggs : Laid in soil I.P. : 14-15 days.

Grubs : Found in soil and feed on egg pods of grasshoppers and locusts.

Pupa : Pupation in soil. Hibernation takes place in pupal stage in soil.

Adult : Emerges out of soil around August and are active till early December.

Management Practices :

1. Hand collection and prompt destruction of beetles keep the population under check during early morning hours, when beetles are less active.
2. Spraying with 0.05% malathion or dusting with malathion 5D or endosulfan 4D @ 20 kg/ha.

4. Serpentine leaf miner : *Liriomyza trifolii* Burg.; Agromyzidae : Diptera;

(Refer the pests of tomato page no. ……).

5. Epilachna Beetle or Hadda Beetle: *Epilachna dodecastigma* M.;
E. vigintioctopunctata Fab.; Coccinellidae : Coleoptera.

Economic Importance : *E. vigintioctopunctata* is the most common and destructive species.

Marks of Identification : Beetles : Spherical, pale brown and mottled with black spots. *E. dodecastigma* has 6 spots on each elytra, while *E. vigintioctopunctata* has 14 spots on each elytra. They are strong flier.

Grubs : Yellow with hairs on their body.

Host Plants : Cucurbits, brinjal, potato, tomato, etc.

Nature of Damage : Both grubs and beetles feed by scrapping chlorophyll from epidermal layers of leaves, which get skeletonized and gradually dry away.

Life History : Eggs : 120 to 180, laid in masses on ventral surface of leaves. I.P. : 2-4 days. Larva : L.P. 12-18 days. Pupa : Pupation on leaves p.p. 3-6 days. Life cycle : Completed in 18-25 days in summer and may extend upto 50 days in winter. No. of generations 7/year.

Management Practices :

1. Hand picking of grubs and collection of beetles by hand nets during early stage of attack helps in reducing the intensity of infestation.
2. Spray with 0.05% endosulfan / malathion / quinolphos.

6. Root-knot nemato : *Meloidogyne* spp.; Heteroderidae : Tylenchida

(Refer the pests of tomato , page No. …….).

Minor Pests : Aphids, jassids and mites also found to infest the crop and have been described under potato and brinjal.

7. White Fly : *Bemisia tabaci* Gen.; Aleyrodidae : Hemiptera.
(Refer the pests of tomato, page No. …….).

8. Thrips : *Thrips tabaci* Lind.;
(Refer the pests of chilli, page No. …….).

****

Exercise No.16

STUDIES ON PESTS OF POTATO AND SWEET POTATO

I) PESTS OF POTATO :

Material : Preserved pests specimens and damaged plant part.

The crop is damaged by several pests in the field and in storage. The tuber moth assumes serious forms causing huge losses.

Major pests :

1. Tuber moth : *Phthoromaea operculella* Zeller; Gelechidae : Lepidoptera

Economic Importance : It is a cosmopolitan pest found in warmer countries throughout the world.

Marks of Identification : Moth : Small, narrow winged and greysh brown. It is nocturnal in habit. Caterpillars : Small, pinkish – White or pale greenish, with dark brown head.

Host Plants: The caterpillars are reported to feed on leaves of potato, brinjal, tobacco and tomato in field, but potato tubers under storage are most vulnerable to its attack.

Nature of Damage: In early stage of the crop growth the pest is injurious to plant as leaf miner. It also bores into petioles and terminal shoots. The main danger is to tubers both in the field and under storage. The caterpillars bore the tubers and feed on the pulp. As a result, potato tubers rot. The presence of black excreta near the eyebuds help to detect its presence in the tubers. On cutting such tubers, one can find the larva in the pulp.

Life History : Eggs : 150-200 eggs are laid singly near the eyebuds of exposed tubers or sometimes on underside of leaves. Incubation period 3-6 days. Larva: Larval period 2-3 weeks. Pupa : Pupation in soil, in earthen cacoons. Pupal period 7-10 days. Life cycle : Total period about 4 weeks. No. of generation : 8-9 / year.

Management Practices : **In field** :

1. Timely earthing up of the crop to cover the exposed tubers helps in reducing the intensity of infestation.
2. Spray with 0.05% endosulfan or quinalphos or 0.1% carbaryl at 60 days after planting.
3. Heaps of harvested potatoes should not be kept exposed in the field but covered with straw and the infested tubers should be rejected before storage.
4. Release of egg-larval parasitoid, *Copidsoma koehleri* B. @ 20,000 mummies/ha at 7 days interval starting 45 days after planting or release of egg larval parasitoid *Chelonus blackburni* @ 60,000 adults/ha in 4 releases at weekly interval found to reduce infestation by 50-55%.

In Storage:

1. The potatoes should be stored in well ventilated cool and dry places, with temp. not exceeding 21°C.
2. Covering of tubers with 2-3 cm layer of dry sand in heap is highly effective remedy against the pest.
3. Fumigate the tubers with CS_2 @ 1 kg/27 cu.m. for 48 hrs at 70°F. or methyl bromide @ 1kg/27 cu.m. for 3 hrs before storage. CS_2 is reported to induce sprouting in storage.
4. Walls of godown should be sprayed with 0.15% carbaryl at an interval of three months.
5. Treatment of seed potato tubers with 5% malathion dust @ 125 g/100kg is reported to offer good protection against the pest. Such treated potatoes however, should not be used for consumption.
6. If cold storage facilities are available, the produce can be safely stored for a longer period.
7. Release of egg-larval parasitoid, *C. koehleri* B @ 500 pairs/quintal or C. *blackburni* @ 200 adults/quintal tubers in storage, helps in reducing the intensity of infestation.
8. Application of Bt powder @ 100 g/quintal tubers in storage also found effective in reducing the infestation of pest.

2. Cutworm : *Agrotis ypsilon* Root; Noctuidae : Lepidoptera.
(Already described under polyphagous pests, Page No…….)

3. Aphids : *Myzus persicae* Sulzer; Aphididae : Hemiptera

Marks of Identification : Adult : Oblong, tiny, yellowish, soft, bodied insect with two projections called *cornicles* on dorsal side of the abdomen.

Host Plants: Polyphagous : Potato, brinjal, cabbage, raddish, chilli, tomato, tobacco, sunhemp, sweet potato etc.

Nature of Damage : They are found in large number on underside of leaves and tender shoots. The nymphs and adults suck the cell sap as a result affected leaves turn yellow, get wrinkled and distorted. The aphids also exude honedews on which a fungus develops and rapidly covers the plant with sooty mould that interferes with photosynthetic activity of plant. The growth of the plant is stunted and the yield is adversely affected. Besides, they transmit various virus disease such as "*leaf curl*", *mosaic* and *veinal necrosis* and cause severe loss.

Life History : Alate and apterous forms reproduce parthenogenetically. Single female produces 8-22 nymphs/day. The nymphs undergo 4 moults. A generation is completed in 7-9 days and several generations are completed in a season.

Management Practices : Spray with 0.05% endosulfan or 0.03% dimathoate control the pest effectively.

4. Jassids : *Amrasca biguttuala* Ishida; Jassidae : Hemiptera

Economic Importance: It is predominant pest. Heavy infestation results in considerable reduction of tuber formation.

Marks of Identification : Adults : Greenish yellow with front wings having a black spot on each at the apical margin and two black spots on the vertex of the head.
Nymphs : are also green. They walk diagonally.

Host Plants : Potato, binrjal, bhendi, cotton and other malvacious plants.

Nature of damage : Both nymphs and adult suck the cell sap from the lower surface of leaves. The damaged leaves curl updwards along the margins, turn yellowish, then brown and show burnt of patches which adversely affect the growth and yield.

Life History: Eggs : Whitsh eggs are laid singly in leaf tissues along the veins. I.P. 1 week. Nymphs: N.P. 1-2 week (moult 5 times). Life cycle: completed in a period of 1 month.

Management Practices : Spray with 0.05% endosulfan, 0.03 % dimethoate control the pest effectively.

Minor pests :

5. Epilachna beetle Or Hadda beetle: *Epilachna dodecastigma* M.; Coccinelidae: Coleopteran; Described under Cucurbits.

6. Thrips : *Hercothrips indicus* B.; Thripidae : Thysanoptera

7. Mites : *Hemitarsonemus latus* Banks.*;* Tetranychidae : Acarina.

II) PESTS OF SWEET POTATO :

Major pest :

1. Sweet potato leaf eating caterpillar or Sphinx caterpillar : *Agrius convolvuli* L.; Sphingidae : Lepidopetra

Economic Importance : It occasionally assumes serious form and causes economic loss.

Marks of Identification : Moth : Stout, pale grey coloured with black pointed head. The abdomen has pink and white lateral bands.
Caterpillar : Dark brown with reddish patches on sides and sharp curved horn-like process at tail end, about 7.5-10 cm long.

Host Plants: Sweet potato, mug, udid, and til.

Nature of Damage: Caterpillars feed on leaves voraciously. In case of severe infestation defoliate the plant.

Life History : Eggs: seed like, laid singly on leaves. I.P. 5-10 days. Larva : L.P. 2-3 weeks. Pupa : Pupation in the soil, P.P. 7-11 days. The pest hibernate in pupal stage. Life cycle : Completed in 4-15 weeks. S.O. Pest is active in monsoon.

Management Practices : 1. Hand picking and destruction of caterpillars in early stage of infestation.

2. Ploughing the field after harvest will expose the pupae.

3. Dusting the crop with 10% carbaryl dust or methyl parathion 2% @ 20 kg/ha or Spraying of carbaryl 50 WDP 0.1%.

2. Sweet potato weevil : *Cylas formicarius* Fb.; Curculionidae : Coleoptera.

Economic Importance : Serious pest of sweet potato, loss of tubers to the extent of 60-70 % has been reported.

Marks of Identification : Adult weevil : Small, ant-like, steel black in colour with brown elongated snout like head. Grub: small, legless and pale yellow in colour.

Host Plants: Sweet potato only.

Nature of Damage:The grub infest vines (stems) and cause tunneling inside. The grubs as well as adults bore into tubers, both in field and godowns, feed on inner content and spoil them. Dark black patches are noticed on the tubers and stems.

Life History : Eggs : 100-200, on the tubers and stems of vines by making small cavities. I.P. : 5-10 days Larva : L.P. 2-3 weeks. Pupa : Pupation in the larval burrows in vines. P.P. 7 days. Adult : Male longevity 10-15 weeks and female longevity 13-16 weeks. Life cycle : Completed in 4-5 weeks. Carry over : Pest is carried from one field to another through the infested vines and from season to season by breeding in tubers left over after harvest.

Management Practices:

1. Healthy cuttings should be selected for planting.
2. After harvest of the crop vines should be collected and destroyed.
3. Follow proper crop rotation.
4. Spray with 0.1% carbaryl.
5. Apply phorate 10 G in the soil at planting @ 10 kg/ha.

****

Exercise No.17

STUDIES ON PESTS OF SPICES AND CONDIMENTS (CHILLI, ONION, GARLIC, PEPPER, TURMERIC AND GINGER)

Material : Preserved pest specimens and affected plant parts.

I) PESTS OF CHILLI :

Major pests :

1. Thrips: i)*Scirtothrips dorsalis* Hood. ii)*Thrips tabici* Lind.; Thripidae : Thysanoptera.

Economic Importance : In case of severe infestation 30-50% crop may lost. Also responsible for transmitting 'leaf curl' disease.

Marks of Identification : Adult : Minut, delicate insect less than 1 mm long and yellow in colour. Wings are fringed with hairs. Nymphs : More minute and wingless.

Host Plants : Polyphagous: onion, chilli, brinjal, bhendi, cotton, mango, tondali, bottle gourd, guava.

