Chhattisgarh Samvad

Practical Manual on Integrated Pest Management

Prepared by :
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Practical Manual

on

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This is to certify that Shri./Ku. .....

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Date: Course Teacher

Content

Practical No.1

Title: : Collection and preservation of insect
Objective : To know the procedures for collection and Pre servation of different insect pest, beneficial insects etc.

Insects are required to be collected for following purposes.

1. To know the pest occurrence of the locality

2. To study the taxonomic characters of the insects.

3. To send the specimens to different places for identification

4. To Keep different insects in museum

5. To study the bionomics of pests

Equipments required for Insect collection:-

1. Insect collecting net

2. Insect killing bottle

3. Specimen tubes of various sizes

4. Forceps and hand lens

5. Insect store box

6. Insect rearing cages

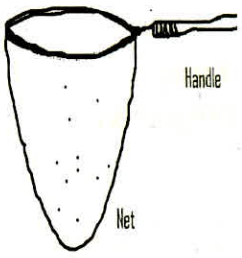
7. Insect killing and preserving media

8. Insect setting board

9. Small hair brush

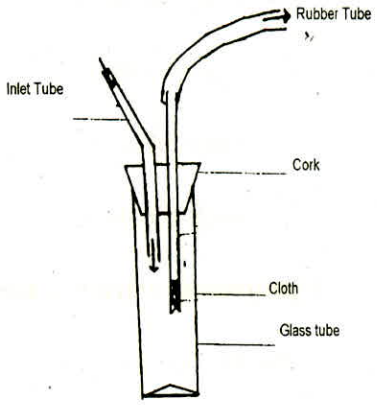
10. Aspirator

1) HAND NET



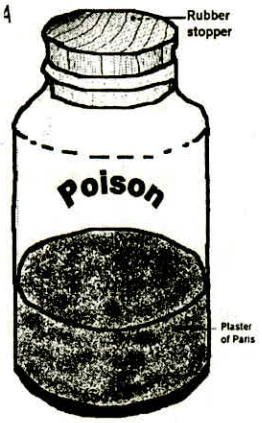
The hand net with a handle nearly 60 cm in length having circular iron ring of 30 cm diameter attached to it. A collecting bag made up of ordinary mosquito netting cloth is attached to the iron ring.

2) ASPIRATOR



A glass tube is used for collecting small insects which is fitted with a rubber cork. A rubber cork is having two holes in which small tubes are fitted. Out of the small two tubes, one is longer and another is shorter tube which is used for sucking purpose and enclosed at other end by means of muslin cloth so as not to allow collected insects to escape. The other tube is fitted with rubber tubes and this tube is used for collecting the insects.

PRESERVATION OF INSECTS



Requirements:

Killing bottle, entomological pins, setting board, insects store boxes, drying chamber etc.

PREPARATION OF KILLING BOTTLES

- Take an ordinary wide mouth bottle, having 1/2kg.capacity with a tightly fitting iron screw cap.

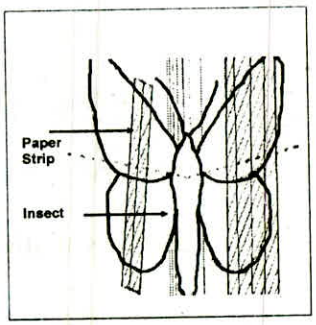
- Put one to two spoons of potassium cyanide or sodium cyanide at the bottom of the bottle and, cover this poison by putting a layer of plaster of Paris upto the height of 2-3 cm.
- Add two drops of water over it.
- Allow the plaster of Paris to harden the layer. A circular blotting paper is placed over it and the bottle is ready for use after a couple of days.

PRECAUTIONS REGARDING THE KILLING BOTTLE

1) Killing bottle should never be kept open as it gives out hydrocynic acid gas which is poisonous.
2) The bottle must be labeled as "POISON".
3) Broken pieces of the bottle should be disposed off by burying.
4) Do not keep the lepidopterous insects simultaneously with other insects

MOUNTING THE INSECT SPECIMEN

The collected specimens if not mounted immediately. They become very hard and brittle. Such insects are relaxed before mounting. Relaxation is done in a wide mouth air tight jar which is filled with moist sand and covered with a blotting paper. In this jar a few drops of carbolic acid are added to prevent mould formation. The insects are placed in this container for a day or two.



I) PINNING OF THE INSECTS

Pinning is the best method for preserving hard bodied insects. Pinning facilitates convenient handling of the specimen for study purpose and also for safe storing. Special rust proof pins are used for this purpose. As a rule 1/3 rd portion of the pin must be above

the insect body and 2/3 rd portion must be below. Pinned insects are carefully set on the setting board and then are kept for drying in the drying chamber. The wings of the lepidopterous insects are required to be - spread before keeping them in the drying chamber. The hind margin of the first pair of wings must be at right angle to the body. The specimens are to be-labelled indicating scientific classification, locality, host plants and date of collection.

INSECTS SHOULD BE PINNED AS INDICATED BELOW

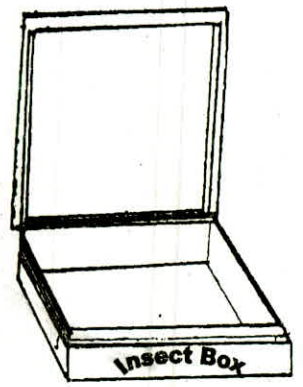
- Orthoptera: The insect like grasshoppers should be pinned through the back of pronotum, slightly to the right of middle line.
- Hemiptera: Insects like bugs and hoppers are to be pinned through scutellum slightly to the right of middle line.
- Hymenoptera: Insects like ants wasps should be pinned at the centre of thorax.
- Coleoptera (Beetles): Pin through the right elytron about midway of the body.
- Odonata (Dragonfly) through centre of thorax.

Very small insects like leaf hoppers are usually pinned on pith by means of smaller pins and then pith is mounted by angular thin pins. Entomological pin is made up of mixture of brass and nickel.

DRYING

Insect specimens after pinning should be kept in drying chamber to avoid rotting. After drying, the specimens are transferred to insect store box.

INSECT STORE BOX



Pinned insects are to be stored in the insect store boxes for preserving them safely for a longer period. The insect store boxes are made up of seasoned wood in such a way that their joints are intact and dust proof. The bottom as well as the top portion is covered with cork sheet. The pinned insects can be easily mounted in these boxes. Dried specimens become very brittle and hence extreme care is to be taken while handling the specimens. The specimens without legs or antennae are considered as useless. Only best specimens are preserved in the insect store boxes. The proper time at insect collection is early morning or at night with the help of light trap Mercury light is always attractive to the insects than any other light.

PROTECTING COLLECTION FROM PESTS

One of the worst enemies is development of mould. It is often difficult to avoid mould developing on newly caught and imperfectly dried specimens especially in damp climate. Before keeping specimens it is desirable to treat the box with saturated solution of naphthalene in benzene. Few drops of carbolic acid on cotton swabs are also kept in these boxes at regular intervals to avoid fungus attack on specimens.

If collected insects in store boxes are attacked by dermestid larvae, ants and other pests and when repellent action of naphthalene is insufficient, it is necessary to fumigate the boxes by fumigants.

II) ALCOHOL PRESERVATION

Soft bodied insect like aphids, jassids, thrips, midges, scales, bugs, and immature stages of the pests are preserved in 70 to 75% alcohol with little quantity of glycerin in

small specimen tubes and the tubes are properly labeled giving details about locality of collection, plant parts infested and name of collector. The insects are also preserved in formalin solution.

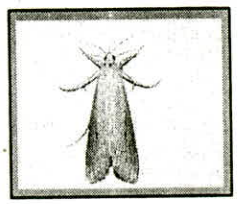
III) PERMANENT MOUNTING

The very small insects are also preserved by mounting on permanent slides. Their various structures and stages are also studied by preserving them by this method. The insects to be preserved are boiled in 10% KOH solution for few minutes and then they are to be passed through 20-100% alcohol series for dehydration and then mounted on slides in Canada balsam.

Brief introduction to some insect pests

RICE

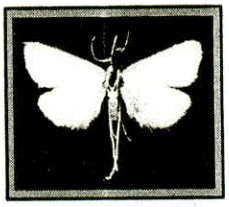
1) Yellow Stem Borer



Yellow Stem Borer
(*Scirpophaga incertulas*)

The adult moth is slender, yellowish white with a pointed head. The female moth has a distinct black spot at the centre of fore wings. The male is smaller and dull in color. The male's wingspan is about 20-30 mm, whereas the female's is 24-36 mm. The female's abdomen is wide with tufts of yellowish hairs. The male has a slender abdomen toward its anal end.

2) White Stem Borer

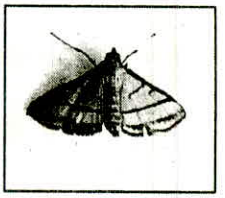


White Stem Borer
(*Scirpophaga innotata*)

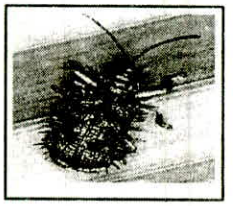
The male and female adults are immaculately white in appearance. They have a tuft of long hairs on the thorax. The male is smaller than the female.

3) Leaf folder

The adult is whitish golden yellow in color. It has three black bands on the forewings, two are complete bands and one is an incomplete middle band. The male moth has a thick black hair tuft on its fore tibia. The dorsal part of its abdominal tip has a thin and very long longitudinal black band. The male has a wingspan of 14 to 16 mm. The female moth has a longer wingspan of 16 to 18 mm.



