

Course code: ENT-401

Course title: Applied Entomology

Credit hours: 3(2-1)

Course contents

THEORY

Introduction; causes of success and economic importance of insects; principles and methods of insect control i.e. cultural, biological, physical, mechanical, reproductive, legislative, chemical and bio-technological control; introduction to IPM; insecticides, their classification, formulations and application equipments; identification, life histories, mode of damage and control of important insect pests of various crops, fruits, vegetables, stored grains, household, termites and locust; entomological industries: apiculture, sericulture and lac-culture.

PRACTICALS

Collection, identification and mode of damage of insect pests of various crops, fruits, vegetables, stored grains and household; insecticide formulations, their dilutions and safe handling; use of application equipments, practicals instructions in apiculture, sericulture and lac-culture.

BOOKS RECOMMENDED

1. Atwal, A.S. 2005. Agricultural Pests of Southeast Asia and their Management.

Kalyani Publishers, Ludhiana.

2. Awastheir, V.B. 2009. Introduction to General and Applied Entomology. Scientific

Publisher, Jodhpur, India.

3. Duncton, P.A. 2007. The Insect: Beneficial and Harmful Aspects. Kalyani

Publishers Ludhiana.

4. Lohar, M. K. 2001. Applied Entomology, 2nd Ed. Discipline of Entomology, Sindh

Agriculture University Tandojam Sindh, Pakistan.

5. Mathews, G.A. 2004. Pesticide Application Methods, 3rd. Ed. John Wiley & Sons,

Inc. N.Y.

6. Pedigo, L.P. 2007. E

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Chapter 1

ECONOMIC IMPORTANCE OF INSECTS

HARMFUL ASPECTS

Insects are harmful to man in the following ways:

1. Insects damage and destroy all types of crops, fruits and vegetables
 - i) by chewing and eating the roots, stem, branches, bark, leaves, flowers, fruits and seeds etc.
 - ii) by boring into the roots, stem, branches, fruits and seeds. By sucking the sap from various parts of the plant such as roots, stem, branches, leaves, flowers etc.
 - iv) By making galls on various parts of the plant especially the leaf galls.
 - v) By making tunnels or mines into various parts of the plants especially the leaves.
 - vi) By spreading plant diseases e.g., viral diseases, bacterial diseases, fungal diseases etc.
 - vii) By laying eggs into various parts of the plant. They young ones, which come out from these eggs. start eating and thus damage the plant parts.
 - viii) By taking some parts of the plant for making their nests.
2. Insects injure and annoy all animals including man:
 - i) by their bad smell, unwanted buzzing sound, presence on the edible things and by entering into eyes, ears and nostrils.
 - ii) By injecting venoms or poisons into the bodies of the animals with help of stings, by biting with mouthparts and by shallow poisonous hair.
 - iii) as external and internal parasites e.g., external parasites are lica, fleas, bed bugs; and internal parasites are maggots.
 - iv) By spreading animal diseases like typhoid fever, malaria, tuberculosis, cow pox etc.

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3. Insects damage and destroy the stored products:
- i) They damage and destroy all food articles, clothes, papers, medicines, wood, timber, furniture, leather, buildings etc.
 - ii) They destroy the insects and plants for experimental purposes.

USEFUL ASPECTS

Insects are useful to man in the following ways.

1. Insects produce some useful and valuable products.
 - i) Silk is produced by silk worms.
 - ii) Honey is collected by the honey bees.
 - iii) Wax is also collected by the honey bees.
 - iv) Lac is produced by the lac insects.
 - v) Cochineal is also produced by some insects and it is used in dyes.
 - vi) Cantharidin is produced by insects and is used for treating many diseases.
 - vii) Insects produce galls which are used for obtaining tannic acid. This substance is used for dyeing the animal skins.
2. Insects pollinate crops, fruits, vegetables especially peas, dates, clover, beans, tomatoes, melons, and others.
3. Insects also serve as food for other animals e.g.,
 - i) fish feed on the aquatic insects.
 - ii) Poultry birds feed on insects.
 - iii) Frogs, lizards, snakes and other reptiles also feed on them.
 - iv) Most of the birds especially the starlings, sparrows also feed on insects.
4. Many insects are used for biological control of insect pests, parasites and predators that are used to control other insect pests which attack on crops, fruits, vegetables, stored grains, clothes, buildings and animals etc.
5. Insects destroy harmful weeds e.g., Ak grasshopper feed on Ak weed.

6. Insects improve the physical condition of the soil especially the soil living insects.
7. Insects act as scavengers (feed dead material).
 - i) by feeding on the dead bodies of animals and plants,
 - ii) by feeding on dung etc.
8. Some insects are useful in scientific research e.g., the genetic research has been conducted on drosophilla, an insect.
9. Insects have aesthetic and entertaining value.
 - i) Different colours and patterns of insects serve as models for artists and decorators.
 - ii) The colour patterns of insects are also used in trays, rings, necklaces and other jewellery.
 - iii) Moth and butterfly have very attractive patterns to guide the artists.
 - iv) The songs of insects are very interesting.
 - v) Insects are used in poetry.
 - vi) Fleas are greatly used in circuses for showing different feats.
10. Insects are used in medicine and surgery:
 - i) Maggots are greatly used for the treatment of wounds.
 - ii) Stings of honey bees are used for the pain of rheumatism.
 - iii) Cockroaches and honey bees are used in medicines.

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Chapter 2

INSECT CONTROL

1. HOW INSECTS HAVE BECOME PESTS

Insects have become pests due to following:

1. Interference with Natural Vegetation

Insects were present on earth before man and were feeding on natural vegetation i.e., grasses etc. When the man came on earth, he started cultivation of the plants by replacing the natural vegetation. In doing so, the insects started feeding on cultivated plants and thus became the pests of crops e.g, grasshoppers and potato tuber moths.

2. Reduction in Insectivorous Animals

The animals which feed on insects keep the population of insects very low. At present, the human being have killed the insectivorous animals or birds e.g., rosy pastor, starling, partridges etc. As a result of this reduction of insectivorous animals, the insects have increased in number and have become pests on crops.

3. Encouragement of Insects by Providing Suitable Conditions

Many insects feed and breeding plant debris which are found in crops. if we don't remove the plant debris, then such insects will increase in number and become important pests of crop. There are many insects which hide during winter season in stubbles of various crops like sugarcane, cotton, maize, sorghum , rice etc. if we don't remove the stubbles, these insects will increase in number and attack the following crop in the next season. Similarly, by sowing a similar crop in a large area will favor the multiplication of insects e.g., cotton sugarcane, rice.

4. By Introduction Of Infested Plants

By introducing plants from one locality to

another of the same country or by importing the plants from one country to another, the insects of that crop are also introduced into the new locality, e.g., Pink bollworm of cotton was introduced in the Pakistan from USA along with the introduction of American cotton.

5. **By Introduction of Pests by Trade**

Many insects are introduced from one locality to other or from one country to another country through trades of crop plants or various things e.g., Pink bollworm of cotton came from America through trade.

6. **Through Scientific Research**

The scientists import some insects for the sake of research with little carelessness these insects become important pests in the new country e.g., Gipsy moth was imported from Europe into America for the Scientific Research. Its eggs from the Research Laboratories accidentally reached into the field and it became important pest of apple in America.

II **FOUNDATIONS OF INSECT CONTROL**

The following s constitute the foundations of insect control:

1. External morphology
2. Internal morphology
3. Metamorphosis
4. Life history.

1. **EXTERNAL MORPHOLOGY**

Under external morphology, we study different appendages on head, thorax and abdomen of insects.

A. **Appendages of Head**

These consist of antennae, compound eyes and mouthparts.

- i) **Antennae:** are sensory organs having the sense of smell and touch in them. Source and thus these help in the control of insects by the help of attractants and repellents.

- (ii) Compound eyes: have perception of light, and through this light, some insects are attracted towards light. We can control with the help of light-traps.
- iii) Mouthparts: determine the type of insecticide to be used for the control of insect pest. Mouthparts are generally of two types:
 - a) Chewing: For chewing type of mouthparts, we use the stomach/contact poison for their control.
 - b) Sucking: For sucking type, we use the systemic poisons.

B. Appendages of Thorax

The thorax bears legs and wings which are locomotory organs. With the help of these organs, the insects move from one place to another and thus reach towards an insecticide or move away (either by wings or legs) from an insecticide and thus escape.

C. Appendages of Abdomen

The abdomen contains two types of appendages, the cerci and genitalia. Out of these two types, only genitalia help in the control. The genitalia or ovipositor tells us where the eggs are laid i.e. whether the eggs are laid in the soil, plant tissue, leaves or plant veins etc. When we know the place of egg laying, we can destroy easily the eggs and thus control the insects.

2. INTERNAL MORPHOLOGY

The body cavity greatly helps for the control of insect pests. Many parasites live in the body cavity of certain insects and thus help in the biological control of various crop pests. The fumigants (volatile insecticides at ordinary temperature) enter into the body of insects through spiracles and tracheae and kill them. Similarly some other internal body parts help in the control of different insect pests of crop pests.

3. METHAMORPHOSIS

The metamorphosis tells us about the following:

- i) Different life stages of an insect pest (i.e. through

- how many stages it passes in life cycle)
- ii) Which stage is harmful
- iii) Which stage can easily be controlled
- iv) Where different stages are found (at what places they are living).

4. **LIFE HISTORY**

The study of life history is also very important for the control of insect pests because it gives us the information about the:

- a) Food plants of a particular pest
- b) The duration of various life stages
- c) Habits and behavior of the insect pests.

If you have the information about the above points, you can easily control the insect pests.

III. **PRINCIPLES OF INSECT CONTROL**

There are three principles of insect control:

1. **Biological Equilibrium**

It has been seen that the population of insects almost remains constant at any time of the year. This is called biological equilibrium. Here naturally the question arises why population does not go very high or very low? The factors like temperature, humidity, light, over-crowding, food etc., become unfavorable, when the population increases beyond a certain limit. These factors are called forces of destruction. On the other hand, when the population goes down beyond a certain limit, increased production and strong survival help the insects to increase the population. These factors are called forces of creation. As a result of these two forces, the population remains almost constant.

2. **Biotic Potential**

It is the hidden power of insects to live successfully even under unfavorable conditions of environment. This phenomenon is called biotic potential.

3. **Environmental Resistance**

The sum total of all factors affecting the life of an insect is called the environment. OR All the factors around the insect which affect its life are called environment.

Environmental factors which tend to reduce the population of insects are called the environmental resistance. The environment consists of the following two types of factors:

- a) Physical or abiotic factors
 - b) Biological or biotic factors
- a) **Physical or Abiotic Factors**

i) **Temperature:** The insects can only live successfully under favorable or optimum conditions of temperature. The temperature is very high or very low. Most of the insects will be killed, and thus their population is reduced. The favorable temperature for most of insects is 28-32 °C.

ii) **Humidity:** The insects can only live successfully under favorable or optimum conditions of humidity. Very high or very low humidity kills most of the insects and thus reduces their population. The most favorable relative humidity for most of insects is 52%.

iii) **Light:** If the light period becomes very less, most insects cannot survive and reproduce. As a result of this, their population is greatly reduced.

iv) **Rainfall:** High rains mostly kill the insects by physical beating. The insects are also drowned in rain water in which they are killed and collected in the fields.

B) Biological or Biotic Factors

There are three important biological factors which reduce the population of insects:

i) **Competition:** the competition within the insects arises for food, shelter, mating etc. Competition is of two types:

a) When the individuals of the same species compete with

- one another, it is called intra-specific competition.
b) When the individuals of different species compete one another, it is called inter-specific competition.
The above both types of competitions reduce the insect population.

ii) **Parasites and Predators:**

Parasite: The insects which live either on or in the body of other insects for getting food are called parasites. It means, the parasites are of two types:

- a) Parasites which live on the body of insect are called ectoparasites or external parasites.
c) Parasites which live in the body of other insects are called endoparasites or internal parasites.

The insects on which the parasites are living are called hosts.