Nature of damage : The thrips scrap the epidermis of leaves and suck the oozing sap. The damaged plant tissues initially become whitish, later brown and ultimately dry. As a result, leaves curl and become small. Such symptoms locally known as "Murda" or "Bokadya".

Life History : Both sexual and parthenogenetic reproduction occur. Eggs : Female lays 50-60 fertilized or unfertilized eggs inside the leaf tissues generally on lower side of the leaf. I.P.: 4-5 days. Larva : L.P. 6-8 days. Pupa : Prepupal and pupal periods are generally found in soil at a depth of 2.5-5 cm. for 4-6 days. The pest is more active during latter part of monsoon season especially during a dry days.

Management Practices : 1) Nursery treatment : Phorate 10G 70 g/m^2, 2) Spraying with 0.03% endosulfan/m. demeton/ dimethoate/ 0.05% monocrotophos as soon as infestation is noticed, NSKE 5% or cypermethrin 0.01%.

2. Mites: i) *Tetranychus* Spp.; *Polyphagotarsonemus latus* Banks; Teranychidae: Acarina; Tarsonemidae : Acrina.

Economic Importance : Cosmopolitan in distribution.

Host Plants : Polyphagous.

Nature of damage : They are found in large numbers on ventral side of leaves under a protective cover of fine webs. Both nymphs and adults suck the cell sap and devitalize the plants. Severally infested leaves show brownish patches and ultimately dry up. It also act as vector for transmitting chilli "leaf curl" or 'murda' disease.

Management Practices : Spraying of sulphur 0.2% or dicofol 0.03%.

3. Fruit borers: *Helicoverpa armigera* Hubn.; *Spodoptera litura* Fab.; Noctuidae : Lepidoptera.; (Refer the polyphagous pests Page.No……)

Minor pests :

4. Aphids : *Aphis gossypii* G.; *Myzus persicae* Suzler; Aphididae : Hemiptera.

5. Cut worms : *Agrotis ypsilon* Rott.; Noctuidae : Lepidoptera.

6. Termites : *Odontotermes obesus R.*; Termitidae : Isoptera.

7. White fly : *Bemisia tabaci* G.; Aleyrodidae : Hemiptera.

II) PESTS OF ONION AND GARLIC :

Onion thrips : *Thrips tabaci* Lind.; Thripidae : Thysanoptera.

Economic Importance : Pest is cosmopolitan in distribution.

Marks of Identification : Adults : Have narrow and long wings fringed heavily with fine hairs. Nymphs : Are wingless. They are minute, about 1 mm long, slender, fragile and yellowish in colour.

Host Plants: Highly polyphagous Besides onion, it attacks cole crops, cotton, cucurbits, chilli.

Nature of Damage : Nymphs and adults found between leaf sheaths and stems lacerating the epidermis of leaves and suck the exuduing sap. The affected leaves show silvery white blotches which later become brownish and get distorted from tips downwards, wilt and ultimately dry away. Heavy infestation at seedling stage results in retardation of growth and severe scarring of leaves which ultimately kills the seedlings outright. In case of heavy infestation at later stage, the bulbs remain undersized and get distorted in shape.

Life History : Eggs : 40-60 in notches in the epidermis of leaves. I.P. 8-9 days. Nymph : N.P. 4-6 days. Pupa : Pupation in soil, prepupal and pupal period lasts for 2 and 3 days respectively. Seasonal incidence : Pests is active throughout the year. It is found on onion and garlic during. Nov. to May, from these hosts it migrates to cotton and other summer crops in June & then to cole crops during Sept-Oct. A long spell of dry weather is favourable for its rapid multiplication.

Management Practices: Spraying with 0.05% endosulfan/ monocrotophos / dimethoate/ malathion/ quinalphos or 0.01% cypermethrin.

Minor pests :

2. Onion fly : *Delia antigua* M.; Anthomyiidae : Diptera

3. Leaf eating caterpillar : Cutworm : *Agrotis ypsilon* Rott.; Noctuidae : Lepidoptera.

4. Tobacco caterpillar : *Spodoptera litura* Fab.; *S. exigua* Hub.; Noctuidae : Lepidoptera.

III) PESTS OF PEPPER :

1. Scales insects : *Lepidosaphes piperis* Gr.; Coccidae : Hemiptera

Economic Importance : Severe in nurseries.

Marks of Identification: Adult: Elongated, oval, dark gray in colour, Active throughout year – peak in March-June, September-November.

Host Plants : Curry leaf and pepper

Nature of Damage : Both nymphs and adults covers stems, leaves, petioles in large numbers. Nymphs and adults with their piericing and sucking type of mouth parts suck the sap from stem, leaves, petioles, berries. The infested vines fade, disfigure, wither and dry up. Nurseries are severely affected. Yellowing and shedding of leaves and berries. Stunted growth and death of vines/plants.

Life History : The female scale insects lays the eggs under the scales and the total life cycle is completed within 4 to 6 weeks.

Management Practices :

1. Prune and destroy infested twings.
2. Spraying of malathion / dimethoate 0.05% or Neonicotinoids like imidacloprid 17.85 SL @ 150 ml/ha or Thiamethoxam 70 WG @ 200 gm/ha or Calothiamidin 50 WDG @ 100 gm/ha or Thiazophos 50 WP @ 100 gm/ha.

2. Pollu beetle : *Longitarsus nigripennis* Mats Chrysomelidae : Coleoptera

Economic Importance : The most important pest of pepper occurring regularly in the plantation.

Marks of Identification : Adult – small shining, yellow and blue flea beetle. Grub-Yellowish with black head, 5 mm in length.

Life History : Female beetles scoop out shallow holes on the berries – lay-100 eggs. Lay 1-2 eggs in each hole. Incubation period – 5 to 8 days. Grub – 20 to 32 days, Pupal period 6 to 7 days in earthen cells in soil. Life cycle – 39 to 50 days No. of generation-4 between July to January.

Nature of Damage : The grubs bore into berry and feed on its internal content excavating it completely within 10 days. Then it moves into another berry and thus 3 to 4 berries are destroyed by a single grub before it becomes full grown in 20 to 32 days. Attached berries appear dark in colour are hallow inside and crumple when pressed such berries known locally as Pollu berries. Grub cause

5 to 8% damage to berries. Grub may eat into the spike stalk causing entireregion to dry up. Adults feed voraciously on tender leaves by makings holes.

Management Practices :

1. Tilting the soil at the base of the vines at regular intervals to destroy pupae.
2. Application of phorate 10 G @ 10 kg/ha or fiprinil 0.3 G @ 10 kg/ha in the soil around vine base will help in destroying the grubs falling to ground to pupate.

3. Mealy bugs : *Ferrisia virgata* Ckll.; Pseudoccidae : Hemiptera
(Refer the pests of guava.)

4. Tobacco leaf eating caterpillar (Refer the pests of tobacco)

5. Green peach aphid (*Myzus persicae* Sul.):Refer the pests of potato .

IV) PESTS OF TURMERIC AND GINGER :

Rhizome fly : *Mimegralla coerruleifrons* Mocquart; Micropisidae : Diptera.

Economic Importance : Rhizome fly is becoming a serious menace to the cultivation of turmeric and ginger crops in recent years in Maharashtra State.

Marks of Identification : Adults : Flies are large in size with slender body and long legs. The body is black in colour, transparent wings with ashy spots. Eggs : Are small, white, cigar shaped, tapering at either side. Larva: Creamy white in colour, apodous and measures 9.5 mm. in length and 1.95 mm in breadth.

Host Plants : Turmeric and ginger.

Nature of damage : The maggots feed on the rhizome as a result of which yellowing of plants and rotting of rhizomes takes place.

Life History : Flies are noticed in fields during Aug.-Sept.

Eggs : Laid singly or in cluster of 6-10 at the base of the plants under the lumps of soil, in cracks and on the surface of soil. I.P. 2-5 days. Larva : L.P. 13-18 days. Pupa : Maggots pupate in rotten rhizomes. P.P. : 10-15 days. Life cycle : Completed in 4 weeks.

Management Practices :

1. Spraying with 0.05% fenitrothion or monocrotophos.
2. Soil application of phorate 10G @ 20 kg/ha or carbaryl 10 D 20 kg /ha.
3. Preventive measures : destruction of stray plants in off season, selection of healthy rhizomes for planting.
4. Removal and destruction of rotten rhizomes along with maggots from the field after harvest of crop will help to check the breeding of the pest.

****

Exercise No.18
STUDIES ON PESTS OF AMARANTHUS

Material : Preserved specimens and damaged plant parts.

Major Pests :

1. Amaranthus stem weevil : *Hylolixus truncatullus* (B); Curculionidae : Coleoptera.

It is almost specific pest of amaranthus widely disrubuted in India and neighbouring countries. The pest attacks both wild and cultivated crops. Varieties with large leaves being comparatively more damaged than those with prominent stems.

Marks of Identification : Eggs are smooth, pale yellow in colour. The grubs are stout, curled, legless, white in colour. Adults are ash-grey in colour.

Host Plants : Amaranthus

Nature of Damage: On hatching the grub bite their way into the stems and feed on pith region, making irregular zigzag tunnels, which are also filled with the excreta. The affected stems become weak and often split longitudinally due to transpiration and this results in excessive evaporation, the plants get desiccated and ultimately dry up completely.

Life History: Oviposition : Inside stem; I.P. : 5 to 6 days. L.P.: 10 to 12 days. Pupation : In stem. P.P.: 8 to 10 days. Adult period : 12 to 66 days.

Damaging State : Grubs and adults.

Management Practices :

1. Remove and destroy all wild Amaranthus plants growing in the vicinity of cultivated crops.
2. Spraying the crop with 0.05% dichlorovos or malathion is effective.

2. Leaf eating caterpillar : *Hymeria rucurvilis* (Fabr.); Noctuidae : Lepidoptera.

It is a sporadic pest of Amaranthus and is widely distributed in the Indian Subcontinent. It is also distributed in tropical and sub tropical regions, including Africa, Asia, Australia and Hawaii Islands.

Marks of Identification : Eggs are very small in size, snow white in colour. Catterpillars are greenish in colour with white lines on thorax. Adults are small sized. Black coloured, slender bodied moths.

Host Plants : Amaranthus, spinach, grassland and pastures.

Nature of Damage : On hatching the caterpillar feed on epidermis and on tissues of leaves, later on they web together with the leaves and silken threads secreted by them and feed within. Gradually these webbed leaves become completely devoid of chlorophyll and dry up.

Life History : Oviposition : Leaves preferably on top shoots. I.P.: 3 to 4 days. Larval period : 12 to 16 days, Pupation : In the soil, 7-9 days. Adult period 6 to 10 days. A life cycle completed in 3 to 4 weeks.

Damaging State : Larvae.

Management Practices : To control these caterpillars, spray with 0.03 % endosulfan / 0.05 % malathion or 0.1% carbaryl.

Following pests infest the leafy vegetables sporadically which have been described under the pests of other crops. Cutworm, aphids, grass hoppers, termites, mustard saw fly, flea beetles, leaf miner (*Liriomyza* spp.) and jassids.

****

Exercise No.19

STUDIES ON PESTS OF CORIANDER

Material : Preserved specimens and damaged plant parts.

1. Coriander Aphid : *Hyadaphis coriandari* (Das); Aphididae : Hemiptera.

It is a common pest of coriander widely disrubuted in the world. Other important species of aphid is *Myzus persicae* Sul.

Marks of Identification : *H. coriandari* has both apteraus and alate farms. The colour of the aphids are in general yellowish green dusted with grayish wax with long cornicles.