Leaf folder
(Cnaphalocrocis medinalis)



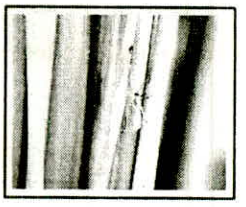
Rice Hispa
(Dicladispa armigera)

4) Rice Hispa

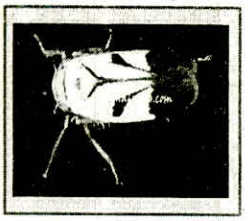
The adult is blue-black and very shiny. Its wings have many spines. It is 5.5 mm long.

5) Gall Midge

The adult is mosquito-like. The female midge has a bright red abdomen, whereas the male has a yellow-brown body. The male is generally smaller than the female. It has a wing expanse of 3.0-3.5 mm. The female has a wing expanse of 3.5-4.0 mm. Both adults have bead-like antennae with more than 10 segments. Their maxillary palpi are 4-segmented.



Gall midge
(Orseolia oryzae)



Green Leafhopper
(Nephotettix nigropictus)

6) Green Leafhopper (*Nephotettix nigropictus)*

The adult is slender and green with a rounded vertex. Vertex has an anterior black band and a sub-marginal black band extending beyond the ocelli to the inner margins of the eyes. Its pronotum is smooth with

a black anterior margin. Black spots are prominent on the forewings. The female hopper measures 4.3 by 1.4 mm, whereas the male is 3.7 by 1.3 mm.

Nephotettix virescens

The adult leafhopper is green. Its head has a pointed vertex without black bands. The face is also green. A pair of black spots is either present or absent on the tegmen of the forewings. A male hopper measures 4.2 by 0.05 mm, whereas the female is 4.3 by 1.4 mm.

Green Leafhopper
(Nephotettix virescens)

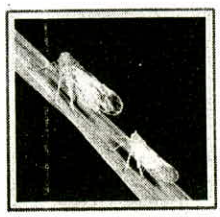
7) White backed plant hopper

White in colour and pronotum is pale yellow. Possess a diamond like marking on the thorax and ovipositional site is black streaks. Adults measures 3-4 mm in length. Males in WBPH are always macopterous.

White backed plant hopper
(Sogatella furcifera)

8) Brown plant leafhopper

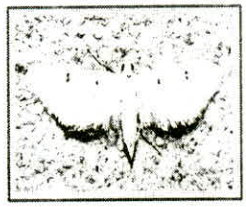
The adult is brownish black with a distinct white band on its mesonotum and dark brown outer sides. The body is yellowish brown. The adults have two distinct winged forms, macropterous and brachypterous. Macropterous forms have normal front and hind wings, whereas brachypterous forms have reduced wings.



Brown plant leafhopper
(Nilaparvata lugens)

9) Case Worm

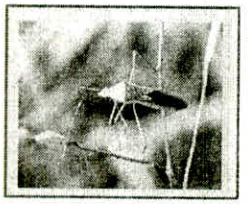
Adult moth -bright white with light brown and black spots on wings. It is about 5 mm long with a wing expanse of 15 mm.



Rice case worm
(Nymphula depunctalis)

10) Gundhi Bug

Adults are slender and light brown measuring 19 mm long with distinct ventrolateral spots on the abdomen. Both the adults and nymphs feed on grains at the milking stage. It releases unpleasant spell and hence the name Gundhi bug.

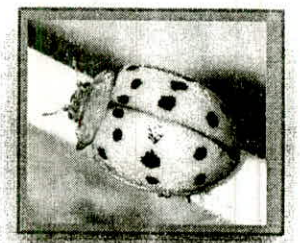


Gundhi Bug
(Leptocorisa acuta)

BRINJAL

1) Epilachna beetle

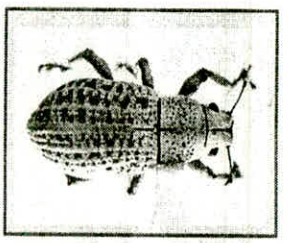
It resembles to lady bird beetle, adults are spherical, D shaped pale yellowish in color. It posses black spots on the elytra. A total of 28 spots are found on *E vigintioctopunctata* while *E.dodecastigma* has 12 spots.



Brinjal Epilachna beetle
(Epilachna sp.)

2) Ash weevil

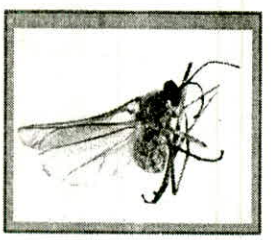
Adult of ash weevil is grayish white in color it posses brown and white spots on elytra.



Brinjal Ash weevil
(Myllocerus discolour)

3) Gall midge

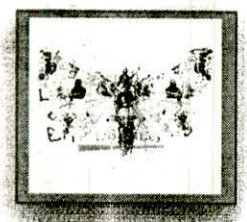
It looks like mosquito adult and blackish in color characterized by a needlelike ovipositor.



Brinjal gallmidge
(Asphondylia sp.)

4) Fruit and shoot borer

The moths measure about 10.0 mm in length, 20.0 mm wing-span and are medium sized, having whitish wings with large

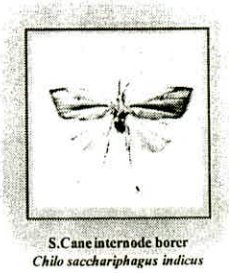


Brinjal shoot and fruit borer
(Leucinodes orbonalis)

brown patches all over wings. The head and thorax are blackish brown.

SUGARCANE

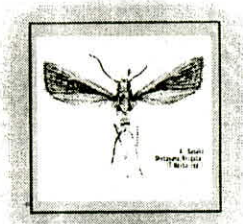
1) Internode borer



S.Cane internode borer
Chilo sacchariphagus indicus

The moths are nocturnal in habit, straw colored with a slight dark spot on each of the fore wings. Moths were sluggish and flew short distance when disturbed. Female moth is quite large than males.

2) Early shoot borer



S.Cane early shoot borer
Chilo infuscatellus

The adult moth is small, pale grayish brown, the forewings with darker markings especially along the outer edge and the whitish hind wings.

3) Pyrilla

S.Cane Leafhopper
Pyrilla perpusilla

Adult hoppers are straw colored to brownish, 7-8 mm long, with a pointed snout bearing piercing and sucking mouthparts. They are found gregariously and jump off readily when disturbed. Adults are active fliers.

SORGHUM

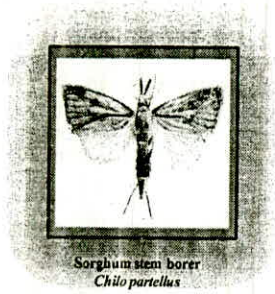
1) Shoot fly

Sorghum shoot fly
Atherigona soccata

The adult fly is about 4 mm long. It looks like a small house fly. Head and thorax of the female are pale grey. The abdomen is yellowish with

paired brown patches. The male is more blackish.

2) Stem Borer



Adult is a stout moth with dark yellow-olive forewings and pale hind wings. Adult moths have a wingspan of 20-30 mm. Males are smaller and darker than females. The forewings of males are pale brown. The forewings of the females are much paler and the hind wings are almost white.

OTHERS

1) Cotton American boll worm

A stout bodied light brown nocturnal moth with a wingspan of 32-40 mm. The body length is 16-18 mm. The forewings are yellowish brown or grayish to brown, with a broad slightly darker band and a small dark spot. The hind wings are pale with a broad dark grey or brown marginal band with two lighter spots on it.

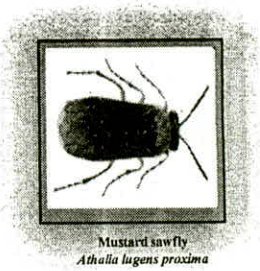
2) Red gram plume moth

Adults are small moth with brown plume-like yellowish wings. Forewings are cut into 2 plumes and hind wings into 3.

3) Groundnut red hairy caterpillar

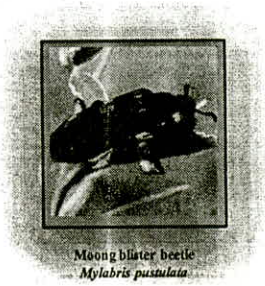
Adult moth is having white colored wings with red margin on forewings and black spots on hind wings.

4) Mustard sawfly


Mustard sawfly
Athalia lugens proxima

Head and thorax is black in colour. Abdomen is orange colour. Wings are translucent, smoky with black veins.

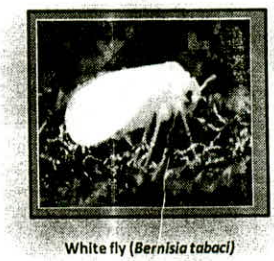
5) Moong Blister beetle


Moong blister beetle
Mylabris pustulata

Adults measure about 25 mm in length and have red and black alternating bands on the elytra. Elytra not flat, typically rolled over abdomen. Head broad, generally rectangular when viewed from above.

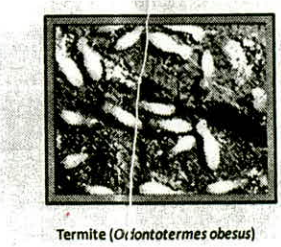
SOME COMMON INSECT PESTS

1) White Fly


White fly (*Bernisia tabaci*)

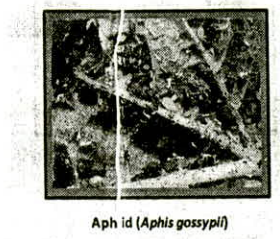
Adults are tiny, moth-like white body including wings which are covered with a white waxy bloom. Nymphs are oval, scale-like and greenish white.

2) Termites


Termite (*Odontotermes obesus*)

Cream colored, tiny insects resembling ants with dark brown colored head. Also called as white ants. *Soldiers* are sterile males and females.