Predator: The insects which catch and eat away the other insects are called predators. The insects which are eaten by the predators are called preys.

Both the parasites and predators are harmful to insects and greatly reduce their population.

- iii) **Diseases:** Many organisms like protozoa, bacteria, nematodes, fungi, virus etc., cause diseases in the insects and kill them and thus greatly reduce their population.

METHODS OF INSECT CONTROL

Insect control in its broad sense includes everything that makes life hard for insects and tends to kill them and to prevent their increase or spread over. The insect control implies the regulation of insect activity with the best the interest of man.

There are two main methods of insect control:

1. **NATURAL CONTROL** / Effort less control

All control measures, which are in the hands of nature, collectively constitute natural control. Natural control has the following types:

- i) **Weather factors:** e.g., Temperature, humidity, light, rainfall, hail storm, wind etc.

- ii) Topographical features: e.g., Mountains, oceans, lakes, deserts, rivers etc.
- iii) Parasites and Predators: Both parasites and predators take their food from other insects and thus harm or kill them.
- iv) Diseases: Many organisms cause diseases in the insects and kill them.

2. **ARTIFICIAL OR APPLIED CONTROL** *Applied by human.*

It has the following types:

- i) Cultural or agricultural control
- ii) Physical control
- iii) Mechanical control
- iv) Biological control
- v) Reproductive or genetic control
- vi) Legal control or legislative control
- vii) Chemical control
- viii) Integrated pest management.

I. **CULTURAL OR AGRICULTURAL CONTROL**

It is the control of insect pests by performing ordinary agricultural practices or operations. The following farm operations can control the insect pests attacking various crops.

- 1. **Ploughing:** Certain insect pests like crickets and grubs of beetles are exposed in the sun by ploughing and thus they are eaten by the birds. By ploughing the insect hibernating in the soil are also exposed to birds etc., and thus they are controlled.
- 2. **Hoeing or Interculture:** Hoeing or inter-culture can also destroy certain insect pests e.g., the eggs of mango mealy bug can be destroyed by hoeing under the mango trees. By hoeing, the eggs are exposed to sun and also eaten by birds and ants. Similarly, by interculturing the crops, various insects and their eggs present in the soil are exposed to birds etc.
- 3. **Manuring:** By putting fertilizer in the field, we make the crop more healthy and vigorous. Such a crop can resist or

withstand the attack of various insect pests. So, manuring or fertilizing has an indirect upon the insects.

4. **Irrigation or Watering:** By irrigating the fields, certain insect pests like crickets attacking the cotton seedlings and the white ants attacking cotton, sugarcane, chilies etc. can be driven out of the field and thus the crop can be saved.
5. **Clean Culture of Eradication of weeds:** The crops, which are not cleaned and are full of weeds, are seriously attacked by some insect pests. For keeping the insects away from the crop, the farmers should not allow the weeds to grow in their field. Some weeds act as food plants and egg laying places for the insects like army worms and hairy caterpillars.
6. **Removal of stubbles:** Stubbles of various crops like sugarcane, rice and maize should be uprooted because the borers of these crops hibernate or hide themselves in these stubbles.
7. **Removal of affected crop plants and the fallen fruits:** When there is attack of top borers of sugarcane at an earlier stage of the crop, the damaged tops of the canes can be pulled out along with the attacking insects. Similarly when there is an attack of Gurdaspur borer in the sugarcane, the affected portions should be cut away to reduce the population of the insects. In the fallen fruits of trees, the maggots of flies are present. By collecting such fallen fruits and destroying them by burning or by burying them in the soil, the attack of the fruit flies can be reduced. This practice of removing the affected plants can be done also in rice crop against the attack of rice borers.
8. **Crop rotation:** You should not grow a single crop year after year in the same field because the insects attacking a particular crop remain hibernated in the soil or stubbles, and attack the crop when it is sown there in the

- next year. This thing has been especially observed in case of sugarcane borers, rice borers, maize borers etc. If the sugarcane is sown every year after cotton, it gets the high attack of white ants or termites.
9. **Sowing of resistant varieties:** The susceptible varieties of crops get the high attack of insect pests whereas the resistant varieties are least affected by them. At present we do not have any absolutely resistant variety of a crop but many varieties of crops have a comparative resistance to an insect pest. Hairy cotton varieties are more resistant to the attack of sucking pests like cotton jassid, cotton whitefly etc., than the non-hairy varieties. The cane varieties with hard skin or epidermis are more resistant to the attack of sugar cane borers than the varieties which have a soft skin. The Basmati variety of rice is highly susceptible to the attack of rice borers than the IRRI varieties of rice which are least attacked by the borers. Similarly the rice Basmati variety is comparatively resistant to the attack of rice leaf hoppers than the IRRI varieties which are highly susceptible to the attack of these leaf hoppers.

10. **Growing of trap crops:** Growing of Bhindi along the outer border or in the neighborhood of cotton crop will greatly attract the cotton jassid and spotted boll worm of cotton and thus cotton crop will be saved from the attack of these insects. Similarly, arhar crop can be sown along the outer borders of the cotton crop to attract the cotton weevil, and thus the crop can be saved from this pest. If you like, you can control cotton weevil on arhar crop by spraying.

II **PHYSICAL CONTROL**

It is practised by the manipulation of physical factors of the environment by man. The following physical factors are used for the control of insect pests:

1. **Temperature:**

The insects can carry out their development and activity at a particular level of temperature (optimum temp.) If the temperature increases or decreases, the insects can't perform their normal activities. If the temperature becomes very high or very, low. The insects are altogether killed.

- i) Use of Solar Energy or Radiant Energy: In Pakistan, it is a common practice to spread the infested grains in the sun heat for killing Khapra etc.
- ii) Use of high temperature: All stored grain pests in the stores can be killed by maintaining a very high temperature of 52-54°C with the help of heating pipes. By this method, all insect pests are killed within three hours.
- iii) Use of low temperature: It is common practice to keep the food products (especially potatoes) in a cold storage to avoid the attack of insect pests. The temperature of cold storage is about 4 °C; and at 0 °C below insects cannot attack the stored products.

2. Humidity:

Like temperature, there is an optimum level of humidity at which insects can carry out their growth and development. At very high or very low humidities, the insects cannot carry out their normal activity and they are killed (High humidity can be obtained by heavy irrigations, and low humidity can be obtained by P2O5 application, sun drying etc.

3. Light:

Light had been used for the control of many insect pests in the form of light traps. If we hang a bulb or a lamp in the field at night time, most of the insects like moths, beetles, crickets and grasshoppers will be attracted towards this light. We place a container of kerosene oil below the source of light. When the insects are attracted towards this light, they first strike the

source of light and then fall down in the container. Thus they are killed and the crop is saved from these insects. Light is also being used in the form of radiation energy or nuclear energy to kill or sterile the insects. When the insects are treated, they become sterile and are incapable of further reproduction.

4. **Sound:**

High intensity sounds are used to save the crops from the damage of certain insect pests. For this purpose drums are beaten to avoid the sitting of locusts on the plants.

III **MECHANICAL CONTROL**

It is the control of insect pest, by special devices, machinery and manual operations which are only meant for killing the insects. The following mechanical devices are done to control the insects:

1. **Hand Picking:**

It is the picking up of insects with human hand and then killing them by some method. In this case e.g., the eggs, sluggish larvae, and adults of certain insects are picked up and then destroyed e.g., egg pods of mango mealy bug which are laid under the mango trees and are collected by hands and destroyed.

2. **Netting or bagging:**

Some insect pests are collected with insect collecting hand nets or with very large field bages and then they are killed by some method e.g., rice grasshoppers, rice bugs.

3. **Trapping:**

There are many types of traps which are used for killing insects. The turnips are chopped and heaped in the fields where there are cutworms. During night time, cutworms come out to damage the crop, and at day time, they hide in those chopped potatoes or turnips. During day time, we can collect the cut-worms from these hiding

places and kill them. Pheromone traps are also used for killing cotton boll worms and fruit flies. Light traps are used for killing many insects especially the adults of sugarcane, rice, cotton and maize borers.

4. **Physical Barriers:**

In old times, physical barriers like construction of mud walls, digging of deep trenches around the fields and filling them with water or using of tin sheets or iron sheets around the field, were used to check the entry of army-worms, locust, hoppers etc.

5. **Physical beating:**

In old times, some insects were killed by physical beating e.g., locust, flies are killed by this method.

6. **Rope dragging:**

Some insects are killed by rope dragging. When there is attack of boll worms on cotton crop, two men drag a rope over the crop, in doing so the infested bolls fell down on the ground. Later on, the field is irrigated and the bollworms present in the bolls on the ground are drowned in the irrigation water.

7. **Use of bands:**

There are many types of bands which are used for killing the insects. Out of these bands, the following two are worth mentioning:

- i) **Sticky Band:** Any sticky material can be used around the tree trunks in fruit orchards to prevent the insects from climbing up the tree. At present, two types of sticky materials or bands are being used against the mango mealybug.
- ii) Ostico Sticky Band is imported from America.
- iii) Nimhar Sticky Band is prepared from following materials.

- 1 lb of castor oil
- 1 lb of conc. H_2SO_4
- 2 lbs of rosin powder

All these things are mixed and boiled, and at the end some glycerin and calcium chloride are added to it. This preparation is used at the rate of 1 lb for 10-20 trees. it remains effective for a week against mango mealy bug nymphs and females.

- ii) **Slippery Band:** In this case, slippery cloth like oil cloth or polythene sheet is used around the tree trunks which stop the upward climbing of the pests.

iv. **BIOLOGICAL CONTROL**

It is the control of insect pest by encouraging and utilizing living organisms by man. There are four methods of biological control:

1. By importing parasites and predators from abroad and then releasing them locally against a particular insect pest.
2. By collecting parasites and predators from one part of the country and releasing them in an other part of the country at the time of need.
3. By rearing parasites and predators in large numbers in the laboratory and then releasing them outside in the field against a particular pest.
4. By collecting parasitized stages of a particular pest (egg, larva and pupa) for emerging of parasites in the laboratory and then releasing them in the field against that particular pest.

The biological control can be done with the biological control agents or many living organisms such as Entomophagous Insects, birds (e.g., sparrows, starling, rosy pector etc.)

Entomophagous Insects

The insects which feed upon other insects are called entomophagous insects. These are of two types:

- i) Parasites ii) Predators
- i) **Parasites:** The insects living or in the body of other insects are called parasites. The insects, on which parasites live, are called hosts. Parasites are of two types:

a) Ectoparasites: Which live on the body of insects.

b) Endoparasites: Which live in the body of insects.

The act of parasitizing insects is called parasitism. The parasites may be primary parasites, secondary parasites or tertiary parasites. The parasites living on parasites are called hyperparasites and this process is known as hyperparasitism e.g., Aphelinus mali is a parasite which controls successfully the wooly apple aphids on apples. Some other parasites of cotton bollworms are Apanteles. Sp. Bracon greeni.

ii) **Predators:** The insects which catch and feed upon other insects are called predators. The insects on which they feed are called preys e.g., Lady bird beetle and chrysopa are predators which successfully controls aphids.

Difference between Predator and Parasite

PREDATORS	PARASITES
The insects that catch, tear, bite and eat in a single meal, the insects which are smaller, weaker and less intelligent.	The insects that live on or in the body of insects (host) which are stronger and more intelligent.
Obtain their food directly.	Obtain their food indirectly
Independent of the habitat.	Same habitat as of host.
Each eats many individuals before maturity.	Feeds on a single individual till maturity.

Important Predators

	Predator
1.	Preying mantis
2.	<u>Chrysopa</u>
3.	<u>Lady bird beetle</u>
4.	Dragonfly
5.	Water bug

6.	Antlion
7.	Beetles e.g., dytiscus sp. Coccinella sp.

Important Parasites

1. Goryphus mursi (parasite of cotton boll-worms, Family Braconidae. Order: Hymenoptera.
2. Family Echniomonidae, Order: hymenoptera (parasites of cotton boll-worm and parasites of sugarcane top borer.
3. Apentles sp. (parasites of Lepidopterus larvae.)