M. persicae : Adult : Oblong, tiny, yellowish, soft, bodied insect with two projections called *cornicles* on dorsal side of the abdomen.

Host Plants : *H. coriandari* : coriander, carrots, soybean, Bishop's weed, fennel, etc.

M. persicae : Polyphagous : Potato, brinjal, cabbage, raddish, chilli, tomato, tobacco, sunhemp, sweet potato etc.

Nature of Damage: They are found in large number on underside of leaves and tender shoots. The nymphs and adults suck the cell sap as a result affected leaves turn yellow, get wrinkled and distorted. The aphids also exude honedews on which a fungus develops and rapidly covers the plant with sooty mould that interferes with photosynthetic activity of plant. The growth of the plant is stunted and the yield is adversely affected. Besides, they transmit various virus disease such as "*leaf curl*", *mosaic* and *veinal necrosis* and cause severe loss.

Life History: Alate and apterous forms reproduce parthenogenetically. Single female produces 8-22 nymphs/day. The nymphs undergo 4 moults. A generation is completed in 7-9 days and several generations are completed in a season.

Management Practices: **For vegetable purpose**: 1.Use of resistant varieties, 2. Protection and encouraging the predators like ladybird beetles, green lace wing, etc.

For seed purpose (*Dhane*) : spraying of NSKE 5% or neem oil 1% or *Verticillium lecanii* at 0.2% or methyl demeton /malathion / diamethoite / endosulfan at 0.05%.

The stored grain pests like granary weevil, red flour bettles, pulse bettles, tobacco/cigarette beetle etc. damage the coriander seed during stoage for which refer the pest of stored grain.

****

Exercise No.20

STUDIES ON PESTS OF COLOCASIA AND MORINGA

Material : Preserve specimens and damaged plant parts.

I) PEST OF COLOCASIA :

1. Web worm : *Hyphantria cunea* ; Arctiidae : Lepidoptera

Marks of Identification : The caterpillar are pale yellow to dark grey with yellow spots are observed, maximum length 35 mm. Adult is mostly white in North but in the South blank or brown spots are observed on fore wings of adult.

Host Plants : Colocassia

Life cycle : Eggs : The adult moth lay eggs under surface of the leaves in hair covered cluster Larval webs are progressively enlarged. Larval period is 4-6 weeks. Papa : Pupal stage is over winter in the bark. Adult : Adult is white in north but in south there may be black spot on the fore wings. It is quite hairy front legs are white yellow or bright yellow wing span of 35-42 mm.

Nature of Damage : Young larva feed on upper surface of leaf. Later they consume the whole leaf causes yield loss.

Management Practices :

1. Use parasitic wasps to control them.
2. Prune and destroy leaves with webs.
3. Spray BTK (Bacillus thuringiensis var. *kurstaki*).

II) PEST OF MORINGA :

1. Leaf eating caterpillar:*Noordia blitealis* W., N. moringae; Pyraustidae:Lepidoptera.

Marks of Identification : The moths seen very much similar in both the species, *N. moringae* slightly bigger in size.

Life History : A female lays as many as 232 creamy white oval eggs in cluster each cluster having 34-96 eggs. The larva is devoid of a prothoracic shield and poses a brown head and measures 14-20 mm long pupation in soil.

Nature of Damage : The larva remain in a thin silken web on the under surface of leaf and feed on the leaf lets resulting in drying of the leaves into papery structures. The whole tree become defoliated.

Management Practices :

1. Collection and destruction of affected plant parts.
2. Application of malathion 0.1% is effective.

2. Aphids : *Lipaphis erysimi*; Aphididae : Hemiptera

Hosts Plants : Moringa, colocassia and mustard

Nature of Damage : Aphids draw sap from plant tissue using mouthparts modified for piercing and sucking. They feed on foliage, twings, branches, fruits etc. Some species inject the toxic saliva into plant during feeding and due to which the growth of the plant is stunted. Discolouration of the leaves and fruits. These aphids excrete the honey dew like substances on the leaves and due to which the sooty mould fungus is attracted towards them and photosynthetic activity is reduced.

Life History : Wingless adult female aphids can produce 50-100 offspring, a newly brown aphid become a reproducing adult within about a week and then can be produce up to 5 offspring per day for up to 30 days.

Management Practices :

1. Avoid excessive application of the Nitrogen fertilizer.
2. Optimum planting date.
3. Collection and destruction of the infected plant parts.
4. Spray the crop with endosulphan 0.05% or monocrotophos 0.08%.

3. Moringa stem borer : *Plocaederus ferrugineous*; Cerambycidae : Coleoptera.

Economic Importance : This is only one common pests of moringa.

Marks of Identification : Adult : Dark brown, beetle which lay egg singly under loose bark or on tree trunk.

Host Plants : Moringa, cashewnut, etc.

Nature of Damage : The grubs bore into the bark in their early stages and into wood in their late stages. Making extensive tunnels within chewed up wood and excreta out of the bore holes. Both young plants and older trees are attacked by the pest and are killed outnight.

Life History : The beetles lay the eggs under loose bark on the trunk. The life cycle is completed in more than a month and there are several overlapping generations in a year. Pupation takes place in larval tunnels.

Management Practices :

1. Swabbing the cut area of the stem and the exposed bark with carbaryl 50 WP 0.2% or lindane 20 EC 0.05%.
2. Paining coal tar + kerosene mixture (1: 2) upto one meter length of exposed trunk region on the stem.
3. Root feeding with monocrotophos 36 WSC 10 ml + 10 ml water kept in a polythene bag on one side of the tree and keep the same amount on the other side of the tree (totally 20 ml/tree) divided into two equal halves will give protection when threre is moderate incidence. In treated trees avoid plucking the moringa fruits for 30 days.

Minor pests :

4. Spodoptera : *Spodoptera moriciana;*
Noctuidae : Lepidoptera.

5. Bark eating caterpillar : *Indarbela quadrinotata* W.*; I. tetraonis* M.
Indarbellidae : lepidoptera

****

Exercise No. 21

STUDIES ON PESTS OF CURRY LEAF AND TOBACCO

Material : Preserve specimens and damaged plant parts.

I) PESTS OF CURRY LEAF :

1. Lemon butterfly : *Papilio demoleus* Linn.; Papilionidae : Lepidoptera.
(Refer the pest of Citrus Page No.).

2. Citrus psylla : *Diaphorina citri* K..; Psyllidae : Hemiptera.
(Refer the pest of Citrus Page No.).

Minor pest:

3. Tortoise beetle: *Siliana farinose*

II) PESTS OF TOBACCO :

1. Tobacco leaf eating caterpillar : *Spdoptera litura* F.; Noctuidae : Lepidoptera.

Economic Importance : The pest is cosmopolitan and polyphagous infesting various crops in the world.

Marks of Identification : Adults : Moths are medium sized stout with forewings grey to dark brown in colour with wavy markings. Hindwings are whitish. Larva:Caterpillar are pale greenish brown and smooth, with yellowish green dorsal stripes and prothoracic plate. Full grown caterpillar measures 35-40 mm in length.

Host Plants : Tobacco, peas, brinjal, banana etc.

Nature of Damage: The caterpillars, when young, feed gregariously on leaves and juicy stems and become isolated at later stage of growth.

Life History : Eggs : Laid in masses, covered with brown hairs on tender leaves I.P. 4-5 days. Larva: L.P. : 14-21 days. Pupa : Pupation in earthen cocoons. P.P.: 9-14 days. Life cycle : Completed in 13-14 days.

Management Practices :

1. Collection of eggs masses and caterpillars.
2. Ploughing after harvest of the crop to destroy the pupa.
3. At the early stage of infestation, dusting with 10% carbaryl @ 20-25 kg/ha controls the pest satisfactory.
4. Spraying of SlNPV @ 250 LE.
5. Use of sex pheromone traps with spodolure.

Minor pests :

2. Stem borer : *Gnorimoschema heliopa* L.; Gelechidae ; Lepidoptera

3. Cut worm : *Agrotis ypsilon* Rott.; The pest has been discussed under polytphagous pests page no…….. .

4. White fly : *Bemisia tabaci* is known as vector for transmitting persistent viruses.

5. Aphid : *Myzus persicae* Sulz.

****

Exercise No.22

STUDIES ON PESTS OF MANGO

Material : Preserved pests specimens and damaged plant parts.

Major pests :

1. Mango hoppers Or Jassids: *Amaritodus atkinsoni* L.; Cicadellidae: Hemiptera.;
Idioscopus clypealis L.; Jassidae : Hemiptera.

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

Marks of Identification : Adults : Wedge shaped, small insect with greyiesh body and three dark brown spots on head.

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

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.

Life History : Eggs : Laid in tissues of 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.

Management Practices : First spray before flowering on bark of branch and two more sprays when buds begin to sprout with 0.04% dimethoate or 0.05% quinalphos or 0.1 % carbaryl, fenvalerate 0.01%, imidacloprid 0.0053 %

2. Mango Stem borer : *Batocera rubus* L.*; Batocera rufomaculata* (de Green)
Cerambycidae : Coleoptera

Economic Importance : Entire tree gets killed in case of severe infestation.

Marks of Identification: Adult: Well built, conspicusously long (5-6 cm) and brownish yellow. Orange yellow spots and lateral spines on thorax, antennae longer. Larva : 8-9 cm long and have strong jaws, whitish-yellowish in colour.

Host Plants : Mango, fig, rubber, mulberry etc.

Nature of Damage : On hatching, the grubs make zig - zag burrows beneath the bark and tunnel into the trunks or main stem, moving upward, feeding on internal tissues. The mass of frass (refuge) gets accumulated beneath the bark or sometimes sap and masses of frass may be seen exuding from the bored hole. The branches and ultimately the tree may die.

Life History : Eggs : Under loose bark, I.P. : 1-2 weeks. Larva : Grub period about 6 months. Pupa : Inside stem, P.P. 3-4 weeks.
Adult : 60-100 days. No. of generation : 1/year.

Management Practices:

1) Locate the grubs, remove and kill.
2) 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 borer holes with syringe and seal with mud.
3) Cut and destroy the affected branches.

3. Mango fruit-fly: *Bactrocera (=Dacus) dorsalis* H.; (Oriental fruit fly)
Trypetidae : Diptera

Economic Importance : Most destructive pest. Rotting of fruits occur.

Marks of Identification : Adults : Small fly (7 mm) resembling to common housecfly. Abdomen is conical, yellowish brown, wings transparent with grey spots or bands on them.
Maggot : white, small and tapers at one end.

Host Plants : Polyphogous – mango, guava, pomegranate, citrus, banana and several vegetable crops. (Cucurbits)

Nature of Damage : Maggots bore into the fruit and feed on pulp. Infested fruits start rotting and drop down. Brown rotten patch appears on fruit. Rotting of fruits occur.

Life History: Eggs : 50, under the rind of the fruit, I.P.: 2-3 days. Larva : L.P.: 1-4 weeks. Pupa : Pupation in soil, P.P. 8-10 days. C.O.: Pest hibernate in pupal stage in soil during winter. S.O. : Pest is active in June – August.

Management Practices :

1) Sanitation- daily removal and destruction of fallen affected fruits.
2) Application of spray bait (20 ml. malathion + 200 g gur + 20 Lit. water).
3) Spraying the trees and adjoining hedges with 0.05% endosulfan, 0.1% carbaryl or 0.05% malathion.
4) Monitor the fruit-fly population in orchards by using methyl eugenol traps. (Rakshak trap).

4. Mango stone weevil : *Sternochetus mangiferae* Fab.; Curculionidae : Coleoptera.

Economic Importance : Totapuri, Neelam and Alfanso varities are more susceptible.