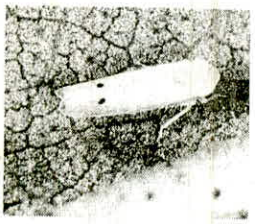
3) Aphids


Aph id (*Aphis gossypii*)

Aphids are tiny yellowish soft-bodied insects, the adult is along 1mm long and has two projections called cornicles on the dorsal side of abdomen. The aphid colors range from pale yellowish to green.

4) Jassids

These small green insects 2.5 mm long, suck sap from both the upper and lower surface of the leaflets. The adult fly when disturbed. The nymphs and adults have similar shape and color, but the nymphs do not have wings and run sideways when disturbed.

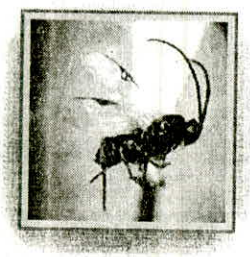


Jassid (*Amrasca biguttula biguttula)*

Brief introduction to some natural enemies

1) *Apanteles sp.*

Adults have a predominantly black body with some yellow coloring on the abdomen and legs, and are 2.0-3.0mm long. Females have a short, pointed ovipositor through which eggs are injected into host caterpillars.



Apanteles sp.

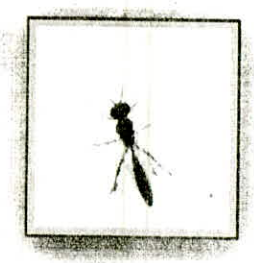
2) *Brachmeria sp.*

Adult are robust, coloration mainly black or brownish, with yellow, reddish or white markings. Head and thorax heavily sclerotized and usually coarsely and densely punctate. Antennae is 13-segmented.

Brachmeria sp.

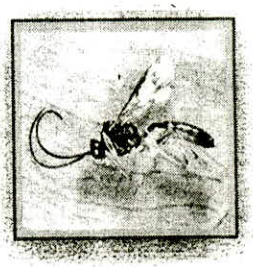
3) ***Bracon spp.***

Braconids are small wasps, rarely over 1/2 inch long, usually dark-colored with 4 transparent wings. Braconids are diverse and parasitize many insects. Some attack the host internally, others feed from the outside of a host insect.



Bracon spp.

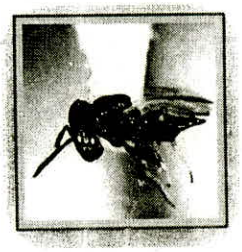
4) ***Campoletis chloridae***



Campoletis chloridae

The adult wasp is black, slender and about 1/4- inch long. The silken cocoon is white, oblong, and about 1/4 inch long. Antennae very long, with 16 or more segments.

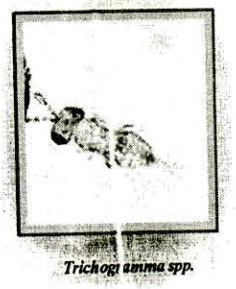
5) *Cotesia sp.*



Cotesia spp.

Cotesia adults are small (about 7 mm), dark wasps and resemble flying ants or tiny flies. They have two pairs of wings, the hind wings being smaller than the forewings, and chewing-lapping mouth parts. The antennae are about 1.5 mm long, and curved (not elbowed) upward. The abdomen of the female narrows to a downward curving extension called the ovipositor with which she lays eggs.

6) Trichogramma sp.



Trichogramma spp.

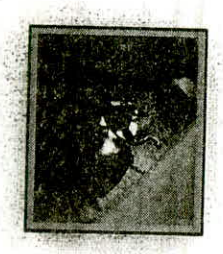
Trichogramma are extremely tiny wasps. The female *Trichogramma* lays an egg within a recently laid host egg, and as the wasp larva develops, the host egg turns black. They are extremely small - 4 or 5 will fit on the head of a pin.

7) Green lacewing

Green lacewing
Chrysoperla carnea

Adults are green to yellowish-green with four, delicate transparent wings with many veins and crossveins. Adults are about 18 mm long, with long hair-like antennae and red-gold eyes.

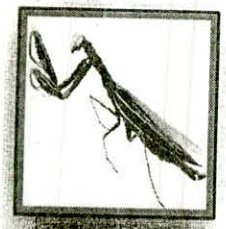
8) Lady bird beetle



Lady bird beetle
Coccinella septumpunctata

An adult ladybird beetle is oval, convex and is typically red in color with 6 black spots on each wing. They have small heads that are turned downward, short legs and their hemispheric body is about the size of 1/2 of a pea.

9) Preying mantid



Preying Mantid
Mantis religiosa

They have two grasping, spiked forelegs in which prey items are caught and held securely. The prothorax, which bears the head and forelegs, is much longer than the other two thoracic segments. The outer wings or tegmina are usually narrow, opaque, and leathery.

PRACTICAL WORK – Collect and preserve important crop pests, predator parasites belonging to different crops.

Practical No. 2

Title : Typical symptoms of damage by various phytophagous insects

Objective : To know about the typical damage symptoms of different insect pests

Insects inflict injury to plant either directly or indirectly to secure food. Almost all portions of plant *viz.*, roots, stem, bark, leaves, buds, flowers and fruits are attacked. The study of signs/ symptoms exhibited by different parts of the plant due to the damage caused by the insect pests is known as symptomatology. Based on the nature and symptoms of damage, insects can be classified into different groups as mentioned below.

1. STEM BORERS


Damage symptoms of Brinjal stem borers

Larvae enter into the stem/ tillers and feed on internal contents. As a result, damaged part is cut off from the main plant and affected part wilts, dries up and exhibits symptoms like dead heart/ white ear/ bunchy top. *Ex*: stem borers of paddy, millets, sugarcane and brinjal, *etc*.

2. SHOOT BORERS


Damage symptoms of shoot borer in Brinjal

Larvae attack tender shoots and bore inside during the vegetative stage of crop growth and cause wilting, drooping of terminal plant part which later dries up. *Ex*: shoot borers of brinjal, bhendi, cotton, castor, shoot fly of sorghum and black gram stem fly.

3. DEFOLIATORS/ SKELETONIZERS

Larvae feed on the leaves completely leaving only midrib/ veins or scrape the chlorophyll content of leaves or cause numerous holes. *Ex*: castor semilooper, red headed hairy caterpillar, Bihar hairy caterpillar, snake gourd semilooper, ash weevils, tobacco caterpillar, Brinjal epilachna beetle.

Damage symptoms of *Spodoptera* in cabbage

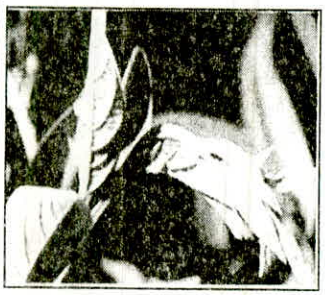
4. LEAF MINERS

Larvae mine leaves/ leaflets between the epidermal layers and feed on greenish matter, resulting in the appearance of translucent white patches/ zigzag galleries on leaves. *Ex*: leaf miners of citrus

Damage symptoms of *Leaf miner* in Citrus

5. LEAF WEBBERS

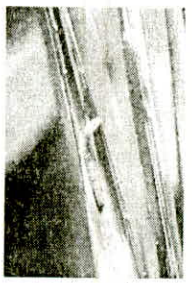
Larvae web leaves/ leaflets by means of silken threads and feed on the chlorophyll content by remaining within the web. Often faecal pellets/ frass are found within the web. *Ex*: leaf webbers on Arhar, ground nut, sapota and mango.



Damage symptoms of Arhar leaf miner

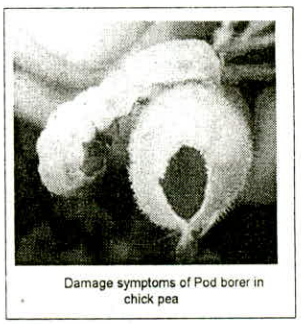
6. LEAF FOLDERS

Larvae fold leaves from tip to base/ longitudinally/ margin to margin there by giving appearance of a fold/ roll. *Ex*: rice leaf folder, cotton leaf folder.



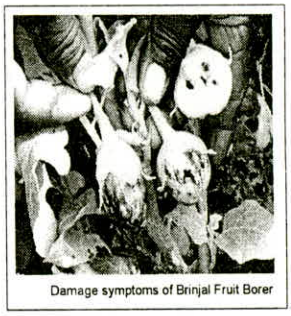
Damage symptoms of rice leaf folder

7. POD/ CAPSULE BORERS/ BOLL WORMS



Damage symptoms of Pod borer in chick pea

During the reproductive stage of crop, larva enter into the pods, capsules and feed on the seeds/ lint exhibiting symptoms like webbed condition of pods/ bolls or web few pods/ capsules with frass and excreta or holes of different sizes and shapes/ damaged tissues (chili)/ lint (cotton). *Ex*: spotted pod borer, capsule borers of castor, red gram pod fly, tobacco caterpillar, gram caterpillar, pink boll worm *etc*.

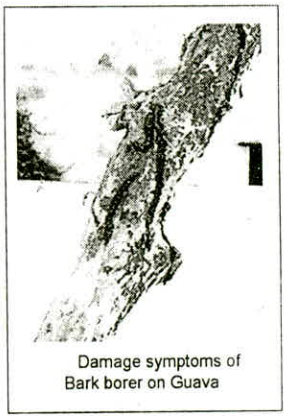


Damage symptoms of Brinjal Fruit Borer

8. FRUIT BORERS

Larvae enter into the tender fruits and feed on fresh matter/ pulp and plug the larval burrow with excreta. *Ex*: fruit borer of brinjal/ bhendi/ tomato etc.

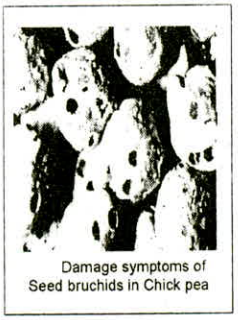
9. BARK BORERS



Damage symptoms of Bark borer on Guava

Larvae remain in a small tunnel at the axils of branches, under the bark, constructing galleries of frassy web on the stem and near bark/ angles of branches and move about, conceal inside the silken gallery and feed on the bark by scraping. *Ex*: bark eating caterpillars of citrus, mango, guava, *etc*.