IV. LEGISLATIVE CONTROL

It is the control of insect pest by enacting and enforcing insect laws, by the Government. There are four types of insect laws in Pakistan like other countries of the world. These are:

1. Legislation preventing the entry of pests from foreign countries (quarantine laws).
2. Legislation preventing the spread of pest within the country.
3. Legislation regarding the control of established pests.
4. Legislation governing manufacture and sale of insecticides.

1. **Quarantine Laws** To check the import and Export of Quarantine laws are those which govern the import and export of an agriculture commodity to ensure that it is insect free. Good

The following quarantine laws and other insect laws have been framed by the government in the sub-continent and our country from time to time:

- i) Pest Act of 1906 for checking the entry of mexican cotton boll weevil.
- ii) Destructive Insects and Pests Act II of 1914. It still exists in our country.
- iii) Regulatory Order of 1940 for preventing the spread

of sanjose scale of apples in the Punjab Province.
Insect Legislation in Pakistan

2. Before one unit

- i) In Punjab province, there was "The Punjab Destructive Insect Pest Disease and Weed Control Act of 1959".
- a) In Sind Province, "The Sind Boll-worm Act of 1947" to control boll-worm.
- b) In N.W.F.P., "The N.W.F.P. Sugarcane Pyrilla Act of 1950" to control the sugarcane pyrilla.

ii) After one unit

The West Pakistan Agricultural Pests Ordinance of 1959 for controlling all serious pests of major crops. The Government of Punjab has amended Rule-I of this ordinance in 1971-72. According to this amendment, no occupier of any land shall sow Basmati or IRRI rice nurseries earlier than 20th May, or transplant the nurseries later than 7th August.

Vi REPRODUCTIVE OR GENETIC CONTROL

It is the control of insect pests by releasing sterilized males into their natural populations in the fields. This method consists of:

- 1. Rearing the insects in large number.
- 2. Sterilizing them and
- 3. Releasing them in the field in their natural populations.

STERILIZING THE INSECTS

The insects can be sterilized by radiation, certain chemicals and hybridization.

i) Sterilization by Radiation

The insects can be sterilized by exposing them to alpha, beta and x-rays, but gamma rays have proved to be the best. For gamma radiation, Co 60 and Cs 137 are commonly used. Generally the dose of radiation is 5000-60,000 radiations. Any stage of the insect like egg, larvae, pupa and adult can be irradiated. The pests like guava fruit-fly, melon fruit-fly, oriental fruit-fly, cabbage

loopers etc., have been controlled by this method.

ii) **Sterilization by chemicals**

The chemicals used for the sterilization are organo metals, DMF, Tepa, Metapa hempa, Colchicine etc. these chemicals can be applied to the insects orally, by injection, by spraying etc.

iii) **Hybrid sterility**

When two closely related species are crossed, the hybrids are all sterile just like a mule. This is called hybrid sterility. *Mid term*

VII. **CHEMICAL CONTROL**

Chemical control is the control of insect pests with the help of pesticides.

PESTICIDE

Any substance or mixture of substance intended for preventing, killing, repelling or controlling any organism which is declared pest.

Classification of Pesticides

Pesticides can be classified as:

A. Insecticides.

B. Rodenticides.

C. Acaricides \Rightarrow To control the mites.

D. Weedicides.

E. Fungicides.

A. **INSECTICIDES**

Any material that disrupts the vital processes of insects by chemical action is called an insecticide.

Classification of Insecticides

Classification can be done according to following:

1. Mode of Entry.

2. Mode of Action.

3. Mode of chemical Nature.

I. **MODE OF ENTRY**

1. Stomach Insecticides

Juvenile Hormone mimick
Ecdys'is / Ecdys'in Agonist

Insect
Regulators

Repellant
Microbial
Insecticides
Fungus

These insecticides are applied on the plants when the chewing insects eat the plants. The insecticides along with food enter into stomach and kill the insect by chemical action.

Contact Insecticides

These insecticides are applied directly on the insects when they are damaging the crops. Such insecticides when come in contract with the body wall of the insects, enter the body through the body wall. These insecticides are used against sucking insects.

3. Systemic Insecticides

These insecticides are applied through the soil and by spraying. They are absorbed by the roots and other parts of plants, and translocated to all parts of plant. When the insects feed on such plants, they are killed. These are actually the stomach poisons. These are best against sucking insect pests.

4. Fumigants

These insecticides are mostly in the form of vapors & in the form of solids which give fumes into the air with the ordinary temperature. These enter the body of the insect by inhaling through spiracles. Examples: Aluminum phosphide (Celphos, detia, delicia, postoxin), methyl-bromide, EDCT (Ethylene dichloride carbon tetrachloride).

II. MODE OF ACTION

1. Physical Insecticides

Those insecticides which insect pests through their physical action.

2. Protoplasmic Insecticides

Those insecticides which kill the insect through their action on the protoplasm of cells.

3. Respiratory insecticides

These are those insecticides which kill the insects by checking the respiration of insects.

4. **Nerve Poisons**

These are those insecticides which kill the insects by their action on nervous system of insects.

5. **Miscellaneous Insecticides**

- a) Insect Attractants: e.g., Methyl eugenol, gyplure, hexap lure etc.
- b) Insect Repellents: e.g., creosote, mercurous chloride, trichlorobenzene etc.

III. **MODE OF CHEMICAL NATURE**

According to the chemical nature, insecticides are divided into two main groups:

1. **Inorganic Insecticides**

Some of the first insecticide ever used are in this category such as arsenics, sulphur, Paris green, sodium floride etc.

2. **Organic Insecticides**

i) **Natural organics**

A) **Animal Origin:**

Oils: fish oil. Oils used as insecticides are of two types:

Summer spray Oils: These are sprayed in spring when buds of plant are sprouted.

Dormant Spray Oils: These are sprayed in winter when buds are dormant. Also called winter oils.

Mode of Action of Oils: Oils action is of physical nature. Spiracles of insects are filled by oils and blockage of air inhalation cause suffocation which results in the death of insects.

B) **Plant Origin:** e.g., Rotenone, Nicotine, Ryania, Derris, Pyrethrum etc.

(b) **Synthesized Organics**

(c) **Organochlorine**
hydracarbons):

Insecticides

(Chlorinated

Salient Characteristics: This is group of synthetic chemicals. These take a long time to disappear from environment and accumualte slowly in the bodies of insect.

Synsac
Enamectin benzoate
metameroid
imidacloprid
Diafenthiol
Mode of Action: It unstable the peripheral nervous system. Ultimately there is hypertoxicity, paralysis and finally death of the insects.

Antidotes: If sudden poisoning occurs in human being, then following antidotes of these chemicals such as atropine sulfate, raw egg and milk etc. can be used.

Range of Target Pest Insects: These insecticides are effective against a variety of insects especially beetles, weevils, mosquitoes, house flies, lice, fleas etc.

Examples:

DDT, Toxaphene, BHC, Aldrin, Dieldrin, Chlordane, Heptachlor, and Endrin.

b) Organophosphorus Insecticides

Salient characteristics They are not as persistent as chlorinated hydrocarbons. It may be contact, stomach or fumigants in action. These insecticides do not accumulate in fat bodies of animals.

Mode of Action:

These insecticides inhibit the production of cholinesterase enzyme which removes acetylcholine (liquid) from the synapse, due to an impulse will go on passing and disturb the insect continuously. Finally death of insect occurs.

Toxicity: It varies in toxicity from extremely hazardous to slightly hazardous chemicals.

Antidotes: Same as in case of chlorinated hydrocarbons.

Range of Target Pest insects: These are applicable for many insects e.g., sucking insect pests of cotton. Bollworms, squash bug, aphids etc.

Examples:

Acephate (Orthene), Azinphos methyl (Gusathion.M), Cartap (Padan), Diazinon (Basudin), Diclotophos (Bidrin, Carbion), Dichlorvos (Nogos, DDVP, Vapona), Fenthion (Lebaycid), fenitrothion (Sumithion), Formothion (Anthio), Malathion, Mevinphos (Phosdrin), MICP (Mipcin), parathion, Methyl (Folidol M), Phosphamidon (dimecron), Phorate

liveo. Neotiwida

Biological

microbial insecticides

Chlorophthalos

(Thimet), Primiphos methyl (Actellic), Triazophos (Hostathion), Trichlorfon (Dipterex), Dimethoate (Cygon, perfeckthion, Rogor), Disulfoton (Disyston) Monocrotophos (Azodrin, Nuvacron), Oxydemeton Methyl (Metasystox), Phosmet (Imidan).

c) Carbamates

Salient Characteristics: It is the new group of synthetic insecticides.

Mode of Action: These are similar to the organophosphates in properties and action.

Antidotes: Same as in chlorinated hydrocarbons.

Range of Target Pest Insects: These are more effective than previous, for insect pests of different crops.

Examples: Carbofuran, Carbosulfam

Aldicarb (Temik), Carbaryl (Sevin), Carbaryl plus Gamma BHC (Sevidol), Carbofuran (Furadan) Methomyl (Lannate) etc.

d) Synthetic Pyrethroids

Salient Characteristics: These have low toxicity to man and other vertebrate animals.

Mode of Action: Same as in organophosphates.

Antidotes: Same as in Organochlorines.

Range of Target Pest Insects: These have a wide range of its effectiveness including insect pests of cotton, wheat and other field crops.

Examples:

Cypermethrin (Ripcord, Cymbush, Sherpa, Airivo), Cypermethrin plus profenofos (Polytrin-C), Permethrin (Ambush) Decamethrin (Decis), Fenvalerate (Sumicidin), Nurelle. Danitol and Mavrik.

B. RODENTICIDES

These chemicals disturb the vital processes of rodents (rats, shrews, squirrels etc.) by chemical action.

Examples:

Brodifacoum (Klerat), Coumatralyl (Racumin), Sodium

cyanide (dymag), Zinc Phosphide.

C. ACARICIDES

This group of chemicals is used to control the mites and ticks etc.

Examples:

Chlorobenzilate (Akar), Dicofol (Kelthane), Eihion
Propergite (omite), Tetradifon (tedion).

VIII. INTEGRATED CONTROL

It is also called pest management or integrated pest management or I.P.M. "It is the control of insect pests by an combinations of control methods which result in less hazards to man and his environment." In the beginning, insect pests were controlled by parasites, predators i.e, by biological control methods, and whenever and wherever insects were not controlled by parasites and predators, the chemical control was applied to control the pest at that place. Now a days, generally many methods of control are combined to control a particular pest to a particular crop.

Elements of Integrated Control

1. Cultural control
2. Physical control
3. Mechanical control
4. Biological control
5. Legal control
6. Reproductive control
7. Chemical control
8. Pheromonal control

Harmones: The secretions which are produced by organisms into their blood, and they act at a

place different from their place of origin are called harmones.

Pheromones: the secretions which are thrown outside the body are called pheomones.

INSECT PESTS OF COTTON

Spotted Bollworm ✓

Earias insulana (Boisd.) and *Earias vittella* (F.)
(Noctuidae: Lepidoptera)

Status

Major pest of cotton.

Distribution

Both species well distributed in all cotton growing areas of Punjab.

Food Plants

Kuchri, Ladyfinger, Souchal, Cotton and others.

Description of Stages

Adult: *E. insulana* moths grass green to straw yellow forewing.

Egg: Greenish

Larva: *E. insulana* larvae dull greenish white with a number of black marks on the body and orange dots on prothoracic segment while. *E. vittella* brownish with a median longitudinal streak and ventrum is pale yellow or greenish.

Duration of Stages

Adult: Whole life of insect 18-34 days in summer, 26-136 in winter.

Egg: 163-420, singly.

Larva: 7-18 days in Summer Aug-Oct and 28-74 days in Winter Nov-Feb.

Pupa: 7-25 days in Aug-Oct and 41-87 days in Dec-March.

Life History

Active period: March to November

Inactive period: November to February

Flower & bolls.