Marks of Identification : Adult : Weevil is short, stout, oval and dark, 5 to 8 mm long. Larva : Is small, thick and white.

Host Plants : Mango only.

Nature of Damage : Grubs bore through the pulp, enter into the stone and passes its entire life inside the stone. Adult feed on the pulp and find its way out of ripe fruit. As a result, discolouration 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 fruit.

Life History : Eggs : In the skin of ripening fruit. (Epicarp) Pupa : Pupation inside the stone. The generation : Is completed in 40-50 days. Only one generation in a year. C.O. Adult weevil remain inactive from July-August onwards, hiding in soil or underneath the bark of trees until next season.

Management Practices :

1) Spraying the trunks with kerosene oil emulsion after harvest to kill the adults.
2) Spraying on young fruits with 0.1 % malathion.
3) Destruction of affected fruits.
4) Digging of soil to expose the hibernating weevil.

5. 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.

Host Plants : Jack fruit, guava, papaya, mango, citrus, jamun, etc.

Nature of Damage : The nymphs and adult females suck the cell-sap from flowers, developing fruits and shoots. Excrete honey dew on which sooty mould develops, affecting adversely on photosynthesis. The flowers and developing fruits drop-off.

Life History : Eggs : The eggs are deposited in soil during April – May and hatch in December – January. Male : 67-119 days; Female : 77-135 days.

Management Practices :

1) Ploughing below the tree to expose eggs.
2) Soil application of 2% methyl parathion dust to kill newly emerged nymphs.
3) Use of sticky bands to prevent the climbing on trees (Sticky substance or greasy band) half meter above ground in second week of December or use of 30 cm alkathene sheet banding around the stem of mango.
4) Spray with 0.04 % monocrotophos or *Verticillium lecanii* 0.2%.

5) Use of predator *Cryptolaemus montrouzieri*.

6. Bark eating caterpillar: *Indarbela quadrinotata* W.; *I. tetraonis* M. Inderbellidae : Lepidoptera (The details of this pest are given under citrus.)

7. Mites : *Oligonychus mangiferus* R and S.; Tetranychidae : Acarina
(Refer polyphagous pests.)

Minor pests :

8. Scale insects :
White mango scale : *Aulacaspis tubercularis* N.; Diaspidae : Hemiptra.
Coconut scale : *Aspidiotus destructor* Sign.; Coccidae : Hemiptera.

9. Leaf gall insects : *Allasomyia tenuispatha* K.; Cynipidae : Diptera

10. Shoot borer : *Chlumetia transversa* WIK.; Noctuidae : Lepidoptera.

11. Red Ants : *Oecophylla smaragdina* Fab.; Formicidae : Hymenoptera.

Other Minor pests :

- Thrips
- Leaf eating caterpillar
- Mango psyllids
- Termites

****

Exercise No.23

STUDIES ON PESTS OF CITRUS

Material : Preserved pests specimens and damaged plant parts.

Major pests :

1. Lemon butterfly: *Papilio demoleus* Linn.; Papilionidae : Lepidoptera

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

Marks of Identification : Butterfly : Have yellow and black markings on wings. Larva : Green colour and measures 38 mm, when disturbed they protrude two fleshy horns from the neck, known as "Osmaterium".

Host Plants: All citrus species and other plants like bael, ber, curry leaf plant, *bawachi* etc.

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

Life History : Eggs : 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 up to 2-3 months in winter. Adult period : Male: 3 – 4 days, Female : 7-8 days. No. of generations : 4/year. S.O.: Pest is more active in monsoon season.

Management Practices :

1) Hand picking of all the stages of insect and their destruction.
2) Spray 0.05% endosulfan or 0.2 % carbaryl or Bt 0.1%.

2. Leaf miner : *Phyllocnistis citrella* S.*;* Phyllocnistidae : Lepidoptera.

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

Marks of Identification : Moths : Small, silver white colour, forewings with brown stripe and prominent black spot near the tip.
Caterpillar : Yellow in colour with brown mandibles.

Host Plants : All citrus species, bael.

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

Life History : Eggs: singly on underside of leaves (36 to 76 eggs), I.P.:3-6 days. Larva : 1- 2 weeks. Pupa : Pupation inside the larval mines of leaves, pp. 1-4 weeks. Life cycle is completed in 2-6 weeks. No. of generations : 9-13/year. S.O. : Pest is active in monsoon season. Population of the pests decreases during hot summer months.

Management Practices:

1) Removal of infested leaves/twigs and their proper disposal.
2) Spray 0.05% monocrotophos, quinalphos or dimethoate or fenvalerate 0.01% or NSKE 5% as soon as attack is noticed.

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 Identification : Adults : Small, dark brown in colour. Wings are folded like roof over body. Nymphs are spherical, pinkish, sedentary.

Host Plants : Citrus and other plants belonging to Rutaceae and curry leaf plant.

Nature of Damage : Both nymph and adult suck the cell sap from tender leaves, shoot and buds, which as a result curl, dry up and ultimately drop down. Complete crop failure is reported in case of severe infestation.

Life History : Eggs : 800 in leaf axis, I.P. : 4-6 days in summer and 22 days in winter. Nymph : N.P. 2 weeks in summer and 3-4 weeks in winter. Adult : Longevity may extend over 6 months. No. of generations : 9/year. C.O. : Pests over wintering in adult stage.

Management Practices : Spray quinalphos or monocrotophos at 0.025% or formathion 0.04%, fenvalerate 0.01% as soon as new sprouts appear in June and January.

4. White fly and Black fly : *Dialeurodes citri* A & *Aleurocanthus woglumi* A
Aleyrodidae : Hemiptera.

Economic Importance : White fly and black fly are of common occurrence and destructive pest of citrus. It causes '*Kolshi'* in citrus and reduce plant vigour.

Marks of Identification : White fly : Adults : Minute insect (1 mm) with yellowish body and red eyes. Wings white or greyish, covered with mealy secretions. Nymphs and pupae : Are oval shaped, scale like and brownish with marginal bristle like fringes. **Black fly :** Smaller in size and black in colour.

Host Plants : Citrus, cotton, castor, banana, coffee, mango, pomegranate, custard apple and some ornamental plants.

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

Life History : Eggs : Underside of leaves, I.P. : 10 days. Nymph : N.P. 3-10 weeks. Pupa : Pseudo pupa (Quescent stage) on underside of leaves. P.P. : 16-22 weeks.

Management Practices :

1) Avoid close planting and water logging.
2) Clip off and destroy infested leaves.
3) Sprays 0.05 % monocrotophos or dimethoate or quinalphos for second and third instar nymphs.
4) Spray 0.08% monocrotophos or 0.1% dimethoate or quinalphos for the control of last instar.

5. Fruit sucking moth: *Eudocima (Othreis) fullonica* C.;
Eudocima (Othreis) materna L.; *Achoea janata* L.;
Noctuidae : Lepidoptera.

Economic Importance : Moths puncture the fruits and causes fruit rot.

Marks of Identification : Moth : Large sized, forewings grey or brown. Hind wings orange or yellow with black spot in the center and marginal dark bands. Kideny shaped black spots in *E. fullonica* and round black spots in *E. materna.* Larva:Typical semilooper and have stout appearance, full grown larva 5 cm long, velvety dark brown colour.

Host Plants : Larva feeds on leaves of wild creepers like *gulvel* and *wasanvel* and moth feeds on fruits of citrus, mango, pomegranate, grape, cashewnut etc.

Nature of Damage : Moths are nocturnal and seen flying in orchards after dusk. Moths puncture the ripening fruits and suck the juice. Bacterial infection to the infested fruit causes rotting.

Life History : Eggs : 300, on leaves of wild creepers I.P. : 3-4 days. Larva: L.P. : 20 days. Pupa : Pupation in soil, P.P. : 9 days. Life cycle is completed in 4-6 weeks. S.O. : Pests is active in kharif season.

Management Practices :

1) Eradication of host plants viz. *gulvel* and *wasanvel*, etc.
2) Collection and destruction of moths at night.
3) Poison baiting (20 ml malathion 50 EC + 200 g jaggary + 2 lit. water).
4) Bagging of matured fruits with paper or cloth bags.

5) Quick removal and disposal of fallen fruits.

6. Bark eating caterpillar Or Bark borer: (i) *Indarbela quadrinotata* W.;
(ii) *I. tetraonis* M.;Inderbellidae : Lepidoptera.

Economic Importance : It causes severe damage to citrus in Maharashtra State.

Marks of Identification: Moth : Short, stout, ashy grey in colour. **Larva***:* Dirty brown in colour, slender and measures 5 to 6 cm.

Host Plants : Citrus, mango, ber, guava, pomegranate, jamun, aonla and other fruit crops and forest trees.

Nature of Damage : Larvae bore into wood making short tunnels in which they hide during the day and come out at night to feed on the bark. As a result of feeding on bark the sap conducting tissues are damaged which interrupt the translocation of cell sap. Frass and silken threads over the bark surface form the webbing. The growth and fruit setting is adversely affected. Withering of branches.

Life History : Eggs : 350, on bark in May-June, I.P. : 8-11 days. Larva : L.P. 8-10 months till about 3rd week of April. Pupa: Pupation inside larval tunnel, P.P.: 21-41 days. Moth longevity: 3 days. No. of generation : 1/year.

Management Practices :

1) Remove ribbon like silken webs from affected branches/trunks, detect the larval tunnel and insert iron spike in it to kill the larva.
2) Inject CS_2 or borer solution (2 parts CS_2 + 1 part chloroform + 1 part creosote oil) in borer-holes and plaster the holes with mud or insert into the borer holes insecticide – soaked cotton plugs and plaster the holes with mud. The insecticides for per litre of water are 4g carbaryl 50 WP or 2 ml dichlorvos 100 EC or 3 ml. endosulfan 35 EC., petrol, kerosene. These chemicals should be applied after removing webbings.
3) Spot application (spraying) of monocrotophos or dichlorvos or quinalphos at 0.08% or fenvalerate 0.04%.

7. Aphids : *Toxoptera aurantii* F., *T. citricidus* K.; Aphididae : Hemiptera.

Nature of Damage : Both nymph and adult suck the cell sap from tender shoots and leaves, as a result leaves curl, shoots wither, dry and the vigour of the plants declines. Severe attack at flowering may affect fruit setting. Besides, pest acts as vector of '*tristeza'* virus diseases.

Host Plants : Citrus, group.

Life History : Completed with 8-10 days.

Management Practices : Spray with 0.05% dimethoate, or monocrotophos or methyl demeton as soon as infestation noticed.

Minor pests :

8. Scale insect : Red scale : *Aonidiella aurantii* M.; Coccidae : Hemiptera

9. Mealy bug : *Planococcus citri*, (Risso); Pseudococcidae : Hemiptera.

10. Mites : *Oligonychus citri* M.; Tetranchidae : Acarina,

11. Citrus Nematodes : *Tylenchulus semipenetrans* (Cobb.);
Tylenchulidae : Tylenchida.

Other Minor Pests :

- Thrips

- Fruit flies
- Fruit sucking bugs
- Fruit borer
- Termites

****

Exercise No.24

STUDIES ON PESTS OF GRAPEVINE

Material : Preserved pests specimens and damaged plant parts.

Major pests :

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 : Adults : Small (4 to 5 mm long) shining flea beetle with metallic bronze colour and 6 dark spots on the elytra. Grub : Small, dirty white.

Host Plants : Specific to grapevine, however recorded on pangara.

Nature of Damage : Adult feed voraciously on sprouting buds and tender shoots soon after pruning. 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.