10. SEED FEEDERS (STORED GRAIN PESTS)



Damage symptoms of Seed bruchids in Chick pea

Larvae feed on stored seeds either as internal/ external feeders/ by webbing the food particles. *Ex*: rice weevil, red rust flour beetle, rice moth *etc*.

SAP FEEDERS

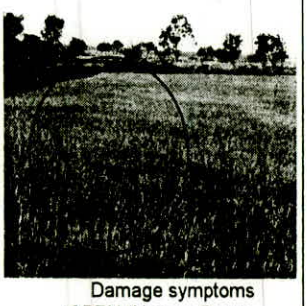
1. FROM GRAIN:

Nymphs and adults suck juice from developing ovaries/ milky grains resulting in the formation of shriveled/ chaffy grains *Ex*: rice gundhy bug, sorghum earhead bug, sorghum midge.

Damage symptoms of Rice Gundhi bug

2. FROM TENDER PLANT PARTS:

Nymphs and adults suck sap from the base of the plant/ leaves/ tender terminal plant parts/ flowers, thereby affect the vigor and growth of the plants. Different insects exhibit different symptoms. In case of severe infestation, sooty mould develops on the plant parts covered with honey dew excreted by insects while feeding.



Damage symptoms of BPH (Hopper Burn)

PRACTICAL WORK –

Examine the damage symptoms and record the insect pest from different crops.

Practical No.3

Title : Preparation of herbarium of insect damaged plant parts

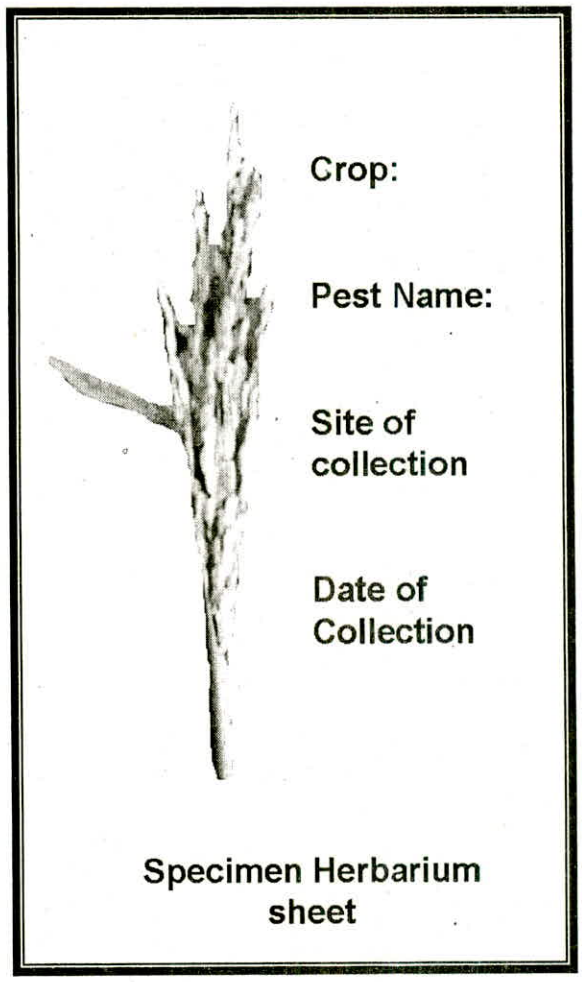
Objective : To know the standard procedure of preparation of Herbarium.

A herbarium consists of preserved plant specimens, each with a label bearing documentary information. In entomology insect pest damage plant parts as specimens are used as references for comparison and identification studies.

Mounting Herbarium Specimens

- Diagnose the correct damage symptoms of particular insect pest.
- Collect the damage plant part and bring them to lab.
- The plant part should be dried and pressed.
- Plant parts can be dried by placing them within a folded newspaper. The plant should not extend beyond the paper.
- Plant parts should be pressed carefully with the help of plant press.
- Plant parts that can't be easily pressed, such as large flowers, bulbs, fruits, cones, bark, or large-diameter woody stems, can be dried in boxes or paper bags.
- The specimen should be mounted on a 11x 17 inch herbarium sheet accompanied by a label. The label should always include at least the scientific name of the plant, Damage causing insect pest, location, collector's name and Date.
- It must have sufficient space to allow placement of a label.

- Strapping of the specimen to the sheet is strongly recommended. Strips of adhesive linen tape provide additional support for woody stems or relatively large, bulky materials such as fruits.



PRACTICAL WORK:

Prepare the Herbarium of various insect damaged plant parts.

Practical No.4

Title : Study of distribution patterns of insects in crop ecosystems

Objective : To get familiarized with distribution patterns of insects in crop Ecosystems

Study of distribution patterns of insects in a crop-ecosystem is most important to validate methods for population estimation and to understand the pest population. Information on distribution or dispersion of pest species provides a valid base for developing a sound sampling plan and gives information about behavior of the species.

The dispersion of species is influenced by social instinct such as breeding, protection against natural enemies and heterogeneity of the environment. Individuals of a population arrange themselves in a manner that is specific to each population and these arrangements in space appear to be of considerable importance in the study of dynamics of ecosystem.

DISPERSION

The manner in which members of pest population are distributed in space is the dispersion or the distribution pattern of the species. The internal distribution patterns are important which are related with some characteristics of a population. Individuals in any population may be distributed according to three basic patterns.

1. Regular 2. Random 3. Clumped / aggregated

1) REGULAR:

Such type of distribution may occur where competition between or among the insects is severe due to physical factors.

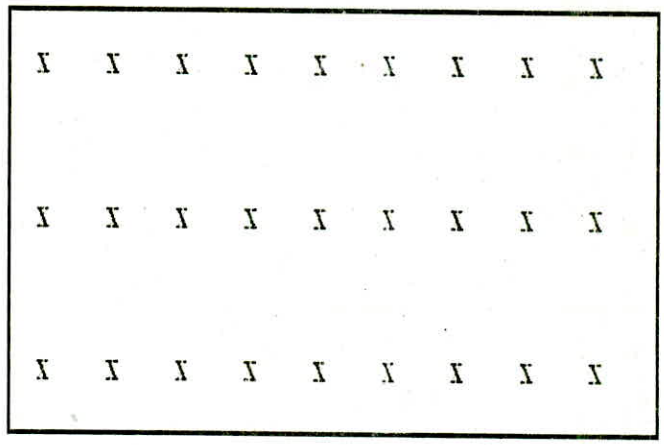


Figure showing regular pattern of distribution

2) RANDOM:

It is somewhat rare in nature and occurs where the environment is very uniform and there is no tendency to aggregate. Each insect has equal probability of occupying any point in space and the presence of one individual does not influence the distribution of another.

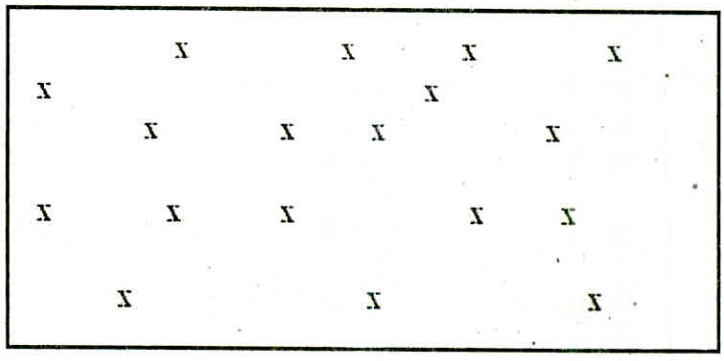


Figure showing random distribution

3) AGGREGATED or CLUMPED

This is generally most frequently observed pattern and individuals show varying degree of aggregation together due to attraction or instinct as in case of some insects.

Large scale clumping helps to evade possible danger of predation, climate or diseases. Bees are able to exist in cold climate by increasing the input of heat among them thus modifying the environments. Usually the environment decides the degree of aggregation of clumped patterns.

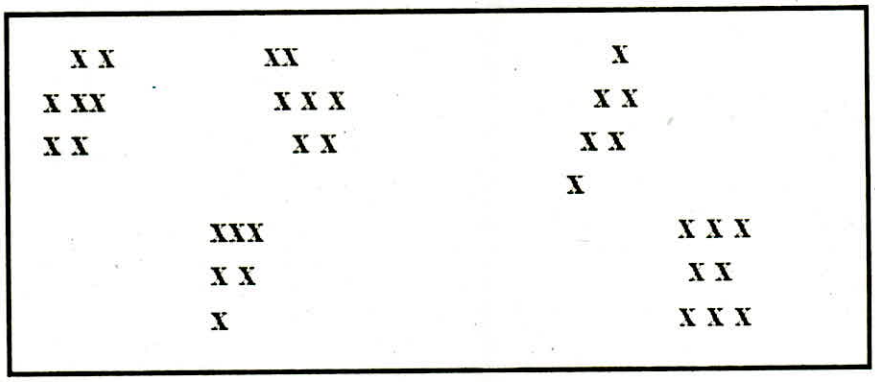


Figure showing clumped pattern of distribution

The aggregation may also be due to

1. Response of microclimatic differences in daily weather changes.

2. As a result of reproduction or social attraction

3. Characteristics of the species *i.e.* degree of sociality

Aggregation always leads to intra-specific competition for food, space and reproduction etc. The degree of aggregation as well as the overall density, which results in optimum population growth and survival, varies with species and conditions.

PRACTICAL WORK :

Workout the mean, to conclude the Distribution/Dispersion patterns of any one major insect pest of available commercial crop.