ETL: (5%) damage bolls

Period of optimum activity: July to September

No. of generations/ year: 6 - 8 generations

Generation Which cause max. damage: During of July - September 5th to 8th.

Control

Cultural Control:

1. Destruction of host plants from and near the yield of cotton.
2. Cotton sticks, removal well below ground level.
3. Eradication of okra before cotton sowing or alternate host plants.

Chemical Control:

Bulldock	25 EC	300-830 ml/acre
Nuvacron	40 WSC	1000 ml/acre
Deltaphos	350 + 10 EC	500 ml/acre
Padan	95 SP	300 ml/acre
Karate	2.5 EC	325 ml/acre

Pink Bollworm

Pectinophora gossypiella
(Gelechiidae: Lepidoptera)

Status

Major pest of cotton throughout the Punjab.

Distribution

It is widely distributed.

Food Plants

Cotton, GulKhera, Kanghi booti.

Description of Stages

Adult: Dark brown

Eggs: Oval

Larva: White when newly emerge that turns pink later on.

Flower & bolls.

ETL: (5%) damage bolls

Period of optimum activity: July to September

No. of generations/ year: 6 - 8 generations

Generation Which cause max. damage: During of July - September 5th to 8th.

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Distribution

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Food Plants

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Description of Stages

Adult: Dark brown

Eggs: Oval

Larva: White when newly emerge that turns pink later on.

Mode of damage:- for bollworm damage caused.
Flower, bolls. ETL:- (5%) damage bolls

Period of optimum activity: July to September

No. of generations/ year: 6 - 8 generations

Generation Which cause max. damage: During of July - September 5th to 8th.

Control:

Cultural Control:

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Distribution

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Food Plants

Cotton, GulKhera, Kanghi booti.

Description of Stages

Adult: Dark brown

Eggs: Oval

Larva: White when newly emerge that turns pink later on.

Pupa: Yellowish brown

Duration of Stages

Adult: 2 - 29 days.

Eggs: A female lay eggs singly about 100 - 250
Between the veins of under side of leaves flower
and buds

Larva: 8 - 16 days.

Pupa: 6 - 8 days.

Incubation 4-5 days.



Life History

Active period: March to October

Inactive period: November to February

Period of maximum activity/damage:

July to

September - October

No. of generations/Year: 4 generations

Mode of Damage

Rosset flower \rightarrow closed flowers
The pest causes shading of squares flowers and
then bolls. However the attack of this pest is at worst
during September.

July to September \rightarrow Active Period

Control

ETL = 10%.

Cultural Control:

1. Removal of crop remains.
2. Ploughing of cotton field with furrow turning plough.

Organophosphate, Parathion

Chemical Control:

Ripcord	10 EC	200-250 ml/acre
Polytrin C	440 EC	250 ml/acre
Baythroid	1050 EC	250 ml/acre

Delta Phos

~~W.V.~~

30

W.V. = ultra low volume. Deltamethrin + Triazophos.

Cotton Jassid ✓

Amrasca biguttella biguttella (Dist.)
(Cicadellidae: Homoptera)

Status Serious pest of cotton.

Distribution

Throughout the cotton growing areas of Punjab.

Food Plants

Brinjal, Potato, Bhindi and holly hock.

Description of Stages

Adult: Greenish yellow with a black spot present on the tip of each fore-wing.

Eggs: Yellowish white

Nymph: 1st instar, yellowish. 2nd instar, dark reddish, underneath. 3rd instar, yellowish green. 4th instar, greenish yellow. 5th instar, greenish yellow with abdomen bluish.

Duration of Stages

Adult: Live for 3 months or more, where noted they survive for 5 weeks in summer and 7 weeks in winter.

Egg: 25-30 singly.

Nymphal Stage: 5 instars

Life History

Active period: March to November

Inactive period: November to February - March

Period of optimum activity: July - August

No. of generation/year:

Generation which cause max. damage: June to August

Mode of Damage

The leaf first become yellowish or brownish due to a pest attack and later cup shaped appearance and

slowly develop a characteristic brick red colour. The number of boll formation is reduced. Bhindi leaves edge: attacked by the pest turn up ward while that of cotton down ward and lint quality is deteriorated. Size of affected lint is also reduced. Attack is more on middle aged leaves than older and newer ones.

Control

Cultural Control:

1. In order to escape from Jassid attack cotton crop should be sown earlier and excessive use of fertilizers should be avoided.
2. Clean cultivation and removal of weeds are found to be effective in reducing Jassid infestations.
3. Cultivations of cotton varieties with hairy leaves.
4. Hairy resistant varieties are less attacked by Jassids.

Chemical Control:

Makontop	40 EC	350-450 ml/acre
Hostathion	40 EC	600 ml/acre
Thiodan	35 EC	600-800 ml/acre
Confidor	200 SL	250 ml/acre

Cotton Whitefly

Bemisia tabaci (Gennadius)
(Aleyrodidae: Homoptera)

Status

Most notorious pest insects of cotton.

Distribution

Well distributed in all cotton growing zones of Punjab.

Food Plants

Tori, lady's finger, cauliflower, melon, potato, peas, alsii, senji, maina, raya, tomato, reddish brinjal, tobacco, cucumber, gourds, sarsoon, water melon, chillies, lehli, sonchal, hollyhock, etc.

Description of Stages

Adult: Body yellowish and is covered with white fine powder/white waxy membrane.

Eggs: Freshly laid creamy-white in colour and changed to brown before hatching

Nymph: **1st Instar Nymphs:** wingless, flattened, oval in outline and light yellow in colour with functional legs. They adhere to lower surface of leaves and do not move, rather grow in size while sucking plant sap in at the same spot.

2nd and 3rd Instar Nymph: Immobile, depressed and pale greenish yellow coloured with oval shaped body. After moulting, they loose their legs and feed.

4th Instar Nymphs: The nymph stop feeding

No. of nymphal instars: Four nymphal instars.

Pseudo Pupa:

(4th instar - feeding pupa)

Dark yellow in colour with varying no. of spines on the back. Reddish coloured eyes of adult become visible through transparent skin as 2 orange coloured spots. Pupa is on the under surface of leaves.

Duration of Stages

Adult: 2-5 days in summer but in November, 24 days.

Eggs: Singly on lower surface of mostly lower and middle leaves. A female may lay upto 110 eggs.

Nymph: 9-14 days during April-Sep. but from Oct. to onward 17-73 days.

Pupa: 2-8 days

Life History

Active period:

B. tabaci remains active throughout the year migrating from one to another plant.

Inactive period:

in *B. tabaci*

Period of optimum activity/damage. June to September

No. of generations/year: 10 - 12 overlapping

Generation which causes max. Damage: 3rd to 9th.

Mode of Damage

The whiteflies are very harmful insects, which pose a great threat to Agriculture all over the world. They damage the plants in following different ways.

1. The young ones and adults suck the leaf sap by remaining on the under surface of leaves. However, the young ones inflict severe damage. Due to the depletion of the nutrients, the plants become stunted, the leaves turn yellowish-brown and fall-off. This also results in low fruiting and their falling down.
2. They inject toxic saliva into the plants that alters the normal physiological processes and thus results in plant disorders.
3. They produce enormous amounts of honeydew (complex of sugars) and throw it on various plant parts. This sugary and sticky material acts as an excellent medium for development of sooty mold, which, besides giving a blackish and sickly appearance to the plants, interferes in the normal process of photosynthesis. It also becomes a source of secondary infection.

4. They act as vectors of many viral diseases of plants, which adversely affect the growth and yield of various crops, e.g., *B. tabaci* alone is responsible for the transmission of 38 viral diseases on 69 different plants.
B. argentifolii is responsible for the transmission of CLCV.

Control

Cultural Control:

1. Avoid cultivation of alternate hosts near the cotton fields.
2. Avoid application of excessive amount of nitrogenous fertilizers in the cotton crop.
3. Avoid over-irrigation of cotton field.
4. Proper manuring of cotton crop is also benefited for rapid recovery of plants.
5. Pressurized water spray effectively killed the adults of cotton whitefly. In heavily cotton infested fields the pressurized spray six times a month i.e. at five days interval normally during the evening hours is highly helpful for the control of this pest.

Biological Control:

Predators

- ii) *Brumoides suturalis*
- iii) *Chrysopa carnea*

Most common predator &

agents of the pest in Punjab from June to Aug - Sep.

Chemical Control:

(Dimethoate) Perfekthion
(Dimethoate) Confidor

1. Diafenthiolan (Polo)
3-Pyridoxylfin 40 EC
200 SL

2. Buprofezan (Buzze)
4-Acetamethid (Mospilon)
200-280 cc/acre.
250 ml/acre

Acetamethid
Mospilon

American Bollworm

Helicoverpa (Heliothis) armigera (Hub.) Tomato fruit
(Noctuidae: Lepidoptera) Worm.

Status

H. armigera is the most destructive pest insects of cotton.

Distribution

Widely distributed in Punjab.

Food Plants:

Tobacco, Cotton, Berseem, Lucerne, Sunflower, Castor, Reddish Okara, Cabbage and many other.

Description of Stages

Adult: Grey to brown

Eggs: Pale white.

Larva: 1st Instar: Yellowish white in colour.

2nd Instar: Yellowish

3rd, 4th and 5th Instar: Yellowish/greenish yellow

No. of larval instars: 6

Pupa: Dark brown

Duration of Stages

Adult:

Male: 4-22 days.

Female: 7-25 days.

Nocturnal: Moths normally rest during days and become active by sunset fly and mating takes place.

Eggs: 584 to 1500 laid on surfaces of leaves, flowers and bolls.

Larva: 15-30 days

Hatching 2-4 days.

Pupa: 5-8 days

Life History

Active period: April-October

Inactive period (Hibernation): November - March

Period of optimum activity/damage: July-October

No. of generations/year: 4-8 generations/year.

Generation which causes max. damage: 5th to 8th

Mode of Damage

They are voracious feeders of the of the cotton

plant especially the bolls leaving only a hollow shell and having destroyed one move about the plant to feed on the next boll. They eat the bolls very rapidly and cause considerable loss to the crop.

Extent of Damage:

A single larva can damage about 10-12 buds, flowers, squares and bolls.

Damage:

The 5th and 6th stage larvae bore and insert their heads into bolls and eat their inner contents while rest of their bodies remain outside the bolls. Hole on the boll surface is an indication of its attack.

Control

Cultural Control:

1. Ploughing of the field immediately after last picking of the cotton (before 1st fortnight of January) will expose the pupae to solar heat and predatory birds.
2. Alternate host plants near the cotton field should also be removed.
3. Remove cotton sticks soon after harvest and also remove affected bolls.

Chemical Control:

Curacron	500 EC	800-1000 ml/acre
Lannate	90 WP	250-300 ml/acre
Deltaphos	350+10 EC	500 ml/acre
Larvin	275 FL	1000 ml/acre

Delta Methixin (Deci N). Triazophos. Chlorpyrifos

Cy Per Methexin, Per Methixin, Profenofos (Cuba (don)

Pinosad (Traces)

INSECT PESTS OF SUGARCANE

Top Borer of Sugarcane

Scirpophaga nivella (F.)

(Pyralidae: Lepidoptera)

Status

Major pest of sugarcane

Distribution

It is widely distributed in all sugarcane growing areas of Punjab.

Food Plants

Wild grasses i.e. Sarkanda, Mandal and Sugarcane.

Description of Stages

Adult: Pure white, front wings long, hind wings shorter and wide. Female with reddish-brown anal tuft. *U-5*

Eggs: Oval, scale like, covered with yellow or reddish brown hairs from the anal tuft of female. *300 eggs*

Larva: Creamy white, dorsal vessel prominent, thoracic region tapers towards head. *28-30 days*

Pupa: Brownish, abdominal tips broadly rounded. *8-10*

Duration of Stages

Adult: 4 - 5 days.

Eggs: 7 - 9 days. Nearly 300 or more in clusters of 5 - 102 laid on the lower leaf surface.

Larva: 28 - 35 days.

Pupa: 7 - 10 days.