Life History: Eggs : In crevices of vines and under bark or in soil. I.P.: 4-8 days. Larva : L.P. 35-45 days. Pupa : Pupation in soil, 6-8 cm deep in earthen cells, P.P.: 7-10 days. Life cycle completed in about two months. C.O.: Adult beetles hibernate under the bark from Nov.- March. S.O.: Pests is very destructive to fresh flush after pruning.

Management Practices : Remove the loose bark and spray with 0.05% malathion or 0.05% chlorpyriphos or 0.2% carbaryl 50 WP/ 0.05% dimethoate or dusting methyl parathion 2%. First spraying immediately after pruning and second spraying 10 days after sprouting.

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 : Adult : Minute with black wings having fringes. Females dark brown, males bright yellow. Nymphs : Reddish.

Host Plants : Polyphagous – mango, pomegranatge, rose, guava, jack fruit, cashew etc.

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 schorchy patches with curly tips, flowers shed and scab formation noticed on infested berries.

Life History : Both sexual and parthenogenetic 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: male 2 to 6 days, female 18-20 days. Life cycle: Completed in 14-33 days. No. of generation: 5-8/year. C.O.: Pests overwinter in pupal stage in soil. S.O.: Pest is active in summer.

Management Practices: Spray with 0.03% dimethoate or methyl demeton, monocrotophos or 0.01% cypermethrin, first spray immediately after pruning in April and October.

3. Mealy bug: *Maconellicoccus hirsutus* Green; Pseudococcidae: Hemiptera.

Economic Importance : It causes severe damage, infest grape bunches.

Marks of Identification : Adults : Females are pinkish, covered with mealy white waxy secretion. Eggs and crawlers are orange in colour.

Host Plants: Grapevine, Hibiscus (bhendi, ambadi), mulberry, custard apple, guava etc.

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.

Life History : Eggs : 350-500, under bark, cracks, crevices in cottony cushion ovisac, 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 Feb.- March and June to August.

Management Practices:

1) Debarking of vines and application of insecticides like methyl parathion. 2D on stem and branches immediately after pruning.
2) Sticky bands around the stem near ground level.
3) Spraying of fruit bunches with 0.05% dichlorvos in combination with fish oil rosin soap @ 2.5 g/lit or sandovit 1-2 ml./lit (wetting & sticking agent).
4) Release of exotic predator *Cryptolaemus montrouzieri* Muls @ 2500-3750/ha. or 5 grubs/ beetles per vine.
5) Spraying of *Verticilium lecanii* 0.2 %.

4. Stem Girdler : *Sthenias grisator* Fab.; Cerambycidae : Coleoptera.

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

Marks of Identification : The adult beetle is dark coloured, greyish-brown with the elytra bearing an eye-spot near their tips. The grubs are whitish, 10-12 mm long, with prominent mandibles and spines on thorax.

Host Plants: Primarily grapevine but can also survive on mango, mulberry, citrus, ber etc.

Nature of Damage : Grubs tunnel into the stem (dry wood). Beetles feed on bark and girdle the vine resulting into drying of branch. Girdling of green branches is an essential event before oviposition.

Life History : Eggs : Under the bark of girdling point, I.P.: 8 days. Larva: Grub period 7-8 months. Pupa : Pupation inside larval tunnel, P.P.: 4-5 months. No. of generation : 1/year. S.O.: Pest is active from Aug-October.

Management Practices :

1) Cut the affected branches below the point of girdling and destroy by burning.
2) Collection and destruction of beetles.
3) Spraying with 0.05% malathion or 0.2% carbaryl.

Minor Pests :

5. Cockchafer beetle: *Adoretus* spp.; *Anomala* spp.; Scarabacidae: Coleoptera.

6. Mites : *Tetranychus urticae* Koch.; Tetranychidae : Acarina.

7. Root-knot nematode : *Meloidogyne incoguita* (Cobb.) ; Heteroderidae : Tylenchida;

Other minor pests :

- Stem borer
- Leaf roller
- Termites
- Leaf hoppers

****

Exercise No.25

STUDIES ON PESTS OF POMEGRANATE

Material : Preserved pests specimens and damaged plant parts.

Major pests :

1. Fruit borer /Anar caterpillar: *Deudorix isocrates* (Fab.); Lycaenidae : Lepidoptera.

Economic Importance: Serious pest, regular in occurance causing 40-90% fruit damage.

Marks of Identification: Adults : Medium sized, males are bluish violet while females are brownish violet with orange spatch on forewings. Larva: Short, stout, dark brown with short hairs and whitish patches all over the body and 2 cm long.

Host Plants : Pomegranate, guava, orange, ber, aonla, mulberry, plum, peach, pear and some other wild fruits.

Nature of Damage: Caterpillars bore the fruits, feed on pulp and seeds. Damaged fruits subsequently get infected by bacteria resulting in rotting of fruits. Such rotten fruits gives offensive smell and fall down. The excreta of the larva around the entry hole is seen.

Life History: Eggs: On calyx of flowers or on fruits, I.P.: 7-10 days. L.P.: 18 to 47 days. Pupa: Pupation inside the fruit or on fruit stalk, P.P.: 7-34 days. Life cycle: 1-2 months. No. of generation: 4/year. S.O.: Pest is active throughout the year. Maximum during *mrig bahar*.

Management Practices :

1. Spraying with 0.2% carbaryl or deltamethrin 0.002% as soon as appearance of flower buds.
2. Bagging of fruits if number of fruit trees are limited.
3. Remove and destroy affected fruits.
4. Prefere *Ambia bahar*.

2. Fruit sucking moths : *Eudocima fullonica* C.; *E. materna* L.; *Achoea janata* L.; Noctuidae : Lepidoptera.

Note : Details of this pests are given under citrus, page no…….. .

3. Bark eating caterpillar : *Indarbela tetraonis* M.; *I. quadrinotata* W.; Inderbellidae : Lepidoptera.
Note : Other details are given under citrus.

4. Thrips : *Scirtothrips dorsalis* H.; *Retithrips syriacus* M.; Thripidae : Thysanoptera.

Nature of Damage : Nymphs and adults lacerate the leaves, flowers and fruits and rasp the sap that oozes out of these wounds. As a result, tips curl and dry away. Flowers are shed and brownish irregular spatches develop on fruits.
(Other details are similar to grapevine thrips).

5. Shot–hole borer or Pin-hole borer: *Euwallacea fornicatus* Eich.
Scolytidae: Coleoptera.

Economic Importance : The incidence of this pest is spreading in most of the pomegranate growing area resulting in wilting and drying of plants.

Marks of Identification : 2-3 mm, black shining beetles, grubs pinkish yellow, creamy white and apodous. Eggs are white, elongate, pupae white.

Host Plants : 99 Host plants, tea, coffee, castor, pomegranate, etc.

Nature of Damage: Female makes deep galleries inside stem, which hinders the translocation of nutrients and water. The larval brood feeds on the ambrosia fungal spores. (*Monocrosporium ambrosium*) which are carried and introduced by the young female at the time of gallery construction. The leaves turn yellow and the plant gets wilted.

Life History : Egg, larval, pupal and adult periods are of 8-10, 21-26, 10-12 and 20-30 days respectively. Egg laying and pupation is within the stem.

Management Practices :

1. Lindane 0.1% or chlorpyriphos 0.1% or carbaryl 0.4% along with geru (red soil) and 0.25% copper oxychloride (Blitox) as a paste application on stem is found quite effective for the control of shot-hole borer.
2. Drenching with chlorpyriphos 0.1% or lindane 0.1% + copper oxychloride 0.25% around stem in soil.

6. Mealy bugs: *Drosicha mangiferae* G.; *Ferrisia virgata;*
Pseudococcidae : Hemiptera. Described under mango and guava.

7. Scale insects : *Saissetia nigra* N.; Coccidae : hemiptera.

Economic Importance : It is becoming serious menace to pomegranate cultivation in Maharashtra State. Commonly known as 'Black scale'.

Marks of Identification : Adults : Female wingless, black brown, oval to circular in shape, Males are winged and are rare.

Host Plants : Polyphagous- Pomegranate, cotton, castor, sandlewood, teak, guava, coffee.

Nature of Damage: Nymphs and adults suck the cell sap from twings, shoots, leaves and fruits. Devitalization takes place resulting in premature shedding of buds & flowers. Fruits hecome small sized. Infested twings present sickly appearance and dry. Development of black sooty mould on leaves affect photosynthesis.

Life History: Males are rare and occasionally seen. Females can lay the eggs without fertilization under the scale covering (Ovoviviparous reproduction). Preoviposion and oviposition periods are 19-27 and 23-42 days, respectively. A female lays 105 eggs within a period of 23 to 42 days, which hatch in about 4-8 days. The nymph become adult in about 36 days and adult female lives for about 44-76 days. A generation is completed in 82-119 days.

Management Practices :

1. Collection and destruction of severely infested twigs and fruits.
2. Spraying of quinalphos, dimethoate at 0.08% or malathion at 0.1%.

Minor pests :

8. White Fly : *Siphoninus finitimus* Sil.; Aleyrodidae : Hemiptera

9. Aphids : *Aphis punicae*; Aphididae : Hemiptera

10. Mites: *Tenuipalpus punicae* P&B; Tenuipalpidae : Acarina.

11. Hairy caterpillars : *Euproctis* spp.; Lymentriidae : Lepidoptera.

12. Root-knot nematode: *Meloidogyne incognita* (Cobb.);
Heteroderidae : Tylenchida

****

Exercise No.26

STUDIES ON PESTS OF GUAVA

Material : Preserved pests specimens and damaged plant parts.

Major pests :

1. Fruit fly : *Bactrocera diversus* Coq., *B. zonatus* S.; Trypetidae : Diptera

Economic Importance : It is a pest of potential importance on guava.

Marks of Identification : Full grown maggots pale creamy colour (5 to 6 mm long). Adults are smoky brown with greenish black thorax with yellow marking.

Host Plants : Polyphagous pest – Besides guava, it attacks banana, citrus, mango, jamun, papaya, melons and some other cucurbit fruits

Nature of Damage : After hatching the grubs bore into fruits, feeds on bulp, rotting and dropping of fruits.

Life History : Eggs : Under the rind of the fruit, I.P : 1-4 days. Larva : L.P. 4-5 days. Pupa : Pupation in soil, P.P. : 7-13 days. Total life cycle : 2-3 weeks. S.O.: Pest is active throughout the year. C.O. : Adult stage.

Management Practices :

1. Harvesting of fruit crops at proper time.
2. Collection and destruction of infested fruits.
3. Use of Rakshak traps with methyl eugenol.
4. Spraying of fenthion 0.05% or deltarmethrin 0.001%.
5. Spray bait : 20 ml. malathion + 200 gms jaggery + 20 lit water.

2. Bark eating catterpillar or Bark borer: *I. tetraonis* M.; *I. quadrinotata* W.; Indarbellidae : Lepidoptera. The details of this pest are given under citrus.

3. Spiralling white fly: *Aleurodicus dispersus* Rus.; Aleyrodidae: Hemiptera.

Economic Importance : White fly, *Aleurodicus dispersus* Russel (Hemiptera) is a serious pest of guava, *Psidium guajava* orchards in Kolhapur since January 1997. It is spreading in Maharashtra specially in districts Kolhapur, Sangli, Satara, Pune, Solapur, Osmanabad, Beed, Latur etc.

Marks of Identification: The pest is characterized by having dark reddish-brown eyes, fore wings with two characteristic dark spots. The wings are clear in newly emerged individuals but within few hours get covered with white powdery material. The 1st instar larvae are crawlers but settle later on near the spiral pattern eggs laid. The 3rd instars are characterized by having numerous evenly spaced short, glass like rods of wax along the sides of the body. The 4th instars are with copious amount of white material covered and with long glass-like minute rods.