Number of Insects Per Plant	Plant Frequency (How Many Such Plants Are there)
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
>10	

Practical No. 5

Title : Sampling techniques for the estimation of insect population

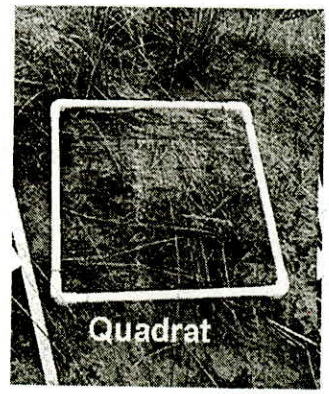
Objective : To understand sampling techniques for the estimation of insect pest population and their damage.

Estimation of Insect Population

Population studies are helpful in pinpointing the factors that bring about numerical changes in the natural population and also in understanding the functions of the life-system of the pest species. Extensive studies over a large area are needed to understand the distribution patterns of a pest population, to predict the damage it is likely to cause to initiate control measures and to relate changes in the pest population to certain climatic factors. The type of population estimation will depend on the objectives in view.

SAMPLING TECHNIQUES

1. Quadrate method



Small areas or quadrates will be chosen at random from a large area which contains the population. The area of the quadrate relative to the whole area is estimated and also population in the quadrate is known exactly. From a quadrate the insects can be counted or collected directly and their number can be correlated directly with the field population. The reliability of estimates made from this method depends on how representative the quadrates are of the whole population and how close one gets to count the numbers.

2. Line-transect method

In this method a person will walk in a straight line at a constant speed through a habitat, the number of individuals encountered can be counted. The data based on such encounters can be used in estimating the absolute population of locusts and grasshoppers. The number of encounters is influenced by the speed of person, the speed of individuals comprising the population the distance over which they can be perceived and the density of the population under studies.

3. Capture, marking, release and the recapture technique

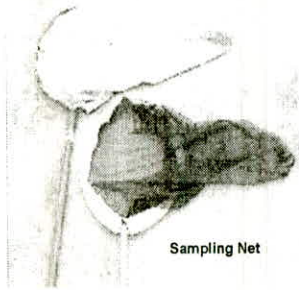
The number of flying insects can not be assessed by any of the methods described earlier. The capture recapture method can be used for these studies. The losses or gains in a population over a period can be determined with the help of this method. For the effective application of capture-recapture technique in population estimations the following conditions must be satisfied.

1. The marking of individuals should not lead to changes in their behavior or longevity and marks do not get lost easily.

2. The marked individuals after being released becomes completely mixed up with the unmarked individuals of the population.

3. The population is sampled randomly with respect to its mark status.

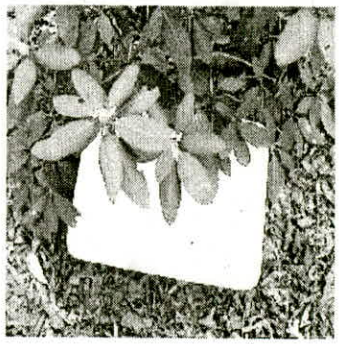
4. The method of marking should be such as to distinguish between different dates of capture.



Sampling Net

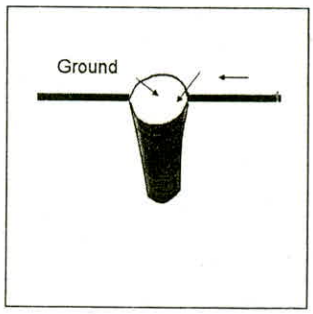
4. Sweep net sampling

Collections of flying insects, or those inhabiting foliage, can be made using a sweep net. Several types of nets are available, with standard sizes being either 30.5 cm (12 in) or 38 cm (15 in) diameter. Aerial nets (net on the right) have an open mesh collection bag and are used mainly to capture flying insects, although they can be swept through light vegetation such as tall grass.



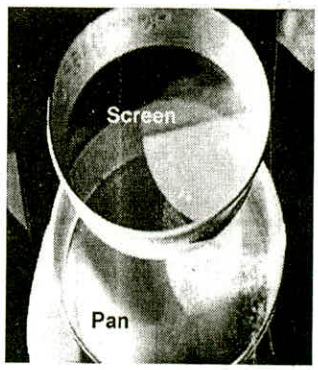
5. Shake or beat sampling

Another technique used to collect insects from foliage is to place a shallow light colored pan, or piece of cardboard, beneath the foliage, and then either roughly shake or strike the foliage, to dislodge insects in the collection pan. To sample low growing plants, a canvas sheet can be placed on the ground under the foliage and the plants shaken over the cloth. Collected insects can be counted alive in the pan, or placed in a container with a piece of paper towel soaked with non-acetone nail polish remover to kill them to facilitate counting.



6. Pitfall trap sampling

Pitfall traps are a survey technique used to assess populations of insects and other arthropods living on the ground surface. Typically, traps are set up and allowed to collect arthropods for a minimum of 24 hours. The basic trap consists of a container set into the ground so that the upper rim is flush with the ground surface. Since many insects are predators and will eat other insects in the trap, a solution to kill and preserve insects entering the trap is used.



7. Screening method

It is the simplest method of sampling. It is basically used against stored grain pests. It can be done by using a specialized pan with 1/12-inch holes and a bottom pan without holes to catch insects that fall into the bottom pan.

PRACTICAL WORK :

Visit the nearby crop field, observe and record the populations of available insect pests, their nature and extent of damage.

Practical No. 6

Title : Assessment of crop losses caused by Insect pests
Objective : To identify the damage and estimate crop losses caused by major insect pests

A species that interferes with activities of plant and cause damage to yield is known as pest. Estimation of crop losses caused by insects to economic crops are exceedingly difficult because,

1. They variable in nature of damage.
2. Insect population fluctuates both in time and space.

The nature of damage caused by insect pests of crop plants is a function of pest population. So it is mostly insect capacity to increase in number rather than the nature of damage.

The following four points should be kept in view to estimate the losses.

1. Any insect which cause some kind of the damage to crop can become pest when its population increase above a critical level. The critical level depends upon the nature of the damage caused by the insect.

E.g. In case of leaf feeders, the leaf eaten is near index of the losses caused by caterpillars. In case of insect vectors of virus of disease a very small population of infective individuals can spread the disease to whole crop.

2. The losses caused vary both in time and space from 0 to 100%.The estimation is fairly easy at these two extremes, but there are large numbers of factors which tend to invalidate any estimation in between these extreme limits.

3. The loss may be either quantitative or qualitative. In case of quantitative loss reduced yield is observed, where as in qualitative loss, quality may be affected. E.g. In case of wheat bug (*Eurygastor integriceps*) is known to affect adversely the baking quality of wheat.

4. Insect losses in terms of money are also objected. That the selling price of the commodity would be reduced, if insect infestation were to be greater extent. The measures generally followed for estimating the losses caused by insect pests are based on either growing a crop as free from insect infestation as possible and then comparing its

yield with that of check crop in which insect activity has been normal, or by making use of differential infestation and comparing the yield. The above ones are used in the following methods for estimating the crop losses.

The methods are as follows,

1. Protection of crop from insect pest damage through mechanical barriers
2. Protection of the crop by application of chemicals .
3. Comparison of yields in different fields having different degrees of pest infestation
4. Relative comparison of average yield of healthy plant with infested plants
5. Abundance of natural enemies.

1. Protection of crop from insect pest damage through mechanical barriers

The crop is grown under the enclosures of wire gauze or cotton cloth. These enclosures keep the pest away from the crop. Then, the yield of crop under such enclosures is compared with the yield obtained from the infested crop under similar conditions. This technique has been used with that various modifications for estimating the losses caused by leafhoppers and whitefly to cotton.

2. Protection of the crop by application of chemicals

The crop is protected from pest damage by best scheduled chemical recommendation of pesticides. Then, the yield of treated crop is compared with that subjected to normal insect infestation. This technique has been very widely used and it can be adopted on a large scale in cultivator's field.

3. Comparison of yields in different fields having different degrees of pest infestation:

The yield is determined per unit area in different fields having different degrees of pest infestation. The correlation between the yield and degrees of infestation is worked out to estimate the loss in yield.

4. Relative comparison of the average yield of healthy plants with infested plants:

In this process individual plants from the same field are examined for the pest incidence and their yield is determined individually. The loss in yield is estimated by comparing the average yield of healthy plants with that of plants showing different degrees of infestation.

5. Abundance of Natural Enemies:

The manipulation of natural enemies of a pest species offers a means of evaluating plant damage. This technique has not been widely used. The pest is controlled by introducing predators or parasites into the field and the yield of such crop is compared that on which no such pest control measures have undertaken. This method is feasible only in small plots and is not practicable on field.

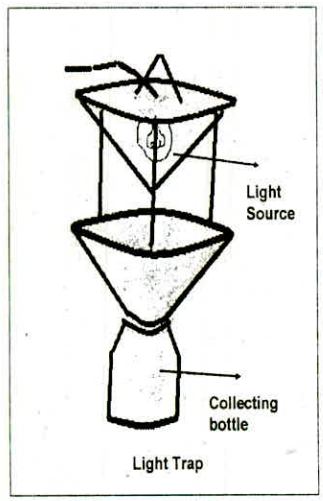
PRACTICAL WORK : Calculate the crop losses caused by any major insect pest.

Practical No. 7

Title : Pest surveillance through light traps and pheromone traps

Objective : To understand the concept of insect pest surveillance through light and pheromone traps

LIGHT TRAPS:



Light Trap

Light acts as a source of attraction for some insects has been deployed to catch insects in suitable traps. Most of the insect species are nocturnal and are positively phototrophic. The phototrophic behavior is altered and modified by temperature, humidity, moisture etc. this phenomenon has been utilized by the entomologists to capture adult insects in a device called light trap. In agriculture, light traps are important tools in insect ecological research and pest management. They are used for the following purposes.