Life History

Active period: Pest is active from March - October. *Carbolf*

Inactive period: The pest over winter as a larvae in the top portion of the attacked sugarcane plants. *Carb*

Period of optimum activity/damage: July to August

No. of generations/Year: 5 generations

Mode of Damage

Damage is caused by caterpillar which is generally found in the top portion of sugarcane. The first two broods (April - May/June) of this pest attack young plants

Dead Heart: The central portion of the cane becomes dry up due to attack of top borers

severely before the formation of cane causing central shoot to dry up. The subsequent brood, the pest attack causes of Bunchy top. Damage by the 3rd and 4th brood may result in more than 25% reduction in weight. The quality of juice is also affected adversely;

- The shoots attacked by 1st two broods (April - June) are killed.

- Cane affected by 3rd brood (July) remains stunted in growth and there is generally on decrease of 14 - 15% in height of such cane.

10 Yr Life Canes attacked by the 4th brood (August) grow slowly.

- By the time of 5th brood appears in September the canes have almost attained their normal height. The height of attacked cane is only 1-2% less than that of healthy cane.

Control

Cultural Control:

- Remove the dead hearts and kill the caterpillars with the help of sharp spike.
- The sugarcane tops should be removed and fed to cattle.
- Mechanically destroy the eggs of the borer.

Chemical Control:

- | | | | |
|------------|----------------------|--------|--------------|
| 10 Yr Life | i. Furadan/Sunfuran | 3G/10G | 14 |
| | Kg/acre | | |
| 10 Yr Life | ii. Diazinon/Basudin | 10% | 8 Kg/acre |
| ref | iii. Padan | 4G | 13-15 per Kg |

Stem Borer of Sugarcane and some grasses.

Chilo infuscatellus (Snell)
(Pyralidae: Lepidoptera)

Status

Major pest of sugarcane

Distribution

It is widely distributed in sugarcane growing areas of Punjab.

Food Plants

Swank Dub grass and Sugarcane.

Description of Stages

4-5 days life

Adult: Brown pale yellow, tinged with dark coloration, front wings brownish with dark spots along the longitudinal veins, one in the centre and a row of black spots along the outer margin. Hind wings whitish.

Eggs: Flattened and scale like, pale yellow when freshly laid. 7-9 days incubation
Lay 300 eggs

Larva: Dirty white or pale yellow with 5 brownish longitudinal stripes on dorsum. Head and prothorax dark brown, 25 mm in length

Pupa: Reddish brown, abdominal segments furnished with a zig zag ridge. 8-10 days life

Duration of Stages

Adult: 2 - 4 days.

Eggs: 5-7 days, 300-450 eggs in clusters of 11-36 av. (30) on lower side of leaf.

Larval: 18 - 23 days.

Pupal: 7 - 12 days.

Life History

Active period: March to October.

Inactive period: It passes winter (November - February) as a hibernating larva in the stubbles of sugarcane.

Period of optimum activity/damage: April to June

No. of generations/Year: 5 generations

Mode of Damage

This is very injurious pest and its caterpillars destroy about 20% of the young shoots during April to June annually. The larvae after hatching from the eggs

reach the plant base, bore into shoot and feed there. In years of severe infestation, damage may be as high as 67%. The caterpillars feed in the stem and cut off growing points (central whorl of the leaves) causing the later to wilt and dry. The central dead shoot is called "dead heart". Such plants never grow further but dormant buds sprout and produce side shoots. After the canes, have established its attack does not produce dead hearts and damage is confined to a few internodes only.

Control

Cultural Control:

The best way to prevent this insect is to plough sugarcane stubbles anytime during November to February when the caterpillars are hibernating in them. The uprooted stubbles should be collected and disposed off in a way that will ensure their destruction.

Mechanical Control:

- i. Destroy egg clusters by collecting them manually
- ii. Destroy the moths by collecting them through light traps.
- iii. Remove the dead hearts during April to May and introduce a sharp spike in a cavity and kill the caterpillars by moving the spike up and down.

Chemical Control:

i. Disyston	10G	8 Kg/acre
ii. Furadan	3G	14 Kg/acre
iii. Basudin	10G	8 - 10 Kg/acre
iv. Methyl-parathion	50%	500 - 700
ml/acre		

Root Borer of Sugarcane ✓

***Emmalocera depressella* (Swin.)**

(Pyralidae: Lepidoptera)

Status

Minor pest of sugarcane in Punjab except Barani areas.

Distribution

It is met in sugarcane growing Barani areas of Punjab.

Food Plants

Baru and Sarkanda besides Sugarcane.

Description of Stages

Adult: Pale or yellow brown. Fore wings pale or yellowish brown, hind wings whitish.

Eggs: Scale like, creamy white.

Larva: Full grown, creamy white with transverse grooves on the body segments.

Pupa: Yellow brown, tip of abdomen knobbed or dorsum.

Duration of Stages

Adult: 5 – 7 days.

Eggs: 3 – 5 days. 277 to 355 eggs laid singly on leaves/stems or on ground.

Larva: 45 – 50 days.

Pupa: 10 – 18 days.

Life History

Inactive period: The pest passes the winter (Nov. - Feb.) as a caterpillar in the stubbles of sugarcane.

Active period: The pest is active during April to November.

Period of optimum activity/damage: April to July.

No. of generations/Year: 5 broods

Mode of Damage

The larvae bore into stem below the soil surface. The central leaves of the attacked plants dry up. In certain years the young plants are killed.

Control

Cultural Control:

Destroy the stubbles after harvesting the crop to kill the hibernating larvae.

Chemical Control:

i. Folidal .M	50%	500 - 700 ml/acre
ii. Furadan	3G	14 Kg/acre
iii. Basudin	10G	8 - 10 Kg/acre

Gurdaspur Borer

***Acigona steniella* (Hampson)**
(Pyralidae: Lepidoptera)

Status

Most destructive pest of sugarcane crop in canal colonies of Punjab.

Distribution

This pest was first recorded in 1923 from Sialkot. This is the most destructive pest of sugarcane in the Punjab province.

Food Plants

Wild grasses and Sugarcane.

Description of Stages

Adult: Dull brown, Hind wings whiter than the fore wings which have seven dark spots between veins along the outer margin.

Eggs: White to pale cream when freshly laid, changing to dark grey before hatching

Larva: Head light orange or orange brown, rest of the body is creamy white ornamented with four longitudinal reddish brown stripes.

Pupa: Body more or less smooth. Creamy white when freshly formed but later on changes to yellowish brown.

Duration of Stages

Adult: 4 - 5 days.

Eggs: 4 - 6 days (no. 190 - 315 in cluster of 3 - 65 eggs).

Larva: 48 - 64 days.

Pupa: 4 - 13 days.

Life History

Active period: From July to October/November.

Inactive period: November to June

Period of optimum activity/damage: July to

November.

No. of generations/Year: 3

Mode of Damage

The caterpillar after hatching feed for a while and then they bore into it. They feed in a spiral manner which is dark and on closer examination is made of series of punctures. The dark spiral streak renders the affected portion weak which breaks off when shaken by wind or passing by animals.

Control

Cultural Control:

- i. The infested parts are either cut, burnt or fed to the cattles, during July and August.
- ii. Earthing up of crop during May - June may check the emergence of adults from stubbles.
- iii. Ploughing up of stubbles and subsequent stirring of the soil is helpful in destroying the hibernating larvae.
- iv. Deep harvesting of cane is helpful.

Chemical Control:

i. Polytrin-C	440EC	800 - 1000
ml/acre		
ii. Furadan	3G	14 Kg/acre
iii. Folidol .M	50%	500 - 700 ml/acre
iv. Basudin	10G	8 - 10 Kg/acre

Sugarcane Leaf Hopper

Pyrilla perpusilla (Walker)
(Lophopidae: Homoptera)

Status

This is major sucking pest of sugarcane in Punjab.

Distribution

Widely distributed in sugarcane growing areas of Punjab.

Food Plants

Wheat, Barley, Oats and Sugarcane.

Description of Stages

Adult: Body straws coloured, wings light brown.

Eggs: Oval pale-white, rounded at the extremity. 770 eggs laid in clusters of 23 – 50 eggs.

Nymph: Greyish brown and have 2-white prominent feather-like filaments at the end of the tail of its body.

Duration of stages

Adult: 27 – 52 days.

Eggs: 8 – 10 days, 770 in clusters of 23 – 50 eggs.

Hatching: 7 – 12 days in summer and 20 – 40 days in winter

Nymph: 56 days (8 weeks) in summer and 150 – 180 days (5 – 6 months) in winter. Nymphal instars – 5.

Life History

Active period: March to October

Inactive period: November to March.

Period of optimum activity/damage: July to September.

No. of generations/Year: 3 – 4 generations.

Generation causes maximum damage: 3rd and 4th generation

Mode of Damage

The insect feeding produces a thick transparent liquid known as honey-dew which falls on the leaves and provide a good medium for the growth of black mould. The black mould/coating interferes with plant photosynthesis and thus very little sugar is obtained. "Gur" made from affected canes turns into liquid with the passage of time.

Control

Mechanical Control:

- i. Destroy the eggs.
- ii. Destroy the pest through hand nets.

Biological Control:

- i. Parasites of leaf-hopper (Epipyrops) should be encouraged as is the most effective biological control agent of the pest in Punjab.

Chemical Control:

i. Deltanet	400EC	300 -
400 ml/acre		
ii. Decis	2.5EC	400 ml/acre
iii. Advantage	30EC	500 ml/acre
iv. Folithion	40EC	600
ml/acre		

INSECT PESTS OF RICE

Yellow Stem Borer of Rice

Scirpophaga incertulus (Walker.)
(Pyralidae: Lepidoptera)

Status

Major pest of rice.

Distribution

Widely distributed in Kallar tract of Punjab.

Food Plants

Rice and wild grasses.

Description of Stages

Adult: Straw colour with brownish dots well scattered, 5 black patches along submarginal area and 8 - 9 black dots near tip.

Eggs: Creamy white, oval shaped.

Larva: Full grown larva pale or yellowish white or with greenish ting; head capsule orange yellow.

No. of larval instars: 4

Pupa: Body colour pale white or flesh to yellowish white; tinged green.

Duration of Stages

Adult: 5 - 7 days.
Eggs: 6 - 7 days (100 eggs in hatches are laid).
Larva: 12 - 27 days.
Pupal stage: 9 - 12 days.

Life History

Active period: April to October.

Inactive period: November to March in stubbles.

Period of optimum activity: Mid August to Mid October.

No. of generations/year: 4 - 5 generation.

Generation which causes Max. damage: 3rd, 4th and 5th generation.

Mode of Damage

It is the most destructive pest of rice responsible for 90% crop loss. Destroy the central growing leaf which dries up this is called as the dead heart. At later stage of the plant development when the crop is at flowering stage the white ear heads stand erect and has no grains more especially during August and September. This damage is commonly known as the milky or the white ears.

Control

Mechanical Control:

1. Destruction of eggs, crushing them on the leaves.
2. Use of light traps in the transplanted fields and nurseries.
3. Picking and destroying of egg masses and dead hearts.

Cultural Control:

1. Nursery should not be sown before 20th May in Punjab.
2. Transplanting should be completed by August in Punjab.
3. Age of nursery should be 30 - 35 days to avoid stem borers.

Chemical Control:

Furadan	3 G	9-10 Kg/acre
Diazinon	10 G	9-10 Kg/acre

White Stem Borer
Scirpophaga innotata (Walker.)
(Pyralidae: Lepidoptera)

Status

Major pest of rice.

Distribution

In Punjab province it is well distributed in Kallar tract.

Food Plants

Rice and wild grasses.

Description of Stages

Adult: Moth is slender, white with orange and tuft of hair and absence of black spot on each wing

Eggs: Colour creamy white.

Larva: Pale white or yellowish white.

No. of larval instars:

Pupa: Pale white, enclosed in a white silken cocoon

Duration of Stages

Adult: 4 - 14 days.

Eggs: 4 - 9 days. Laid in clusters.