Host Plants : Alarming on several agricultural and non-agricultural crops like guava, custard apple, banana, brinjal, mango, papaya, cotton, citrus, pomegranate, chilli, coconut, fig, sapota, groundnut & other flowering and ornamental plan

Nature of Damage : Damage to the crop is caused by both nymphs (larvae) and adults by sucking the cell sap, secreting boney dew like substance and further creating sooty moulds on leaves, as a result photosynthetic activities, growth of plant and fruit setting is adversely affected. Infected leaves becomes yellow, dry and drop down finally.

Life History : The egg stage lasts for 4-6 days, the larval 14-21 days and the pupal stage lasts for 2 to 5 days. Thus the total life cycle is completed in about 21-32 days only.

Management Practices :

1. Dichlorvos or malathion 0.1%.
2. Diflubenzuron 0.012%
3. Release of Encarsia parasitoids @ 1 lakh/ha.

4. Mealy bugs : *Ferrisia virgata* Cock.; Pseudococcidae : Hemiptera

Marks of Identification : Adult female apterous, oval, covered with white waxy filaments and two long waxy processes at posterior end. Males are winged.

Host Plants : Custard apple, aonla, citrus, banana, guava, grapevine and jack fruit.

Nature of Damage : Nymphs and adult female remains clustered on ventral surface of leaves, terminal shoots and sometimes on fruit and suck cell rap. Yellowing of leaves, premature shedding of fruits.

Life History : Incubation period 3 to 4 hours. Egg masses on leaves under female. The developmental period of nymph of male and female varies from 31 to 57 and 26 -47 days respectively. Longevity of male is 1-3 days and female 36-53 days.

Management Practices : Spray with 0.1% acephate or monocrophos or 0.2% carbaryl, *Verticillium lecanii* 0.2%, use of predator *Cryptolaemus montrouzieri*.

Minor Pests :

1. Scale insect : *Chloropulvinaria psidii* M.; Coccidae : Hemiptera.

****

Exercise No.27

STUDIES ON PESTS OF FIG, AONLA AND CUSTARD APPLE

Material : Preserved pests specimens and damaged plant parts.

I) PEST OF FIG

Major Pests :

1. Jassids : *Velu caricae* G.; Jassidae : Hemiptera

Economic Importance : 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.

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

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 October.

Management Practices : Spray with 0.1% carbaryl or 0.03% moncrotophos, 0.03% dimethoate. First spray should be given in the first week of October when new flush appears and subsequent sprays as and when infestation noticed.

2. Stem borer : *Batocera rubus* Lin.; *B. rufomaculata* de Geer.
Cerambycidae : Coleoptera. (Described under mango).

3. Mites : *Aceria ficus* (Cotte); Eriophyidae : Acarina.
(Refer the polyphagous pest page no……).

Minor Pests :

1. Mealy bugs : *Drosicha mangiferae* G.; Pseudococcidae : Hemiptera

2. Scale insects : *Hemiberlesia lataniae* A. Coccidae : Hemiptera

II) PESTS OF AONLA :

Major Pests :

1. 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.

Marks of Identification: Adult: Moth is small and dark brown. Caterpillar: Small, dark pinkish to reddish, cylindrical, slightly tapering to both ends.

Host Plants : Ber, jamun, olive and aonla.

Nature of Damage : Caterpillar enters the fruit by puncturing a hole in rind and feeds on seed. Infested fruits drop down, ferment and emit disagreeable odour.

Life History : Eggs : 11-34, singly in depression near the stalk of fruit. I.P. : 4-7 days. Larva: L.P. : 13-17 days. Pupa : Pupation in soil, P.P. 5-8 days. Adult: Longevity 3-4 days. Life cycle : 1 month. C.O.: Pest is carried through shed fruits from one season to other in hibermating larval stage. S.O. : Activity of the pest is in fruiting season, from Sept. to Jan. and infestation reaches at its peak in middle of November.

Management Practices :

1. Removal and destruction of infested and shed fruits.

2. Spray with 0.2% carbaryl, fenvalerate 0.01% or deltamethrin 0.002%, well before harvesting of fruits (half maturity stage).
3. Growing of less susceptible varieties e.g. Surati No.1, Kashi, Mehroon and Mehroon Khirani.

2. Bark eating caterpillar : *Indarbela quadrinotata* W.; *I. tetraonis* M.;
Indarbellidae : Lepidoptera (Described under citrus).

Minor Pests : Aphids, leaf folder etc.

III) PESTS OF CUSTARD APPLE :

1. Mealy bug : *Ferrisia virgata; Maconellicoccus hirsutus* G.
Pseudococcidae : Hemiptera.
Details are given under grapevine & guava.

****

Exercise No.28

STUDIES ON PESTS OF BER

Material : Preserved pests specimens and affected plant parts.

Major Pests :

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.

Marks of Identification: Adult: Moth is small and dark brown. Caterpillar: Small, dark pinkish to reddish, cylindrical, slightly tapering to both ends.

Host Plants : Ber, jamun, olive and aonla.

Nature of Damage : Caterpillar enters the fruit by puncturing a hole in rind and feeds on pulp. Infested fruits drop down, ferment and emit disagreeable odour.

Life History : Eggs : 11-34, singly in depression near the stalk of fruit. I.P. : 4-7 days. Larva: L.P. : 13-17 days. Pupa : Pupation in soil, P.P. 5-8 days. Adult: Longevity 3-4 days. Life cycle : 1 month. C.O.: Pest is carried through shed fruits from one season to other in hibermating larval stage. S.O. : Activity of the pest is in fruiting season, from Sept. to Jan. and infestation reaches at its peak in middle of November.

Management Practices :

1. Removal and destruction of shed fruits.
2. Spray with 0.2% carbaryl, fenvalerate 0.01% or deltamethrin 0.002%.
3. Growing of less susceptible varieties e.g. Surati No.1, Kashi, Mehroon and Mehroon Khirani.

2. Ber fruit fly : *Carpomyia vesuviana* C.; Trypetidae : Diptera.

Economic Importance : It causes severe damage to fruits to the extent of 77% has been noticed. Fleshy and late maturing varieties are more susceptible.

Marks of Identification : Adult flies : Small, brownish yellow, lodgitudinal strips on thorax and wings transparent, with four yellow cross bands

Maggot : Creamy white, about 6 mm long.

Host Plants : Only ber.

Nature of Damage : Maggots feed on fleshy and juicy pulp. The infested fruits turn dark brown, rot and give offensive smell.

Life History : Eggs : Inside the epidermis of ripening fruits, I.P. 2-3 days. Larva : L.P. 9-12 days. Pupa : Pupation in soil, 5-7.5 cm deep under the tree. P.P. 11-13 days in summer and 45-87 days in winter. No. of generation : 3 /year. S.O.: Pest is active in winter, maximum damage during Feb-March.

Management Practices :

1. Remove and destroy infested fruits.
2. Spraying with 0.1% carbaryl as soon as infestation noticed.
3. Application of spray bait (20 ml malathion + 200 g. jaggery + 20 lt. water).
4. Rake soil around trees frequently during summer to expose and kill pupae.

Minor Pests :

3. Hairy caterpillar : *Thiacidas postica WIK.*; Noctuidae : Lepidoptera.

4. Jassids : *Amrasca lybica* de Berg.; Jassidae : Hemiptera.

5. Tingid bug : *Monosteira spp.*; Tingidae : Hemiptera.

****

Exercise No.29

STUDIES ON PESTS OF BANANA AND SAPOTA

Material : Preserved pests specimens and affected plant parts.

(I) PESTS OF BANANA :

Major pests :

1. Root stock weevil : *Cosmopolites sordidus* G.*;* Curculionidae : Coleoptera

Economic Importance : Most destructive pest of banana in Maharashtra.

Marks of Identification : Adult weevil : Small (1cm) shiny black and have long curved snout and short eleytra.

Grub : Creamy white, stout, fleshy and legless with spindle shaped body (1 cm)

Host Plants: Only on banana, prefer the varieties viz., Malbhog and Champa.

Nature of Damage : Grubs bores into stem or sucker. As a result, the affected stem get riddled with holes while the roots are weakened. Bacterial and fungal infection leads to rotting. With strong blast of wind, the plants break down from the place of infestation. If the fruits are formed, they are few in number and inferior in quality. Both grub and weevil are the damaging stages.

Life History : Eggs : In decaying leaf sheath or rhizome or soil near stem. I.P. : 1 week. Larva : L.P. 2-6 weeks, Pupation 10-12 days, pupation in rhizome or soil. Adult: Weevil sluggish and avoid day light, they live upto 2 years and can remain without food for 6 months.

Management Practices :

1. Healthy suckers or rhizomes should be used for planting.
2. Spray with 0.05% dimethoate or carbaryl 0.1% or apply carbofuran 3 G. @ 40 g/sucker or phorate 10 G @ 15 g/sucker around the collar of affected plants. The treatment is to be repeated once in a month.
3. Uproot and burn the severely infested plants.

2. Aphids : *Pentalonia nigronervosa* Coq.; Aphididae : Hemiptera.

Economic Importance : Sporadic pest but its importance concern with its activity as vector of the disease 'bunchy top' and chlorosis or heart rot.

Marks of Identification : Adults are 1 to 2 mm long brown in colour with long antennae. Both alate and apterous forms are common.

Nature of Damage : Although the direct damage is by sucking the cell sap, pest causes serious damage indirectly by acting as a virus vector and transmitting the 'bunchy top' disease. In case of severe infestation, leaf dwarfing and leaf or heart-rot and chlorosis, leaf curling are noticed & fruit bunches becomes small.

Life History : The aphids reproduce by agamic viviparity. The life cycle is completed within 7 to 12 days.

Management Practices :

1. Remove the virus infested plants and destroy.
2. Spraying of 0.05 % dichlorvos, dimethoate or methyl demeton.

3. Burrowing nematode : *Radopholus similis* (Cobb) Thorne
Hoplolaimidae : Tylenchida

Economic Importance: Important non-insect pest of banana causing spreading decline of trees and migratory endoparasitic in habit.

Marks of Identification : Both male and female are thread like, elongate, microscopic, 0.4 to 0.9 mm in length.

Host Plants: banana, citrus and other plantation crops and spices.

Nature of Damage : These are migratory endoparasites, enter into roots at any point. Reddish brown cortical lesions are formed on roots, growth of the plant retarded, some times mature plant collapse.

Life History : The female lays eggs on root. The total life cycle is completed within month.

Management Practices :

1. Soil application at planting with phorate 10 G. @ 15 g/sucker or carbofuran 3 G @ 40 g/sucker reduces the nematode population.
2. Application of non-edible, oilseed cake like neem or karanj cake @ 1500-2000 kg/ha. will also help in reducing the nematode population.
3. Nematode free rhizomes/seedlings should be planted.
4. Crop rotation : Sugarcane after banana.
5. Avoid the planting of Robusta variety

Minor pests :

4. Tingid bug : *Stephanitis typicus* Dist.; Tingidae : Hemiptera

(II) PESTS OF SAPOTA (CHIKU) :

1. Chiku moth : *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 : Small, active, deep pink in colour with 3 longitudinal pinkish brown strips on each side of the body.

Host Plants: Sapota and bakul.

Nature of Damage: The caterpillar webs the tender leaves with silken treads & 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.

Life History : Eggs : 225, singly or in groups on tender shoots or ventral side of leaves, I.P. : 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.

Management Practices :

1. Removal and destruction of infested clumps keep the pest under check.
2. Spray with 0.1% carbaryl, 0.05% quinalphos or chlorpyriphos.