- Determining the presence or absence of insect species in an area.
- Obtaining quantitative estimates of population density, species composition, age and sex.
- Providing early warnings of crop infestation and oviposition.
- Determining economic threshold levels to assist insecticide application.
- Suppressing population to help managing the pest.
- Detecting migration.
- Collecting specimens for taxonomic purposes or for establishing laboratory cultures.

An ideal light trap should be cheap, durable and robust. It should be serviced easily by personnel of little training, should be highly efficient and attract a large number of insects of different species.

Trap design : Light traps vary in design but generally consist of three components *viz.*, 1) a light source 2) arrangement of baffles around the source 3) a catch container with a killing agent.

1. Light Source : Various types of light sources have been tested and used. Numerous studies have shown that the shorter visible and near ultraviolet wavelengths between 320-600 nm are most attractive to a wide variety of insects. The most efficient sources are the mercury vapor lamp and fluorescent tubes.

2. Baffles : Most light traps are fitted with baffles, which surround the bulb. They are often four, arranged perpendicular to each other to help retain these insects and thus greatly increase the catch of a trap. They may be made from an opaque material such as galvanized iron, or from a transparent material such as acrylic.

3. Container : In most traps, insect attracted to light fall into a funnel fixed below which opens into a killing and holding container. Dichlorvos is commonly used as a killing agent. Kerosene and water mixed with some detergent also serve as killing agent in many local light traps.

Some of the commonly used light traps are

- The Chinsura light trap
- Robinson trap
- Bamboo light trap
- Mercury vapor lamp

- Modified Robinson light trap
- Rothamsted trap
- The Pennsylvania and Texas trap
- The new Jersy trap
- The aquatic light trap
- Incandescent lamp

Advantages :

1. Both male and females are attracted and there is possibility of using them as a control measure.
2. It is an eco-friendly measure of control since it is non-insecticidal.
3. It is compatible with any other methods of control in IPM.
4. It is simple, cheap and can be handled even by a less trained person.
5. Technical know-how requirement is less except that identification of desired target species is essential.

Disadvantages :

1. Beneficial non target insect species may also be trapped.
2. Light trap data vary with the weather conditions as well as moon light phases.
3. Expensive and bulky.
4. Availability of power source restrict trap installation.
5. It is not specific to a particular species of insect and therefore cumbersome to work with mixtures.
6. It should be operated in a large area and useful for strong flying insects.

PHEROMONE TRAPS:

Pheromones are semiochemicals that are secreted into the external environment by insect which elicit a specific response in receiving individuals of the same species. These chemicals are also called as ectohormones. Pheromones are identified by extracting them from the insects and later synthesized artificially. The synthesized product is then impregnated in rubberized septa and used in integrated pest management. Pheromones are used in integrated pest management (IPM) programmes for,

a) Population density surveys

b) Forewarn regarding outbreaks of important insect pests

c) Male confusion – Mating disruption

Pheromones have greater direct behavioral control usefulness in surveys to determine the presence/abundance of insect species so that other control measures can be exercised. Several models of pheromone applications and traps are available.

Modes of Pheromone Application:

1. **Rubber septa – sulphur free**

2. **Hollow fibers:** Small thermo-plastic tubing sealed at one end & filled with pheromone. Pheromone release depends on evaporation through open end . Effectiveness is controlled by adjusting the length.

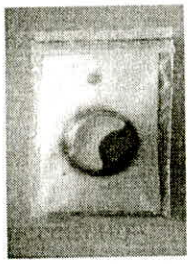
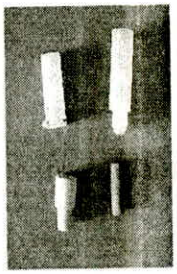
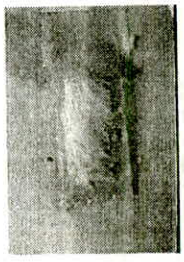
3. **Twist tie ropes:** 15 cm long plastic tube containing pheromone sealed at both ends is attached to crop manually. High concentration of pheromone provides relatively long persistence of release.

4. **Laminated flakes:** Two layers of vinyl sandwiching central porous layer with pheromone. Flakes are applied with sticker and thickening agent through special

equipment or by hand. Emission rate from flakes controlled by layer thickness & chemical concentration.

5. Micro capsules : Micro encapsulation of small drop lets of pheromone done by using polymer can be easily manufactured on large scale. Readily applied over a large area with conventional sprayers.

Different modes of Pheromone

1. Laminated flake lure 2. Rubber septa and poly vials 3. Short fiber lure

Types of Pheromone Traps:

1. **Delta trap :** It is a rigid and durable plastic trap using a replaceable sticky insert. The insert on its top consists of a non-drying adhesive. It can be removed by opening one end of the trap. Pheromone lures are placed in the centre of the sticky inset. Catch inspection is possible without the need for dismantling the trap. The dispensers and sticky inserts should be replaced every six weeks. Traps should be inspected once in every two to three weeks.

2. **Funnel trap :** Robust trap made of moulded plastic with a large base and removable cap, for housing a pheromone dispenser. Kits may be supplied with an optional killing agent (insecticidal strip) or an insecticidal spray may be used inside the trap for control purpose. Flying insect pests are lured into the trap by the pheromone attractant. Insects once enter the trap, unable to escape and are exposed to the insecticidal strip.

3. **Probe trap :** This is used in grain storage silos. It is an acrylic cylindrical tube with small angled holes drilled on the upper 2/3rd of its length. Lower part of the tube contains a removable collection tube. At the top of the trap, there are two holes to pass a card to fix a marker, which lies on the to of the grain. The tap is vertically buried in the grain 0.5 to 1 m below the grain surface. The trap should be kept at 10-35 m distance. The crawling insects enter the tap through holes and fall into the specimen tube through funnel. The collection tube is coated with a substance, which prevents insects from crawling out.

4. **Omni directional pheromone trap** : It is exclusively used for monitoring *Earias*. It consists of an aluminium vessel of 30 cm diameter. Holes are provided on the sides of vessels. The trap contains a septum on the inner side and hung in the field.

Advantages of pheromones in pest control :

1. Pheromones are safe to environment.
2. They are species specific.
3. They are safe to natural enemies.
4. Pheromones need small doses.
5. Compatible with other pest management programmes.
6. They are economical than other control techniques.

Disadvantages :

1. Basic behavior of most of important insect pests like pheromone reception, migration *etc*. was not fully understood.
2. The pheromones of a few insects were only identified, a large number of them are to be identified.

3. If the crop is affected by more than one pest and when pheromone trap is placed for major pest, there are chances of secondary pest outbreak.

PRACTICAL WORK :

1) Draw neat labeled diagrams of different light and pheromone traps.

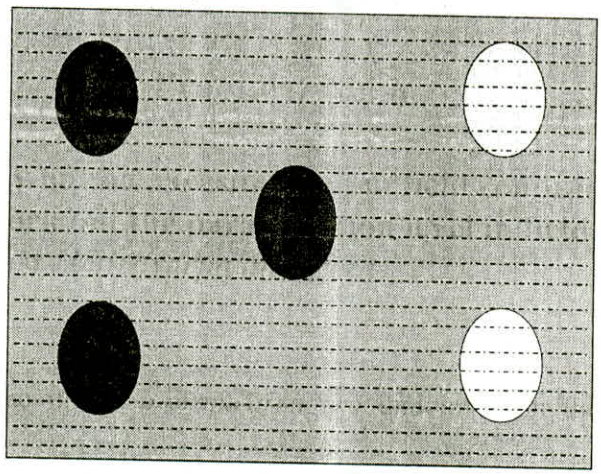
2) Record populations of known insects trapped in the light/pheromone traps.

Practical No. 8

Title : Study on the parasitization in field condition
Objective : To work out the parasitization level in field condition against *Helicovarpa armigera*

Procedure:

1. Collect the larvae of *Helicoverapa armigera* randomly from the areas of field representing the whole field.(As shown in Figure)



2. Count the total number of larva collected from field.
3. Separate out the healthy and parasitized/infected larvae.
4. Follow the collection of larvae on weekly interval from same field.
5. First and second instar larvae parasitized by *Campoletis chloridae*

   i.e. First week

   Second week

   Third week and

   Fourth week

   Percent parasitization can be calculated by following formula

$$\% \text{ Parasitization} = \frac{\text{Total no. of infected larva}}{\text{Total larva (Healthy+Infected)}} \times 100$$

Sr. No.	Month	Week	Total larva	Infected larva	% Parasitization

6. Plot the time period on X axis and percent parasitization on y axis and plot the graph
7. Interpretation of the results.

PRACTICAL WORK

Calculate the percent parasitization in *Helicoverapa armigera* in any major crop at field condition.

Practical No. 9

Title : Determination of economic injury\ level
Objective : To work out the economic injury level of major pests

Material required: following materials are required for the calculation of EIL.