Larva: 25 - 31 days.

Pupal stage: 7 - 11 days.

Life History

Active period: April to November

Inactive period: November to March.

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Period of optimum activity: Mid August to Mid October
No. of generations/year: 5 - 7 generations.
Generation which causes Max. damage: 4th and 5th generation.

Mode of Damage

Same as in case of yellow stem borer of rice.

Control

Mechanical Control: (Same as under yellow
Cultural control: stem borer of rice)
Chemical Control:

Mapcin.	50 WP	1 Kg/acre
Padan.	4 G	10 Kg/acre

White-backed Plant-hopper

Sogatella furcifera (Horv.)

(Delphacidae: Homoptera)

Status

It is major pest of Rice.

Distribution

Widely distributed in Kallar tract of Punjab.

Food Plants

Rice and wild grasses.

Description of Stages

Adult: Straw coloured, with white back.

Eggs: Laid in masses in leaf sheath

Nymph: Greyish white that turns dark grey white when near maturity.

No. of nymphal instars: 5

Duration of Stages

1 - 13 days

4 - 4.6 days

2. 11 - 12 days.

3. Picki.

dead ph to November

Cultural Control December to February egg or

nymphal stage.

Period of optimum activity: August - September

No. of generations/year: Several

Generation which cause Max. damage: 3rd to 5th

Mode of Damage

The nymphs and adults suck cell sap from the leaf surface and tend to congregate more especially on the leaf sheath base of the plant. The attacked leaves of the plant turn yellow and later on rust red. Such rust red leaves are commonly called as Hopper burn.

Control

Chemical Control:

Sevin	10%.	10 Kg/acre
Lannate	90 SP	250-300 gm/acre.

Rice Leaf Folder ✓

Cnaphalocrocis medinalis (Gn.)
(Pralidae: Lepidoptera)

Status

There is regular pest in Kalar area of Punjab.

Distribution

Important pest of Kalar tract of Punjab.

Food Plants

Rice and wild grasses.

Description of Stages

Adult: Golden or yellow brown.

Eggs: Flat and oval, creamy white in colour.

Larva: Dull white or light yellow with a brown head that turns greenish after feeding

No. of larval instars: The larvae passes through 5 larval instars before pupation.

Pupa: Dark brown

Duration of Stages

Adult: Male 32 days

Female: 36 days

Eggs: A female lays on an average 56 eggs singly or in groups 3 - 4 days.

Larva: Larval duration is 15 - 25 days.

Pupal stage: Pupal duration is 6 - 8 days.

Life History

Active period: The pest is active from July-October.

Inactive period: October - November and April May.

Period of optimum activity: September - October

No. of generations/year: There are 4 generation.

Generation which causes Max. damage: Maximum damage due Sep. - Oct.

Mode of Damage

The larvae on the emergence feed on tender leaves without making a fold. The grown up larvae fasten the longitudinal margins. Edges of leaf together with a sticky substance and feed inside the fold by scraping the green matter till membranous leaf skeleton is left behind that dry up. Heavily infested crop has whitish streaks on leaves and from a distance can easily be recognised or visible.

Control

Chemical Control:

Padan	95 SP	275-300 gm/acre.
Mipcin	50 WP	900 gm/acre.
Deltaphos	10+350 EC	400 ml/acre
Somithion	50 EC	500 ml/acre

INSECT PESTS OF GRAM

Gram Cutworm

Agrotis flammatra Schiff
(Noctuidae: Lepidoptera)

Status

Major pest of Gram.

Distribution

Widely distributed in Punjab particularly in Faisalabad.

Food Plants

Gram, Potato, Cucurbit and Wheat seedlings.

Description of Stages

Adult: Greyish brown

Eggs: Yellowish white

Larvae: Dark grey

Larva: 6

Pupa: Reddish brown

Duration of Stages

Adult: 5-11 days in male and that of female is 13-20 days.

Eggs: 25 - 50 eggs in the life cycle.

Larva: 68 days

Pupa: 14 - 20 days.

Life History

The insect lay eggs singly or in batches. The life cycle is completed in 5 month during Nov - March.

Active period: November to May

Inactive period: May to October as the pest migrate to hilly areas.

Damage period: Mostly damage is caused during the month of January.

No. of generations/year: Usually one generation per year.

Max. Damage causing generation: January to February

Mode of Damage

The damage of the insect is usually at night time. The insect come out from its shelter and become active in the field and cause damage throughout the night till day dawn. They cut away growing shoot of gram and this follow cut off shoot in the field is a proof of the pest attack.

Control

Clean the field by a Khurpa or a Kudali.

1. Tillage and activation
2. Collect the eggs and larvae with hands
3. By using light trap.

Chemical Control :

Thiodan 35 EC 800-1000 ml/acre

Greasy Cutworm

Agrotis ipsilon (Rott.)
(Noctuidae: Lepidoptera)

Status

It is a serious pest of gram.

Distribution

These are distributed in Faisalabad region commonly.

Food Plants

Same is in other cutworm.

Description of Stages

Adult: Brown

Eggs: Singly or in batches.

Larva: Greasy grey

Pupa: Dirty in colour and also have small ridges on the body.

Duration of Stages

Adult: Male 4 - 10 days, female 11 - 20 days.

Eggs: May be singly laid or in batches, more than 45 eggs are laid at a time.

Larva: 28 - 35 days.

Pupa: 10 - 130 days.

Life History

Active period: December to March - April.

Inactive period: May to October migrates to hilly areas.

Damage period: Mostly damage during the month of January - February.

No. of generations/year: Usually one generation in an year.

Mode of Damage

Young larvae feed upon succulent green leaves from the underside leaving only the stalk of the branch. Later they cut down at night the growing shoot of the plant and therefore called cutworm. These cut away plant portion can be seen in the field.

Control

Eradication of weeds.

1. Clean cultivation.
2. Timely irrigation
3. Collection of larvae and eggs with hands.
4. By installing the light traps.

Chemical Control

Cypermethrin	10 EC	250-300 ml/acre
Endosulfan	35 EC	600-800 ml/acre

Gram Pod Borer

***Autographa nigrisigna* (Wlk.)**
(Noctuidae: Lepidoptera)

Status

Major pest of gram

Distribution

Throughout Punjab

Food Plants

Gram, Cabbage and many others.

Description of Stages

Adult: Fore wing fuscous with a cuprous tinge Hind wing pale at the base. The outer are suffused with focus. Body 17.44 mm long, wing span 38.88 mm.

Eggs: The fresh eggs are rounded creamy (somesay yellowish white) coloured and with sculptured chorine.

Larva: The larvae on emergence is straw colour. In fifth instar head green body green with 3 white longitudinal on streaks dorsal and 2 white longitudinal on streaks lateral side.

No. of Larval instars: 6 instars.

Pupa: Green to dark brown

Duration of Stages

Adult: Male: 4 - 5 days

Female: 7 - 19 days.

Eggs: One female can lay approximately 220 - 442 (Av. 247) eggs during her life. The eggs are laid singly as well in batches of 3 - 6.

Larval: 8 - 30 days.

Pupal: 5 - 13 days.

Life History

The eggs are laid on leaves, shoots and flowers of the host, incubation period is variable depending upon the ambient temperature. At Faisalabad it was 3 - 6 (Av. 4) days. During November - December across greenish or dark brown larva start feeding on leaves and tender shoots.

Active period: The newly hatched larva consumed 1 - 2 leaves per day by biting small holes from December to February. During this period the insect population and damage was so little that could not be detected easily. However by March it multiplied in large no. and built up sizeable population. Severe damage was caused to crop which was near maturity in March-April.

Inactive period: October to March

Period of optimum activity: March - April.

No. of generations/year: 3 generations

Generation which cause Max. damage: 2nd and 3rd

Mode of Damage

The insect damage on gram is the maximum on gram during March and April when it bores into developing pod and feed the developing gram grain. Practically no field in Punjab is free from the attack of this pest.

Control

Shaking the gram plant regularly during March - April at 4 days unlevel and their collection by hands is useful practice.

Chemical Control

Decis.	2.5 EC	200 ml/acre
Cypermethrin	10 EC	200 ml/acre
Bulldock.	25 EC	200 ml/acre

INSECT PESTS OF

MAIZE

Stem Borer of Maize and Sorghum

***Chilo partellus* (Swinhoe)**

(Pyralidae: Lepidoptera)

Status

Major pest of maize crop.

Distribution

All over the Punjab.

Food Plants

Baru, Sudan grass, Sarkanda, Maize and Jawar.

Description of Stages

Adult: Front wings straw coloured with a double row of black spots near the outer margin. Hind wings smoky.

Eggs: Freshly laid eggs are whitish then later change to orange yellow and become dark before hatching. These are flat, oval and scale like.

Larva: Four longitudinal stripes present on the body of full grown larvae.

Pupa: Cylindrical, brownish yellow that later turns reddish brown.

Duration of Stages

Adult: 2 - 12 days.

Eggs: 265 - 361/female in cluster and clusters (8 - 12) in 4 - 7 days.

Larva: 2 - 15 days.

Pupa: 5 - 10 days.

Life History

Active period: March - April to September - October.

Inactive period: Hibernates as larvae in stubbles.

Period of optimum activity/damage: April and then in August.

No. of generations/Year: 5 to 6

Generation causes maximum damage: 1st - 2nd and

5th - 6th generations

Mode of Damage

The newly hatched larvae starts feeding on leaves eating there in the form of holes on leaf. It tunnels into the stem and having destroyed the stem internally, kills the central shoot that forms "dead hearts". At the tesselling stage the borer destroy the tessel by feeding on them. At ear formation the pest enters the ear from its base and make the tunnel in the centre of the cob, and later feed on grains as well.

Control

Cultural Control:

- i. Destroy the maize and sorghum stubbles.

Mechanical Control:

- i. Use of light traps.
- ii. Removal of egg clusters.

Chemical Control:

- | | | |
|-------------------|--------|-------------|
| i. Decis | 2.5 EC | 200 ml/acre |
| ii. Monocrotophos | 40 WSC | 500 ml/acre |

INSECT PESTS OF CITRUS

Citrus Whitefly

Dialeurodes citri (Ashm.)

(Aleyrodidae: Homoptera)

Status

Major pest of citrus.

Distribution

It is almost found in all citrus growing tracts of Punjab.

Food Plants

Citrus

Description of Stages

Adult: Pale yellow in colour with wing and body covered with white powder.

Eggs: Stalked, pale yellow in colour.

Nymph: 3 nymphal stages

Pseudo pupa: Pale yellow

Duration of Stages

Adult: Adult life varies from 2 - 8 days in captivity.

Eggs: A single female lay more than 200 eggs. Eggs are laid singly irregularly scattered on the lower surface of the young and soft leaves.

Nymph: 25 - 5 days in case of summer.
49 - 71 days in case of winter.

Pseudo pupal: 114 - 159 days in case of winter.
125 - 154 days in case of summer.

Life History

Active period: March - April to October

Inactive period: November to March

Period of optimum activity/damage: March - April
and August - September

No. of generations/Year: 2

Generation which cause maximum damage: 2nd
generation.

Mode of Damage

All stages of the pest are met with together during March - April. Only the nymph and pupa are found in May. In June - July, only pupal stage is present. All the stages are again met with in August - October. From October to the end of February only pupae are found.

Both nymph and adult cause damage by sucking the cell sap from the leaves which curl over and fall off. The adult on emergence avoid bright sunlight and settle on the under side of the leaf. Preferring the north side of leaf of tree. The infested tree present a blackish appearance due to sooty mould which develop on the honey dew produced by the pest. Infested tree produced scanty blossom, most of which is shed whatever the little fruit is produced, it is

undersized and of poor quality.

Control

Mechanical Control: The attacked leaves and branches should be pruned off and burnt to check the further spread of pest.