2. Sapota seed borer : *Trymalitis margarias* Meyrick; Tortricidae : Lepidoptera

Economic Importance: The severe incidence of the pest has been noticed since 1999-2000 in Thane district resulting in 40 to 90% infestation.

Marks of Identification : The full grown larva is pinkish in colour, 12 to 13 mm in length. Adults are small (7 to 11 mm long) forewings whitish with grayish spots, hindwing creamy, with thick hairs at the margins.

Host Plants: Sapota

Nature of Damage : Larva is damaging stage. After hatching, the larva bores immature fruits, enters into seed through micropyle, feeds on immature milky endosperm of the seed leaving its excreta in the seed. The full grown larva comes outside the fruit by making gallery in pulp and makes exit hole. Finally rotting of fruits may takes place.

Life History : The female lays eggs on fruits surface ranging between 7 and 272, singly or in batches of 2 to 4. Incubation period 10-12 days. Larva period 10 to 13 days. Pupa: Pupation takes place on

leaves by folding leaf margins. Pupation period 12-13 days. The longevity of adults: 3-5 days. Total life cycle is completed by 31-36 days.

Management Practices :

1. Collection and destruction of fallen fruits and leaves by burning.
2. Proper pruning of trees to allow sunlight
3. Conservation of red ants (predators).
4 Spraying with any one of the following insecticide alternatively at an interval of 15-20 days. (a) Endosulfan 0.05%; (b) Dichlorvos 0.05%; (c)Malathion 0.1% (d) Carbaryl 50 WDP 0.1%.

****

Exercise No.30

STUDIES ON PESTS OF COCONUT, ARECANUT AND OTHER PALM TREES

Material : Preserved pest specimens and affected plant parts.

Major pests :

1. Rhinoceros beetle or Black palm beetle : *Oryctes rhinoceros* L.*;* Dynastidae : Coleoptera.

Economic Importance : Most destructive pest causes serious damage to young trees.

Marks of Identification : Beetle : Stout, elongate, blackish in colour, 3.5 to 5 cm. long, head bears a large tapring 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, whitish, wrinkled.

Host Plants: Coconut and other plams, occasionally banana, pineapple etc.

Nature of Damage : Only beetles are harmful. They damage unopened central leaflet (tender fronds) and feed voraciously on softer tissues of growing points, with the result the growth of the tree is arrested which ultimately wither and dies. Injury can be recognized on the basis of clipped leaves (fan like appearance) and fibrous mass oozes out of the bored hole. The Beetles are nocturnal and not capable of longer flight.

Life History : Eggs : in decaying organic matter or in manure pits or compost heaps, 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: Beetles are nocturnal in habit – 76-219 days. Life cycle: Completed in 10-12 months. S.O.: Pest is active in monsoon season.

Management Practices :

1. Treating manure pits with 0.1% carbaryl or 10% carbaryl dust or 2% methyl parathion dust once in three months reduce the intensity of infestation.
2. Extracting beetles with iron hooks.
3. Filling bored holes as well as leaf axills with 2% methyl parathion dust + sand (1 : 1) to avoid re-infestation.
4. Removal and destruction of decaying organic matter within or near about orchards.

2. Red plam weevil : *Rhynchophorus ferrugineus* F.*;* Curculionidae : Coleoptera

Economic Importance : Most destructive pest, common on matured palm.

Marks of Identification : Adult weevil : Reddish-brown, bigger sized with curved snout, 3 - 4 cm in length. Grubs: Brownish fleshy and 5 cm long.

Host Plants: Coconut and some ornamental palms.

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. A few small holes occur in the crown from which chewed fibers come out and brownish sap oozes out. In young palm the top wither while in older ones the top portion bends and beraks.

Life History: Eggs : 204, in soft tissues at the base of leaf sheath, cuts of wounds on the trunk, I.P. 2-5 days, Larva : L.P. 24-61 days. Pupa: Pupation in cocoons of fibrous material,P.P.18-34 days. Life cycle: 50-90 days. S.O.: Pest is active throughout the year.

Management Practices :

1. Fill the leaf axis with 2% methyl parathion dust + sand (1 : 1) to kill the female resting in leaf axis.
2. Painting of cuts, scars and wounds immediately with lime or coal-tar for preventing egg laying.
3. Inject monocrotophos 20 ml/palm by drilling a slanting hole on trunk, one metre above ground level, with the help of bent funnel and close the hole with cement or mud. Care

should be taken to harvest all matured nuts prior to treatment or do not use the nuts from such treated palms for at least 3 months thereafter.

3. Black headed caterpillar: *Opisina arenosella* WIK.; (= *Nephantis serinopa* M.)
Xylorictidae : Lepidoptera.

Economic Importance : It causes severe damage to matured palms. The outbreaks of the pest occurs in the dry hot months.

Marks of Identification : The adult moth is medium sized.
Caterpillar : Slender, elongate, pale grayish with blackish head and 15 mm long.

Host Plants : Coconut and other plams.

Nature of Damage : Caterpillars feed on tender leaflets by remaining inside the leaf folds, in galleries made of silken threads and excreta. As a result, dried patches are seen on fronds and trees starts withering.

Life History: Eggs: 130, tip of older leaves, I.P. 5 days. Larva : L.P.: 6 weeks. Pupa: Pupation inside the silken galleries of leaf, P.P.12 days. Life cycle: 2 months. S.O.: Pests is active in hot months i.e., from March to May.

Management Practices :

1. Prompt removal and destruction of affected leaflets showing larval galleries along with caterpillars. This will check the population build up of the pest.
2. Spray with 0.1% carbaryl or 0.05% monocrotophos or dichlorvos as soon as pest appears.
3. Release of larval and pupal parasitoids such as *Microbracon brevicornis* M. and *Perisierola nephantidis* M. are found useful in controlling the pest.
4. Release of larval parasitoide, *Goniozus nephantidis* in coconut plantation in the month of March when pest assumes peak activity reduces the pest population effectively.
5. Use of light traps.

4. Eriophyid mite : *Aceria guerreronis* Keifer; Eriophyidae : Acarina.

Economic Importance : Most important pest of coconut now days causing huge losses of the fruit yield and quality.

Marks of Identification : Very small, elongate, wormlike, creamy white, microscopic in nature, measuring 0.25 mm, with two pairs of legs both in nymphs and adults.

Host Plants : Coconut.

Nature of Damage : The nymphs and adults feed by scrapping the surface of developing nuts under cover of the bract perianth which leads to premature nutfall and also leads to inferior quality, reducing the size and yield due to sucking of cell-sap. The nuts show typical triangular, brown, warty skin after maturity, deformed and 'T' shaped split may appear on the surface.

Life History: The complete development from egg to adult takes about 10 to 12 days.

Management Practices :

1. Root feeding of 2% Borax @ 250 ml/palm or soil application of borax @400-600 g/palm.
2. Root feeding of monocrotophos 15 ml in 15 ml water per palm or spraying as spot application of triazophos or monocrotophos 5 ml/litre of water.

5. Rats : *Rattus rattus* Wrougall; Muridae : Rodentia;
Refer polyphagous pests page no…….. .

Minor Pests :

6. Termite: *Odontotermes obesus* R.; Termitidae : Isoptera

7. Mites : *Raoiella indica* Hirst ; Phytoptipalpidae : Acarina

8. Scale insects : *Aspidiotus destructor* Sign.; Coccidae : Hemiptera.

9. Mealy bugs : *Pseudococcus coccotis C*; Pseudococcidae : Hemiptera

Exercise No.31

STUDIES ON PESTS OF CASHEWNUT

Material : Preserved pests specimens and affected plant parts.

Major pests :

1. Tea mosquito or Mosquito bug: *Helopeltis antonii* S.; Capsidae: Hemiptera.

Economic Importance: Major pest of cashewnut causing considerable damage.

Marks of Identification : Adult bug : Small (7-9 mm), active, reddish brown having peculiar pin-like knobbed process, arising vertically from the thorax & have long legs and antennae Bugs having a mixture of red, black and white coloration. Nymph : Ant like, hairy and amber coloured.

Host Plants: Polyphagous - cashewnut, tea, apple, grapevine and guava.

Nature of Damage : Both nymphs and adults suck cell sap form the tender leaves, shoots and fruits. As a result leaves, shoots turn dark brown and then black, white blisters and scales appear on fruit. In case of severe infestation shoots dries up, nuts shrivel and fall prematurely.

Life History : Eggs : 500, in tissues of tender shoots, buds, midribs and petioles of leaves. I.P.: 1-4 weeks. Nymph : N.P.3-6 weeks. Adult female bug live for 6-10 weeks. S.O.: Pest is active in rainy season. Heavy & continuous rains with no sunshine is favourable for its rapid multiplication.

Management Practices : Spray with 0.1% carbaryl, 0.05% monocrotophos during flowering season gives satisfactory control of the pest.

2. Cashewnut stem borer or tree borer : *Plocaederus ferrugineus* Lin.;
Cerambycidae : Coleoptera

Economic Importance: This is the most important pest of cashew tree in South India.

Marks of Identification : The adult is medium sized dark brown beetle. Full grown larva measure 7.5 cm, whitish yellow colour.

Host Plants: Cashewnut.

Nature of Damage: The newly emerged grubs bore into the bark and feed on soft tissues, making tunnels in all directions. The grown up grubs may also feed on wood. The opening of tunnels are plugged with a reddish mass of chewed fibre and excreta. The tree is weakened and it may die.

Life History: The beetles lay the eggs under loose bark on the trunk. The life cycle is completed in more than a month and there are several overlapping generations in a year. Pupation takes place in larval tunnels.

Management Practices:

1) Remove the grubs mechanically & destroy them.
2) Drench the basal trunk with 20 EC lindane or chlorpyriphos at 0.1% concentration.
3) Inject carbon disulphide into the tunnels and plaster with mud.
4) Destroy the severally infested plants.

3. Leaf miner: *Acrocercops syngramma* Mey.; Gracillaridae: Lepidoptera

Economic Importance : This pest is distributed throughout the cashew growing area.

Nature of Damage : The caterpillar mines through tender leaves. In mined area thin epidermal peel swells up as blistered patches. As the infested leaves mature the damage is manifested as big holes.

Life History : The eggs are laid on very tender leaves. Incubation period is 2-3 days. Larval period 2 weeks. Pupal period 7-9 days, pupation takes place in soil.

Management Practices : Spraying of 0.05% monocrotophos or endosulfan or malathion or 0.2% carbaryl 50 WP.

Minor Pests :

4. Leaf eating caterpillar: *Sircula trifenestrata* H.; Saturnidae: Lepidoptera.

5. Thrips : *Rhipiphorothrips cruentatus* H.; Thripidae: Thysanoptera.

****

Exercise No.32

STUDIES ON PESTS OF BETELVINE

Material : Preserve specimens and damaged plant parts.

1. Mites : Refer the polyphagous pests page no…… .

2. Root-knot Nematode : *Meloidogyne incognita;* Heteroderidae : Tylenchida.

Economic Importance : It causes severe damage to the crops like tomato, brinjal, bitter gourd, okra, bottle gourd, pomegranate, grape vine etc.

Marks of Identification : Full grown female is microscopic, lemon shaped and 0.5 to 0.7 mm long 0.3 to 0.5 mm broad. While the juveniles (larvae) and the males are thread like and full grown males are about 1 mm long.

Host Plants : Highly polyphagous, non-insect pest damaging different vegetable and fruit crops as well as pulses, ornamental and flower plants.

Nature of Damage : After hatching the juveniles (larvae) enters into the roots and feed within the roots by sucking cell sap. This is endoparasitic nematode causing formation of root galls. It affect adversely on the absorption of nutrition by the roots and hence the symptoms like stunting growth, yellowing and wilting of the plants is observed. The damage by this nematode also encourages the root-rot disease.