- Crop
- Treatments (Recommended Insecticides) for examples Dimethoate 30EC
- Water, Sprayer etc.
- Cost of plant protection (Rs/ha)
- Price of produce (Rs/Kg)

Layout and Randomization of experiment:

R1	R2	R3
T1	T6	T3
T2	T5	T1
T3	T4	T7
T4	T3	T6
T5	T2	T4
T6	T1	T2
T7	T7	T5

Treatments details:

No. of treatments: 7

T1= Six spray of Insecticide (Dimethoate 30EC)

T2= Five spray of Insecticide (---------"----------)

T3= Four spray of Insecticide (---------"----------)

T4= Three spray of Insecticide (---------"----------)

T5= Two spray of Insecticide (---------"----------)

T6= One spray of Insecticide (---------"----------)

T7= untreated control (water spray)

PROCEDURE

- The experiment should be conducted in Randomized Bock Design with seven treatments including untreated control, replicated thrice for the determination of Economic Injury Level.
- Treatments in which the number of sprays (weekly) is ranged 6 to zero. Accordingly, the crop exposed to pest infestation for different periods ranging from zero to 42 days when the crop not treated with any insecticide.
- Seven exposure periods of pest infestation should be maintained by spraying of insecticide at weekly interval.
- Treatment having 42 days exposure to pest is considered as untreated control having no insecticide application. Spraying of insecticide should be start just before the appearance of pest at particular stage of the crop for particular pest.
- The quantum of pest infestation under complete protection will be treated as unavoidable losses. Details of treatments, Number of sprays and exposure period against pest are given as below:

Treatments	No. of sprays	Exposure periods (days)
T1	6 (unavoidable losses)	0
T2	5	7
T3	4	14
T4	3	21
T5	2	28
T6	1	35
T7	0	42

- Pest infestation on ten plants per replication of each treatment should be observed by counting the total and infested parts of each plant.
- The seed yield will be recorded at harvest and thus, the data obtained on pest infestation as well as seed yield will compute for their critical differences.
- The data on percent infestation recorded on different dates should be transformed. Linear regression model will be established between pest and seed yield on mean basis.
- The economic injury level of pest infestation can be determined as suggested by Stone and Pedigo (1972).

For example we will consider the bud fly of linseed

1. Percentage of bud fly infestation = $\frac{\text{Number of infested part}}{\text{Number of healthy + infested parts}} \times 100$

2. Linear regression model – "$y = a \pm bx$" for yield / infestation relationship

Here,

y = Yield of linseed in kg/ha

a = Constant

b = Regression coefficient, and

x = Percentage of bud infestation

$$\text{Gain threshold} = \frac{\text{Cost of Plant Protection (Rs/ha)}}{\text{Price of Produce (Rs/Kg)}}$$

$$\text{Calculated EIL} = \frac{\text{Gain threshold}}{\text{Regression coefficient}}$$

$$\text{Actual EIL} = \text{Calculated EIL} + \text{Unavoidable loss}$$

PRACTICAL WORK

Work out the EIL of any major pest

Practical No. 10

Title : IPM in rice and pigeon pea

Objective : To know the different IPM tactics being used in crop protection with special reference to rice and pigeon-pea crops.

IPM is a systematic approach to pest management that focuses first on preventing problems. It involves monitoring pest populations, identifying pests and choosing a combination of tactics to keep pest populations below ETL. Tactics may include cultural, mechanical, biological and chemical methods of pest management. IPM always focuses on trying the least toxic methods first.

IPM IN RICE

CULTURAL METHODS

Paddy Stem borers

1. Follow summer ploughing to expose resting stages of insects to heat of the sun and predators.
2. Grow stem borer resistant/tolerant varieties *viz.*, Khandagiri, Ghanteswari, Udayagiri, Lalitagiri, Sidhant, Konark, Kharvela, Gajapati, Surendra, Pratikshya, Manika, Ratna, Sasyasree, Vikas etc.
3. Destruction of stubbles after the harvest decreases the carry over to next crop should be followed.
4. Harvest the crop close to the ground.
5. Avoid high dose fertilizer (use the recommended dose).
6. Trap cropping with Basmati rice in transplanted rice (9:1 ratio).

BPH/WBPH/GLH

1. Close planting creates favorable micro climate for rapid development of hopper population. Hence spacing of 20 x 30 cm should be followed.
2. Alternate drying and wetting of field during peak infestation and drain standing water from the field checks hopper population.

3. Use resistant/tolerant rice cultivars e.g. Lalat, Sebati, Konark, Surendra, Tapaswini, Meher, Vijeta, Durga, Rambha, Kanchan, Kanaka, Karthika, Sonasali, Manasarovar, Co42, Rashmi, Jyothi etc.
4. Strict surveillance of rice fields for pests and defenders (mired bugs and spiders).

White-backed planthopper

Use resistant/tolerant varieties like Ramachandi,Mahanadi, Prachi or Indravati, HKR 120 etc

Green leafhopper

Use resistant/tolerant varieties like Heera, Pathara, Badami, IR-36, Navin, Lalat, Rambha, Kanchan, Parijat, Srabani, Moti,Tulasi, Nidhi, Vikramarya etc.

Leaf folder:

Remove grass weeds from bounds around paddy field.

Rice Hispa:

Nursery bed are flooded, the beetle float and can be collected at a corner of nursery and destroyed.

Gall midge

Growing tolerant/resistant varieties like Heera, Ghanteswari, Lalitagiri, Jogesh, Sidhant, Sebati, Bhoi, Gouri, Samalei, Konark, Kharavela, Lalat, Gajapati, Surendra, Jajati, Meher, Vijeta, Pratikshya, Manika, Savitree, Uphar, Sneha, Kavya, Ruchi, Asha,Vikram, Kunti, Daya Pratap, IR36,Phalguna etc.

Case worm:

Do not allow standing water in the field. Drain out standing water.

MECHANICAL CONTROL

Stem borer / Leaf folder

1. Light trapping of adult help to reduce pest population.
2. Pheromone for stem borer-Monitoring 3 traps/ acre at distance of 60 m in triangular pattern in rice field Mass trapping- 8 traps per acre at distance of 20 X 25 m.
3. Setting up of bird perches @ 20-25/ha.
4. Setting up of pheromone traps for YSB @ 20-25/ha.

5. Dragging a rope across the field to dislodge larvae of leaf-folder to kerosenized water in the field.

Gundhi Bug:

Keep fermented snail or crab bait @ 20-25/ha to attract and divert pests from sucking milk of rice grain.

Case worm

Dragging a rope across the field to dislodge larvae of case worm to kerosenized water in the field.

BIOLOGICAL CONTROL

Paddy Stem borers

- Release of *Trichogramma japonicum* against YSB @ 1 lakh / ha starting from 15 days after planting (DAP) at 7-10 days intervals 5-6 times.
- Spraying of *Beauveria bassiana* product (Boverin, Biopower, Ankush, Daman, Biorin) @ 1kg/ha against YSB.
- Spraying of *Bacillus thuringiensis* (*Bt*) based biopesticides available in the market (Dipel, Delfin, Biodart, Thuricide, Bioasp, Biolep, HIL *Btk*) @1kg or 1lit/ha.

Leaf folder

- Release of egg parasitoid *Trichogramma chilonis* @ 1 lakh / ha starting from 15 Days after planting (DAP) for 5-6 times at 7-10 days intervals.
- *Bacillus thuringiensis* (*Bt*) based commercial bio-pesticides may be sprayed @1kg or 1lit/ha (Dipel, Delfin, Biodart, Thuricide, Bioasp, Biolep, HIL *Btk*) at 7-10 days intervals in the evening hours.

BPH

Conserve Mirid bug which are predator of egg and nymph of hopper.

CHEMICAL CONTROL

Paddy Stem borers

- Seed treatment with fipronil (Regent) @ 25g/kg seed.
- If the pest crosses economic threshold level (ETL) i.e.5% Dead heart (DH) or 1 egg mass per m^2 then apply cartap hydrochloride 4G @ 20kg/ha or fipronil 0.3G –25kg/ha or

phorate 10G @ 10kg/ha or carbofuran @ 33 kg/ha or carbosulfan 6G @ 16Kg/ha in the main field.

BPH

- When BPH population crosses ETL (5-10 insects/hill) apply any of the following insecticides as foliar spray (thiamethoxam – 100g/ha, imidacloprid –125ml/ha, ethiprole 10EC – 500ml/ha, clothianidin 50WDG – 60g/ha, bifenthrin (Talstar) 10EC -250ml/ha, BPMC (Fenobucarb) 50EC –1lit/ha, buprofezin 25%WP (Applaud, Buprolord) – 300 to 500ml/ha) or imidacloprid 0.2G – 25kg/ha in the main field.
- Foliar spraying of NSKE @ 5% or neem oil 0.5% or neem based commercial pesticides 300ppm @ 2.5lit/ha (Margocide OK 80%EC, Achook, Nimbicidine, Bioneem, Neemark, Neemgold, Neemax, Rakshak, Econeem, Limonool, Repelin, Ozoneem Trishul, Multineem etc.).

WBPH

When WBPH population crosses ETL (5-10 insects/hill) apply any of the insecticides as suggested in case of BPH.

GLH

When GLH population crosses ETL (5-10 insects/hill, 2 insects / hill in Tungro endemic areas) apply any of the insecticides as suggested in case of BPH.

Ghandi Bug:

Dust 5 % Malathion or 5 % Carbaryl @ 25 kg/ ha 15 days after panicle emergence.

Leaf folder

1.Spray insecticide at economic threshold level of 10 % damage.

2.cartap hydrochloride 50 SP – 500g/ha or fipronil 5 FS –1 kg/ha or 0.12 % Fenetrothion 50 EC (2.4 ml/ liter water), 0.2 % Carbaryl 50 wp (4 ml/ liter water) or 0.1 % Monocrotophos 36 EC (2.7 ml/liter water) or 0.15% Chlorpyriphos 20 Ec (7.5 ml/liter water)

3.Foliar spraying of NSKE @5% or neem oil 0.5% or neem based commercial bio-pesticides 300ppm @ 2.5lit/ha or 1500 ppm @ 1.5lit./ha.

Gall midge

• When the pest crosses ETL i.e. 1 silver shoot (SS)/m2 in endemic and 5% SS non-endemic areas then go for chemicals described for stem borer management. Besides, imidacloprid spray @ 125ml/ha is also effective.

• Sprouted seed soaked with imidacloprid 200SL @ 0.05%(2.5ml/lit) for 3 hours – then shade dried and broadcasted on raised nursery bed give protection against gall midge.