Chemical Control.

i. Metasystox	25 EC	0.5 lb. a.m/100 gallon of
ii. Diazinon	60 EC	116 a.m./100 gallon of water
iii. Folidol. M	50 EC	0.1% solution
iv. Supracid	40 EC	100 - 150 ml/acre
v. Master	60 SL	200 ml/acre

Citrus Caterpillar

Papilio demoleus (Linn.)
(Papilionidae: Lepidoptera)

Status

It is major pest of citrus crop.

Distribution

It is almost found in all citrus orchards.

Food Plants

Citrus

Description of Stages

Adult: Bluish-green in colour with black wings, ornamented with numerous yellow spots.

Eggs: The eggs are small round, creamy in colour.

Caterpillar: The full grown caterpillar green in colour with few oblique brownish stripes.

Pupa: The pupa is straw colour (i.e. orange) and mottled with black.

Duration of Stages

Adult: Adult life varies from 2 - 8 days in captivity.

Eggs: 105 eggs

Caterpillar: Two week in summer and four weeks in winter. summer.

Pupa: A week in summer and upto 14 weeks in winter.

Life History

Active period: April to November

Inactive period: Winter; October - November to March

Period of optimum activity/damage: April - May and July - August

No. of generations/Year: 4 - 5.

Generation which cause maximum damage: 2nd and 4th.

Mode of Damage

The larvae feed upon leaves eating them from the edge up to mid-rib. The tender shoots and fresh sprouts in the later stages are also attacked. Heavily attacked plants bear no fruits. The pest damage to the young plants in the nursery sometimes results complete defoliating.

Control

Chemical Control:

i. Monitor	600 SL	300 ml/acre
ii. Decis D.	2.5 EC	100 ml/acre
iii. Methyl parathion	40 EC	200 ml/acre
iv. ...aster	60 SL	100 ml/acre

Citrus Leaf Miner

***Phyllocnistis citrella* (Stnt.)**
(Gracillaridae: Lepidoptera)

Status

It is major pest of citrus crop.

Distribution

It is widely distributed in citrus growing areas.

Description of Stages

Adult: Adult is tiny moth, silvery white in colour. Fore and

hind wings with fringes of hairs.
 Egg: Egg is minute and round.
 Larva: Pale greenish colour.
 Pupa: Brownish in colour.

Duration of Stages

Adult: 12 - 55 days.
 Eggs: Female lay egg singly on leaves.
 Larva: 5 - 30 days.
 Pupa: 5 - 25 days.

Life History

The entire life cycle 12 - 65 days.
 Active period: March to November
 Inactive period: December to February
 Period of optimum activity/damage: March - April to
 July - August
 No. of generations/Year: More than 13 generations.
 Generation which cause maximum damage: July-
 August.

Mode of Damage

The larvae cause damage by making zigzag galleries in the young leaves between the upper and lower middle layers. These silvery galleries are visible on fresh affected leaves. On the older leaves brownish patches are formed. Attacked leaves get twisted or folded over but remain on the plants for a considerably long time. Heavily attacked plants can be spotted out from a distance.

Control

Chemical Control:

- i. Metasystox 25 EC 0.5 lb. a.m/acre/100
gallon of water
- ii. Malathion 57 EC 1 lb. a.m/acre/100 gallon
of water
- iii. Folidol. M 50 EC 0.5 lb. a.m/acre/100
gallon of water

Citrus Psylla

Diaphorina citri (KUW)
(Psyllidae: Homoptera)

Status

It is major pest of citrus orchards.

Distribution

It is widely distributed in citrus orchards of Punjab.

Food Plants

Citrus

Description of Stages

Adult: Small size, brown, 1/10 inch in length.

Eggs: Pale-yellow, 0.3 mm length.

Nymph: 5 nymphal stages, full grown nymph is light yellow.

Duration of Stages

Adult: 189 days.

Eggs: 379 - 897 eggs in life time.

Nymph: 11 - 25 days, after that it become adult. It mean pupal stage present during in these days.

Pupa:

Life History

15 - 48 days, life cycle complete.

Active period: March - October

Inactive period: November - February

Period of optimum activity/damage: March, April and August

No. of generations/Year: 9 generations.

Generation which cause maximum damage: 1st, 2nd and 6th to 9th.

Mode of Damage

Both nymph and adult are responsible for causing damage. They suck the plant sap and secrete white globules of sugary stuff on which sooty mould develops.

The infested plants become weak, the young shoots are killed. Old leaves fall off and the yield falls due to premature falling of fruit.

Control

Chemical Control:

i. Metasystox	25 EC	0.5 lb. a.m/acre
ii. Diazinon	50 EC	100 gallon of water
iii. Methyl parathion		0.05% solution
iv. Folidol	50 EC	250 ml/acre
v. Triodan	35 EC	250 ml/acre
vi. Dimecron	40 WSC	200 ml/acre
vii. Supracid	40 EC	100 - 150 ml/acre

INSECT PESTS OF MANGO

Mango Leaf Hopper

Amritodus atkinsoni (Leth.)

(Cicadellidae: Homoptera)

Status

It is most destructive pest of mango.

Distribution

It is widely distributed in Punjab

Food plants

Mango

Description of Stages

Adult: 5 mm long, central longitudinal narrow dark streak on the scutellum absent.

Eggs: Fertilized females insert eggs singly in the tissue of the panicles, unopened flowers and young leaves.

Nymph: Elongated, more active and pale yellowish in colour.

No. of nymphal instars: 4 - 5

Duration of Stages

Adult:

Eggs: 200 or more - singly hatching period 8 - 10 days.

Nymph: 7 - 19 days.

Total life cycle: one month

Life History

Active period: Pest is practically, active throughout the year but during the hot months of May, June. The adult are found sitting in thousand on the trunk, branches of the plant.

Inactive period: October - November to March

Period of optimum activity/damage: February and March months and cause severe damage to inflorescence and young leaves.

No. of generations/Year: Two (1st during February - April and 2nd in June - August) .

Generation which cause maximum damage: First generation during February

Mode of Damage

Injury is caused by the nymphs and adults by sucking cell sap from the inflorescence and tender shoots. The inflorescence is also injured in the process of egg laying by the females. The nymphs are particularly harmful as they de-sap fruit bearing portion of the plant. They cause the inflorescence to wither and turn brown consequently flowers fall off prematurely without setting any fruits. The nymph also produce honey dew on which black mould develops giving the attacked plant a dull blackish look.

Control

Chemical Control:

Metasystox	25 EC	200 ml/100 lit. of water
Folidol	50 EC	250 ml/100 lit. of water
Talstar	10 EC	20 ml/100 lit. of water

Mango Mealy Bug

Drosicha stebbingi (Green)
(Monophlebidae: Hemiptera)

Status

It is a serious pest of mango.

Distribution

The mango mealy bug is widely distributed through out the mango growing of the Punjab.

Food plants

Besides Mango, Mulberry, Pluns, Peaches, Guava, Fig etc.

Description of Stages

Adult: Female wingless, oval, flattened, body covered with a white mealy powder.

Male dipterous: Fore wings black, hind wings modified as halteres, body crimson.

Eggs: Pink becoming palish near maturity.

No. of instars: Male: 4
Female: 3

Pupa: Occurs only in the male.

Duration of Stages

Adult: Male: 4 - 7 days.

Female: 22 - 47 days.

Eggs: 200 eggs singly, eggs hatch in 7 to 14 days.

Nymph: 3 - 6 months

Pupa: 4 - 7 months. Only in Male.

Total life cycle:

Life History

Active period: January to June.

Inactive period: After egg laying pest dies-away in June

Period of optimum activity/damage: January to April - May

No. of generations/Year: They complete one generation

in 1 year.

Generation which cause maximum damage: January to May generation.

Mode of Damage

The eggs hatch in 2nd fortnight of December and tiny nymph come out. These crawl up the plant during January and cluster round shoot and draw up food by desapping. Consequently lowering the vigor of the inflorescence. Continuous feeding results in premature fall of fruits or even setting of shrivelled fruit is common result of the pest attack.

Control

Cultural Control:

- i. Ploughing up the soil thoroughly near mango trunk during June to DEC
- ii. Collection of eggs and their throwing them away on roads during (July to December) will kill the eggs by moving traffic.
- iii. Polythene sheet of 9" to 1" width at a 4' height from soil must be put round the tree trunk in December to January. This practice will ensure safety to plant.

Chemical Control:

Spraying the trees with carbaryl 0.1% or methyl parathion / phosphamidon/ Endosulfan/Dimethoate/malathion 0.05% effective controls the pest. spraying should preferably be done during morning hours.

Dimecron	50 WSC @	200	ml/100	lit. of
water				
Basudin	60 EC	"	"	"
Thiodan	35 EC	"	"	"

INSECT PESTS OF VEGETABLES

Red Pumpkin Beetle

Aulacophora foveicollis (Lucas.)
(Chrysomelidae: Coleoptera)

Status

Major pest of vegetables.

Distribution

Widely distributed in Pakistan.

Food Plants

Serious pest of cucurbits all over the Punjab.

Description of Stages

Adult: Red orange colour.

Eggs: Yellow later on orange coloured.

Larva: Creamy yellow or white

No. of larval instars: 4 instars

Pupa: Creamy white

Duration of Stages

Adult: One month.

Eggs: 27 - 293 singly or in batches.

Larval stage: 13 - 25 days

Pupal stage: 7 - 17 days

Life History

Active period: March - April to November

Inactive period: Hibernate in November to March

Period of optimum activity: April and May at seeding stages.

No. of generations/year: 5 generation

Generation which cause Max. damage: 1st, 4th and 5th

Mode of Damage

The attack of this pest is severest on germinating cucurbit seedling during spring season. The grubs also attack roots stem and fruit of plant.

Control

Chemical Control :

Malathion

57 EC

500 ml/acre

Cabbage Butterfly

Pieris brassicae Linnaeus
(Pieridae: Lepidoptera)

Status

Major pest.

Distribution

Distributed throughout Pakistan.

Food Plants

Cabbage and other Cruciferous plants.

Description of Stages

Adult: Yellow white: Female larger with 2 black spots on the upper side of each fore wings. Male: Smaller than female with 2 black spots on the under side of each fore wing

Eggs: Pale white or yellow.

Larva: Pale-yellow

No. of Larval instars: 5

Pupa: Greenish yellow

Duration of Stages

Adult: Adult

Male: Life 3 - 4 days.

Female: Life 6 - 8 days.

Eggs: 190 - 390 singly or in clusters of 50 - 90 usually on underside of leaves 3 - 8 days. (Incubation period).

Larval instars:

1st instar = 3 - 4 days

2nd instar = 3 - 5 days
3rd instar = 3 - 4 days
4th instar = 3 - 4 days
5th instar = 4 - 5 days

Total larval duration = 16 - 22 days

Pupal stage: Pre-pupal period = 1 - 12 days.

Life History (Migratory Pest)

Active period: November to March/April. Plains of Punjab. May to November Hilly areas.

Inactive period: May to October

Optimum activity: November - December and March - April

No. of generations/year: 2 - 3

Mode of Damage

The damage is caused by caterpillars as they feed on leaf area making gregariously bigger holes as indication of its attack

Control

Chemical Control:

Chlorpyrifos	40 EC	500-750 ml/acre
Decis	2.5 EC	200 ml/acre
Malathion	57EC	500 - 700 ml/acre

Brinjal Fruit Borer

***Leucinodes orbonalis* (Guenee)**
(Pyralidae: Lepidoptera)

Status

Major pest of brinjal.

Distribution

It causes serious damage in all areas where brinjal vegetable is intensively cultivated.

Food Plants

Brinjal and may attack potato.

Description of Stages

Adult: White with pale brown or black spots on dorsal side of thorax and abdomen. Wings white with apical and anal margins fringed with small hair.

Eggs: Creamy white and before hatching the colour changes to reddish brown.

Larva: Creamy white that later on turns pinkish.

No. of larval instars: 5

Pupa: Reddish brown enclosed in dirty brown, tough boat shaped silken cocoon.

Duration of Stages

Adult: 2 - 5 days

Eggs: 80 - 120 singly or in clusters.

Larval stage: 5 larval instars in 9 - 28 days.

Pupal stage: 6 - 17 days.