Life History : The females lay the eggs on surface of feeder roots in masses in gelatine matrix. The life cycle is completed within 3-5 weeks depending on climatic conditions.

Management Practices :

A) Cultural methods : 1) Summer follow and ploughing, 2) Crop rotation with non-host plants, 3) Soil solarization before sowing seed of vegetable crops, 4) Intercropping by sowing the crops like tagetes, sunnhemp, mustard, fenugreek etc., 5) Application of F.Y.M., organic amendments oil cakes like neemcake, caranj kake etc. @ 2 t/ha., 6) Discoiuraging the planting seedlings of vegetables or fruit crops from nematode infested fields.

B) Biological control: Use of fungal biopesticidal formulations comprising Trichoderma and paecalomyces.

C) Chemical Control : Application of granular insecticides like carbofuran 3G or phorate 10G @ 1 to 2 kg a.i./ha for vegetables and other seasonal crops and 4 kg a.i./ha for grown-up fruit crops.

****

Exercise No.33

PESTS OF COFFEE & TEA

I) PESTS OF COFFEE :

1. Coffee Green Bug : *Coccus viridis* Green; Coccidae : Hemiptera.

Marks of Identification : Crawlers are flat, ovate, slightly convex, pale green to yellowish green in colour.

Nature of Damage : The scales crowd under the surface of leaves along the midrib and veins. Tender branches and developing fruits are also attacked. The leaves and fruits become discoloured, malformed and drop down. Plant become very weak and unproductive.

Life History : They are produced ovoviviparously. Eggs: Female lays 300 to 500 eggs in a period of 2-5 months on leaves. I.P.: Few hours. Life cycle : Completed in 1 to 2 months. No. of generation: There are several generations in years.

Management Practices :

1) Spray 0.1 % malathion or 0.03% dimethoate.
2) Use of *Cryptolaemus montrouzieri*.

2. Coffee Stem Borer : *Xylotrechus quadripes* Chevrolat; Cerambycidae : Coleoptera.

Marks of Identification : Adult : Blackish brown beetle with prominent antennae, a characteristic pattern of yellowish bands on the elytra.

Nature of Damage : The branches are tunneled by larvae, wilt & break easily.

Life History : Eggs : 100 eggs per female are laid in cracks and crevices of trunk bark or primary branches. I.P. : 10 days. larval period 6-8 months. Pupation in the tunnels of stem. P.P. : 30 days. No. of generation/year : One.

Management Practices :

1) Pest can be suppressed by removing and destruction of grubs.
2) Collection and destruction of beetles during their egg laying period.
3) Carry out swabbing of the main stem and branches with chlorpyriphos 20 EC @ 1.25 lit in 125 lit of water/ha. once during April-May and twice during September-January.

3. Coffee berry borer: *Hypothenemus hampei* Ferrari; Scolytidae: Coleoptera.

Economic Importance : The most serious, world wide pest of coffee, native of Central Africa, detected in India during February, 1990. Now it has spread all over the major coffee growing areas in the country.

Marks of Identification : The adult is small black beetle having sub-cylindrical body with thick hairs. The larva is white, legless, brown headed grub.

Host Plants : Monophagous, on coffee only.

Nature of Damage : The adult female enters in coffee berry through a circular pin hole at the tip of berry. The grub feed by tunneling into the beans (berries). The damage caused by this pest makes the coffee beans unfit for marketing.

Life History : The females lay 30-90 eggs within beans (berries). The eggs hatch in 8-9 days. The larval period is completed in 2-3 weeks. The pupal stage lasts 6-8 days in larval galleries. Life cycle is completed by about 35 days.

Management Practices :

1. Timely harvesting of berries.
2. Dip the infested berries in boiling water for 2-3 minutes to kill the pest stages inside the berries.
3. Dry the coffee berries to a prescribed moisture level.
4. Application of *Beauveria bassiana* @ 10^8 spores/ml with 0.25% groundnut oil at the beginning of monsoon.

5. Spraying of endosulfan 0.07 %, dimethoate 0.06% or malathion 0.05%.

4. Stripped mealy bug: *Ferrisia virgata* Cock.; Pseudococcidae: Hemiptera.
(Refer the pests of Guava).

II) PESTS OF TEA :

1. Tea Mosquito Bug : *Helopeltis theivora* Wat.; Miridae : Hemiptera.

Marks of Identification : Adult : Female bug is orange across the shoulders and male is almost black colour.
Nymphs : Wingless, look like spider.

Host Plants : Tea, cashewnut, guava and medicinal plants.

Nature of Damage : The bugs puncture the leaf frequently to suck the juice. While feeding saliva is injected and tissues are necrotized, which become brownish or black in colour. The entire leaves are shriveled and fall down. The severe attack causes complete defoliation of branches and plants look like the brooms.

Life History : Eggs : eggs laid in the leaf axis, buds and often in the broken ends of the plucked shoots. I.P.: 5-27 days, depending upon the prevailing temperature. Nymphal period : Passes through 5 moults, 8 weeks in winter and 2 weeks in summer. Life cycle: Completed in 8-9 weeks.

Management Practices :

1. Collection and destruction of nymphs with hand net during morning and evening.
2. Spray the trees with 0.05% malathion.

2. Bunch caterpillar: *Andraca bipunctata* Walk.; Bombycidae : Lepidoptera.

Marks of Identification : Adults : are brown in colour, fore wings have wavy cross lines with two white spots near the outer margin. Larva: The full grown larva light yellow in colour.

Host plants : Tea

Nature of Damage: The larvae feeds on leaves and defoliate the the plants.

Life History : Eggs : Female lays 500 eggs on underside of leaves. Incubation period: 8-12 days Larva : Larval period is 20 to 30 days. Pupa : Pupation in dry leaves on ground. P.P.: 15 to 30 days. No. of generation: 4 / year.

Management Practices :

1. Collection and destruction of caterpillars.
2. Spray 0.05 % malathion.

3. Red Crevice Tea Mite: *Brevipalpus phoenicis* G.; Tenuipalpidae : Acarina.

Economic Importance : It is a sporadic pest of tea in India, Srilanka and Malaysia

Marks of Identification : Adult : Flat, elongate and oval in shape. It is scarlet red in colour with black mark dorsally. Nymphs: are flat, oval in outline and are scarlet red in colour.

Host Plants : Tea, coffee, citrus, rubber and medicinal plants.

Nature of Damage : Nymphs and adults feed on underside of leaves along the midrib at base. The loss of cell sap causes yellowing of leaves. The affected leaf petioles and the bark turn brown and dry up.

Life History : Eggs : About 47 bright red oval shaped eggs are laid on the lower side of leaves or in the crevices of bark. I.P. : 6-13 days. Life cycle : Completed in 21-28 days.

Management Practices : Spray 0.03% dicofol or 0.2% wettable sulpur.

4. Yellow Tea mite : *Polyphagotarsonemus latus* Banks; Tarsonemidae : Acarina.

Marks of Identification : Adult is yellow with white strip on the dorsal side; eggs are oval and flattened. Nymphs are minute, white and pear shaped.

Host Plants : Coffee, jute, tomato, potato, peppers, citrus, chillies, mango and rubber.

Nature of Damage : It is a serious pests in tea nurseries. Due to severe infestation yellowing of leaves takes place. Pest is responsible as vector of virus disease, ‘leaf curl’ or ‘murda’ disease.

Life History : Eggs : laid on under side of young flush of leaves. I.P.: 2-3 days. Nymph: N.P. 2-3 days, P.P.: 2-3 days. Life cycle: Completed in 4-5 days.

Management Practices : Same as under red crevice mite.

****

Exercise No.34

STUDIES ON PESTS OF APPLE

Major pests :

1. San Jose Scale: *Quadraspidiotus perniciosus* (Comstock); Diaspididae : Hemiptera.

Economic Importance : This insect pest has world-wide distribution and is the most serious pest in temperate region.

Marks of Identification : The scale which forms a covering on the body of the insect is black or brown. Underneath, a lemon-yellow insect is visible when the covering is lifted.

Host Plants : Prefers the plants belonging to the family "Rosaceae" such as apple, plum, pear, peach etc.

Nature of Damage : All parts of the plant above ground are attacked. The nymphs and adults suck cell-sap from plant. The growth of plant is checked and in severe cases the plant may die. The infested fruit has scaly appearance affecting adversely on quality and market price.

Life History : The pest is active from March to December and passes the winter in nymphal stage. Each female give birth to 200-400 nymphs. They become full grown in 3-40 days. The adult duration is 50-53 days. The males are winged insect and have a short life of 24-32 hours. There are four overlapping generations in a year.

Management Practices :

1) Prune the infested material and keep good orchard sanitation.
2) The parasitoid *Encarsia perniciosi* may be released.
3) Spraying of methyl demeton 25 EC 0.05%.
4) In nursery protect the plant by application of carbofuran 3G @ 0.75-1.0 g a.i./plant.

2. Woolly Apple Aphid : *Eriosoma lanigerum* H.; Aphididae: Hemiptera.

Economic Importance : This insect is a serious pest of apple in India and Pakistan

Marks of Identification : Adults and nymphs are red to purple and covered with bluish white, cotton like wax filaments. Winged and wingless forms appear during the year.

Host Plants : Apple, pear, crab apple etc.

Nature of Damage : The nymphs and adults suck cell-sap from the bark of twigs and roots. Swelling or knots appear on the roots which hinder the normal plant functions. The twigs shrivel and young nursery plants may die quickly.

Life History: The adult female reproduces parthenogenetically 116 young ones. The total duration of life history is 11 to 42 days. There may be 13 generations in a years.

Management Practices:

1) Use of resistant root-stock like Golden Delicious, Northern spy etc.
2) Biological control by parasitoid *Aphelinus mali*.
3) Selection of healthy plants for nursery.
4) Application of methyl demeton or chlorpyriphos or fenitrothion at 0.05% or malathion 0.07%.

Minor Pests:

3. Codling moth : *Cydia pomonella* Lin.; Tortricidae: Lepidoptera.

4. Tent caterpillar : *Malacosoma indicum* Walker; Lasiocampidae : Lepidoptera.

5. Indian Gypsy moth : *Lymantria obtuscata* Walker; Lymantridae : Lepidoptera.

6. Apple Stem borer : *Apriona cinerea* C.; Cerambycidae : Coleoptera.

Exercise No.35

PESTS OF ORNAMENTALS IN FIELD AND POLYHOUSE

The uniform growing conditions in polyhouses throughout the year favours the multiplication of insect pests round the year. The damage caused by these pests includes curling, distortion, discolouration, browning and drying of plant parts which results in quantative and qualitative loss.

The following pests are of common occurrence on ornamental crops and the crops under protected cultivation.

A) Foliage feeders / Bud borers :

1. Bud borer : *Helicoverpa armigera* Hub.
2. Tobacco leaf eating caterpillar : *Spodoptera litura* F.
3. Leaf miner : *Liriomyza trifolii* Burg.

B) Sucking pest complex :

1. Thrips : *Thrips tabaci* Lind.; *Rhipiphorothrips cruentatus* H.
2. White fly : *Bemisia tabaci* Genn.
3. Aphids : *Microsiphum rosaeiformis* Das.
4. Mealy bugs : *Ferrisia virgata* Cock.
5. Mites : *Tetranychus* spp.

C) Root feeders :

1. Plant parasitic nematodes : Root-knot nematode : *Meloidogyne* spp.
Reniform nematode : *Rotylenchulus reniformis* Lin. & Oliv.

All the above pests have already been included in different crops and hence refer the respective pests.

****