Rice hispa

Application of Phorate 10 G in nursery minimises infestation or spray 0.1 % Monocrotophos 36 EC (2.7 ml/liter water) or 0.15% Chlorpyriphos 20 EC (7.5 ml/liter water) 0.2% quinalphos 25 EC (8 ml/ liter water).

Case worm

When the pest crosses ETL i.e. 1-2 cases/hill give foliar sprays with monocrotophos / chlorpyriphos 50% + cypermethrin 5% @ 1lit./ha.

Gundhi Bug:

When the pest crosses ETL i.e. 1 bug/ hill then give spray with carbaryl – 2 kg/ha or abamectin – 500ml/ha or phosphamidon 40SP–1 lit/ha or dusting with malathion 5%D @ 25kg/ha.

Swarming caterpillar (Army worm): Climbing cut worm:

If the population is less than 1 larva/hill then

1. spray with *Beauveria bassiana* product (Boverin, Biopower, Ankush, Daman, Biorin) @ 1kg/ha or
2. *Bt* based biopesticides available in the market may be sprayed @1kg or 1lit/ha or
3. Give foliar spraying of NSKE @5% or neem oil 0.5% or neem based bio-pesticides 300ppm @ 2.5lit/ha or 1500 ppm @ 1.5 lit/ha.
4. When the pest crosses ETL i.e. 1 larva/ hill then spray with chlorpyriphos / triazophos/ profenophos –1 lit/ha and dust the field bunds heavily with methyl parathion 2%D, chlorpyriphos 1%D, malathion 5%D, quinalphos 1.5%D - 25 to 30kg/ ha.

Termite

Management:

1. Locate the termintorium and destroy by pouring Chlorpyriphos solution into termintorium.

2. Seed treatment with Chlorpyriphos 0.5- 1 kg/ 100 kg seed.

3. Seedling dip with Chlorpyriphos.

4. Application of Chlorpyriphos 10 G granules @ 7.5 kg/ ha.

TRADITIONAL METHODS OF INSECT MANAGEMENT

1) Pour kerosene on a flooded field and drag a rope across the foliage bending it into kerosene film on the water. The insects dislodge into the oil and get killed. And the filed are drained off after 6 (six) hours to prevent phytotoxicity. In this method beneficial insect also get killed.

2) Placing a rotten frog/ dry fish in the filed during milky stage, the foul smell of these attract bugs and keep busy on feeding carcass.

3) To control termite in the field some farmers cut approximately 5 kg each of *calotropis* and Kheemp (*Leptadenia pyrotechnica*) twigs into small pieces and put them in an earthen pot. Then add 1 kg salt and 10 ltr water/cow/human urine. The pot is kept in a pit for 15-20 days. The suspension is filtered through cotton cloth and filtrate is applied as an insecticide @ 10 ltr/ha in irrigation channel.

4) Paddy at grain filling stage when infested with swarming caterpillars, cooked rice mixed with sheep blood is broadcasted. These rice halls attract birds to the paddy field and they pick up these caterpillars thus controlling pest.

5) To prevent leaf folder attack in paddy and ragi, sand is sprayed on the leaves that are wet with fog, so that sand sticks to the leaves. This sand prevents the larva from attacking the crop and feeding on the leaves. The sand also abbreviates the skin of the larvae and causes desiccation and death of the larvae.

6) A new method of protecting paddy from the brown plant hopper has been developed by aprogressive organic farmer of Karnataka. At night time, two torch lights are beamed in a 'v' shape in the centre of the paddy field. The person holding the torches walks from the centre to the edge of the field. The insects are attracted to the light and attempt to follow it. Thus, they leave the paddy field. This process is repeated for two to three days in succession and the population of BPH is reduced.

6) Brown plant hopper and green leaf hoppers can also be controlled by lightning fire on the field bund in the evening. The above pests are attracted by the light and are killed in the fire.

IPM IN PIGEON PEA

CULTURAL CONTROL

Pod Borer *(H.armigera)*

- Deep summer ploughing to expose the pupae.
- Sowing should be done by the end of June to avoid pod borer attack.
- Remove the weeds from the field.

Intercropping of early maturing pigeon pea with mungbean in alternate and paired row results in low infestation of pod borer.

Maize / Turmeric 4: 2 ratio

Mungbean /urdbean 1:1 ratio

Sorghum / Millet 1:1 ratio

- The varieties Bahar and Sharad should be grown
- Gujarat Tur-100 and Jawahar Arhar - 4 tolerant to Pod border can be adopted

Plume moth (*Exelastis atomosa*)

Timely sowing of the crop will reduce the damage of plume moth.

Adoption of mixed or intercropping with non host plants.

Maintaining complete field sanitation.

Do not repeat sowing of pigeon pea crop in same field.

Pod fly (*Melanagromyza obtusa*)

Intercropping with jowar, maize or groundnut etc.

Crop rotation should be followed

Gujarat Tur-100 and MA - 3 (Malviya Vikalp) tolerant to Pod fly can also adopted

Spotted pod borer (*Maruca testulalis*)

Timely sowing should be done preferably up to first quarter of July.

Excess application of nitrogen should be avoided.

Water logging should be prevented.

BIOLOGICAL CONTROL

H. armigera

Bt formulations @ 1 kg/ha, or HaNPV @500 LE / ha

Use of NPV at 500 LE with adjuvant like teepol, tinopal and jaggery etc.

Applying HNPV at a rate of 500 larval equivalents (LE) per ha.

This application can be repeated at 15-20 days intervals.

Plume moth (*Exelastis atomosa*)

Spraying of NPV 625 LE/ha with adjuvants (Tinopol 0.1% + Jaggery 0.5%)

Pod fly (*Melanagromyza obtusa*)

Conserve Ormyrus sp (parasite of pod fly).

Spotted pod borer (*Maruca testulalis*)

Conserve ants and praying mantids as these are good predators of egg and larva of the pest.

MECHANICAL METHODS

Erection of bird perches @ 25/ha for facilitating predation of *Helicoverpa* larvae.

Monitoring Pheromone

- Helilure Pheromone trap @ 10 / ha should be maintained.
- In cases of heavy infestation, physical shaking of pigeon pea plants to dislodge larvae is favored.
- Bird perches placed just above the crop canopy will also help to reduce the population of the pest. T shaped bird perches@ 50/ha

Plume moth (*Exelastis atomosa*)

Remove and destroy the damage plant parts.

Mylabrus postulata

Chemical control may fail because the beetles are large and robust, and highly mobile. Manual picking and destruction of adult blister beetles is often the only practical control measure.

CHEMICAL METHODS

Green pod borer (*Etiella zinckenella*)

Apply chemical insecticide only if the pest population crosses ETL.

Spraying of endosulfan 35 EC 0.07% (2ml of 35 EC/lit. of water) or monocrotophos 36SL 0.04% (1 ml of 36 SL /litre of water) or chlorpyriphos 20 EC @ 3.5 ml/lit. of water at 600-1000 lit. of spray material per ha. with hand sprayer.

Plume moth (*Exelastis atomosa*)

Spraying of the suitable insecticides should be done at 50% flowering stage to protect the crop from the moth and larva.

Spray monocrotophos 36 SL at the rate of 1l/ha.

First spray of profenofos 50 EC @ 2ml / l of water + @ 2ml / l of water.

Second spray of indoxacarb 14.5 SC @ 0.4 kg/ha spinosad 45 SC @ 73 g a.i./ ha

Pod fly (*Melanagromyza obtusa*)

Spary monocrotophos @ 36 SL @ 1 ml/lit of water at 50 %

flowering stage and after 10 - 15 days neem seed kernal extract should be used.

Spotted pod borer (*Maruca testulalis*)

Apply chemical insecticide only if the pest population crosses ETL.

Spraying 0.04% monocrotophos (1 ml of 36 Sl /litre of water) or chlorpyriphos 20 EC @ 3.5 ml/lit. of water at 600-1000 lit. of spray material per ha.

Pod borer

Two applications of NSKE 5% in September and October.

Spray of Ha NPV @ 500 L.E. (1.5 x 1012 POB) / ha in September and October.

Stem fly: *Ophiomyia phaseoli*

Soil application of carbofuran 3G @ 15 kg/ha at sowing.

Spray Imidacloprid 70 % WG 500 ml/ha a week after germination and second round 10 days after first round or NSKE 5%.

Management of sucking pests

- Shaking the infested plants over the vessels of oil and water or oily cloth gives most effective
- Dusting of Imidacloprid @ 25 kg/ha
- Spray methyl demeton 25 EC 500ml or dimethoate 30 EC 500 ml or phosphomidon 85 WSC 250 ml/ha.

Management of pod borer complex

- Deep summer ploughing in 2-3 years to eliminate quiescent pupa.
- Early sowing, short duration varieties.
- Avoid closer plant spacing.
- Grow tall sorghum as comparison crop to serve as biological bird perches
- Collect and destroy larvae and adults to the extent possible
- Install pheromone traps at a distance of 50 m @ 5 traps/ha for each insect pest.
- Install Bird perches @ 50/ha.
- Setting of light traps (1 light trap/5 acre) to kill moth population.
- Control is achieved by releasing of *Trichogramma chlionis* at weekly intervals @1.5 lakh/ha/ week for four times.
- Conserve green lacewing, predatory stink bugs, spider, ants
- Application of NPV 250 LE /ha with teepol 0.1% and Jaggery 0.5% thrice at 10 – 15 days interval commencing from flowering stage. (Note: Insecticide / Ha NPV spray should be applied when the larvae are in early stage).
- Bt @ 600 g, neem oil/ pungum oil 80 EC @ 2ml/lit
- Spray NSKE 5% twice followed by triazophos 0.05%.
- Spray the crop at ETL 10% affected parts
- Spray insecticides like Carbaryl 10% DP (or) Quinalphos 25 EC @ 1000 ml/ha.

CITATIONS

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