Life History

Active period: March to October

Inactive period: February - March.

Optimum activity: March-April and August - September

No. of generations/year: 4 - 5

Generations which causes Max. damage: 2nd and 4th generation

Mode of Damage

The caterpillar bore into the tender growing shoots and as a result of this the growing points are killed. Affected shoots die off and hang down. The attacked fruits on the other hand called as "KANA" in Punjabi fetches low or no price in the market. These attacked fruits serve as a source of further multiplication of pest population.

Control

Physical Control:

Clean cultivation and regular removal of the plant debris from the field are necessary to destroy pupae in

such debris.

Mechanical Control.

Affected fallen and hanging fruit alongwith dead shoots should be cut, collected and properly disposed off to destroy the larvae contained in them.

Cultural Control:

After harvesting, the crop, the plants should be pulled out and properly destroyed. A deep ploughing would necessary to destroy the pests in various developmental stages of present in soil.

Chemical Control:

Malathion

57EC

500 ml/acre

Melon Fruit Fly

Bactocera cucurbitae (Coq.)
(Tephritidae: Diptera)

Status

Major pest of cucurbits.

Distribution

It is widely distributed in all the vegetable growing areas of Punjab.

Food Plants

Cucurbit, vegetables etc.

Description of Stages

Adult: Reddish with yellowish patches on thorax.

Eggs: Whitish yellow.

Larva: Dirty white.

Larval stages:

Pupa: Light yellow later on dark brown.

Duration of Stages

Adult: 14 - 54 days.

Eggs: Eggs laid in young fruits with soft and tender skin.
Total no. of eggs laid by one female ranges from 60 - 120 in its life time.

Larva: 15 days
Pupa: 6 - 10 days

Life History

Active period: March to October

Inactive period: November to February

Period of optimum damage: March - April and July - August.

No. of generations/year: 4 - 10 generations/year.

Max. Damage causing generation: 3rd to 5th and 8th to 9th

Mode of Damage

Female punctures the raw fruit and lays eggs. From the eggs larvae came out and begin feeding on the pulp that continues till fruit decay. Such affected fruit fall to ground and larvae come out and enter the soil to become pupae and adults.

Control

Physical Control:

Regular collection and destruction of the infested fruits to 2 - 3 feet depth in soil or their burning is helpful to control the pest.

Mechanical Control: Pheromone trap (Methyl Eugenol) is also effective.

Cultural Control:

It is done mainly for destruction of pupae in the soil. Thus surface ploughing after crop harvesting is recommended to expose the pest to temperature extremes. Moreover heavy irrigation is also helpful.

Chemical Control:

Diptrex	80 SP	680 gm/acre
Thunder	100 EC	250 ml/acre

Perfekthion

40 EC

100 cc/acre

Brinjal Stem Borer

Euzophera perticella Rag.

(Pyralidae: Lepidoptera)

Status

Major pest of Brinjal.

Distribution

Widely distributed in Punjab.

Food Plants

Brinjal

Description of Stages

Adult: Pale yellow to grey brown.

Eggs: Creamy white

Larva: Yellowish pale white

Larval instars: 5

Pupa: Light brown

Duration of Stages

Adult: 7 days

Eggs: 104 - 363 eggs singly or in clusters on underside of young leaves.

Larva: 26 - 58 days depending upon environmental conditions.

Pupal stage: 6 - 8 days

Life History

Active period: March to October - November

Inactive period: November to February

Period of maximum damage: March - April and August - September

No. of generations/year: 5 - 6 overlapping generations per year.

Max. Damage causing generation: 2nd, 3rd and 4th.

Mode of Damage

The caterpillar on hatching enter into the shoot that is killed off. Such killed away shoots are clear indication

as to the attack of this pest insect. Maximum damage is done by the pest at earlier stage.

Control

Cultural Control:

Avoid ratooning of crop.

Chemical Control:

Polytrin-C	440 EC	400 ml/acre
Decis	2.5 EC	200 ml/acre

STORED GRAIN PESTS

1. KHAPRA BEETLE:

Trogoderma granarium Eerts.

Distribution:

Throughout Indo-Pak sub-continent. In Punjab's hotter and drier parts.

Food:

Wheat grain favourite. Also feeds on grains of rice, jowar, gram and maize.

Life History:

Winter over a larva form October-April in cracks and crevices of walls and floor of granary. Active in May-September. Eggs singly loose among the grain. Larva feeds on grain. Pupa in last larval skin among the grain.

Egg stage	5-7 days
Larval stage	19-37 days
Pupal stage	7-6 days

Control

- i) Thigmotropism: trapping of larvae and adults by spreading gunny bags over infested grains in the active season.
- ii) Fumigation with EDCT @ 10-25 lb/1000 cu., ft. Exp. 3 weeks
- iii) Fumigation with Al-Phosphide Tablets.

2. RICE WEEVIL:

Sitophilus oryzae L.

Distribution:

In stores of rice, wheat and other grain in warm and moist places.

Food:

Wheat, rice, maize, jowar.

Life history:

Harmful during hot weather. Eggs in grooves of grain or in pits made by insect. larvae on hatching enter grain and feed inside. They destroy more and eat less.

Larval stage 15-30 days

Pupal 6-15 days.

3. DHORA:

Bruchus chinensis L.

Distribution:

Wide.

Food:

Stored grains, peas, lentils, pulses but most destructive to gram.

Life history:

Eggs on seed on top layer of heap. Larvae inside seed or groon. Pupa near seed surface inside the seed.

Eggs stage 4-7 days

Larval stage 17 days

Pupal stage 7 days at 10°C

Damage:

Adults do not take any food, grubs most destructive during April-october. They eat grain completely from inside leaving shell behind.

Control:

- i) Dry grain in sun during summer for 3 days,
- ii) Two inches layer of sand over grain surface, as in Khapra.

GENERAL PESTS

1. DESERT LOCUST:

Schistocerca gregaria

Phase theory of locust:

Desert locust is polymorphi whom morphological colour and behaviour variation in different phases e.g., colour of body, shape of pronotum length of wings and adults leading a solitary or gregarious existence

Differences between destructive gregarious and harmless solitary phases are:

GREGARIOUS	SOLITARY
Swarm and move Single.	No movement.
Body colour changes form pink lead grey yellow. Small dark spots on elytra.	Greenish white-yellowish grey with Stripes or. pronotum and a pale stripe stripe along its middle.
Pronotum concave short constricted in front.	Arched or crested. No constriction.
Prosternal spine scale smaller.	Prominent.
hind femur shorter, tegminal longer.	Hind femure longer,
Body size smaller	Body robust.
More in bands.	Solitary life.
Bold colour independent in environment, yellow	Resemble environment with black markings.

Distribution:

Africa, Portugal, South of Spain. North Syberia, Sudan, Arabia, Syria, Iran, Afghanistan

West Pakistan. India. It is connected with dry, desert and semi-desert regions.

Food Plants:

Excepting AK, Neem and Dhake, feeds on about all kinds of vegetation. Feeds on moist.

Wool of sheep and eye lashes of children. Also show cannibalism. Feed on dead bodies of their fellows.

Habits and behaviour:

- i) Feeding habits extremely wasteful.
- ii) Positively geotropic in the morning and afternoon.
- iii) Hoppers feed in the morning and afternoon.
- iv) Adults and big hoppers feed 24 hours.
- v) Sluggish when cold and cloudy.
- vi) Moults on plants.
- vii) Body parallel to or at right angle to sun-rays according to heat requirements.

Life history:

Mating on ground lasts for few minutes to 8-24 hours. Under field conditions, egg laying immediately after mating but in laboratory may be delayed upto 37 days. Eggs in light soil, in a hole drilled with ovipositor eggs in one cluster. Maximum 11 clusters.

Pre-oviposition period	26-103	days
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Oviposition period	8-74	days
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Post-oviposition period	1-14	days
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Polygamy and polyandry are common.

The area of egg laying can be recognized by holes, drop off wings and legs and birds eating eggs.

Incubation period 18-21 days March-April, 15 days

May-September, 12-14 days July-August, 21 days

February. Incubation may be delayed if no moisture.

Hoppers undergo 5 moults and are gregarious.

Hopper stage 4.8 weeks. Breeding February-October and

2-4 broods.

Damage:

Severe in summer. Wheat seedling and earings, oil seeds and cotton seedlings are destroyed. Hoppers may enter house, beds, kitchen etc. and are anuissance. Foul water by falling in it. Make railways slippery when crushed under.

Control:

It is an international problem. Anti locust organization supplies information. Control is a collective effort and carried out on emergency basis because hoppers are vulnerable and short lived.

- i) Prevent adults from alighting by beating drums etc. explosion of crackers, firing guns, waving cloth.
- ii) During mating and egg laying, adults are sluggish and should be killed by
 - a) beating
 - b) running a sohaga
 - c) burning.
- iii) Destruction of eggs by
 - a) Ploughing.
 - b) Digging and feeding to poultry.
 - c) Irrigation at the time of hatching.
- iv) Burning of resting hoppers and adults in the morning or night with the help of a flame thrower or by burning trash.
- v) Destruction of hoppers by
 - a) Trenching which is efficient and cheap method for
 - i) Isolation of egg laid area.
 - ii) Protection of valuable crop.
 - b) Erection of barriers of metal sheets etc.
 - c) Cloth screen. Dig pits along screen.
 - d) Poisons
 - i) Dust BHC 0.25% 1st instar

0.050%	2 nd instar
0.075%	3 rd instar
0.1%	4 th instar
0.2%	5 th instar
0.3%	Adult

- ii) Bait with Aldrin @ 2.40 oz, a.m./
acre in 100 lb bran or saw dust +
10 seers of water.

2. TERMITES

(*Termes obesus* Ramb).

Social insect living in colonies with following individuals.

Queen: large, abdomen greatly, stretched. Lays eggs

King: Small, mates with queen.

Soldier: head flat, long scissor like mandibles and shield

shaped pronotum. Defends colony.

Worker: head small, blind

Fungus comb: Spongy. Cultivated in fungus garden.

Young ones feed on these combs.

Royal chamber: King and queen live in Numerous holes

through which workers come and go to take eggs.

Live in nests underground. Winged individuals seen on light during monsoon.

Biology:

Colony headed by dealthed king and queen. Live in Royal chamber deeply hidden in termitarium. Couple in monogamous. Brachypterous and Apterous forms are reproductive and can replace royal couple when necessary. They are polygamous, macopterour forms found in new colonies.

Founding of new colonies

In monsoon Macopteros caste leaves the colony and swarms after first shower of rainfall. Not strong fliers, eaten by bird, lizards, etc. and only a few survive. They fall on ground, shed their wings. Couples separate and mate. Then enter in soil, make a small burrow called nuptial chamber. The female lays of few eggs (15-50) and some of them may be eaten by parents. Most of the first brood is workers which build colony. The first workers appear after 7 months of swarming. In the early stages they are fed by parents and then they take up the whole work. During first season reproductive castes are not produced. The queen grows in size and becomes inactive and is fed by workers on saliva etc. Now she starts laying eggs @ 70,000-80,000 eggs in 24 hours. About 1 million eggs in one year and life of a queen is 6-9 years. Workers feed royals and take exudate of their bodies themselves. Sterile caste may live for 1-2 years.

Food:

Wood and vegetable tissues, matter of their fellows and in that way they get protozoa. Feed on moults and dead bodies. Some termites collect grass, seeds, pieces of leaves.

Wood eating termites cannot digest fiber or cellulose portion of food and hence harbour a rich family of protozoa which contain cellulose digesting bacteria.

Other Occupants

Insects and other Arthropoda mites, spiders, centipedes, millipedes, scorpions, lizards, snakes and birds.

Control

- i) Destroy royals when they are out and treat nests with boiling water.

- ii) In recently cleared areas do not grow crops. Do not use green manure of unrotten F.Y.M.
- iii) clean cultivation, hoeing and frequent watering.
- iv) later sown wheat less attacked.
- v) Sow in proper moisture.

Chemical Control:

Place chopped leaves of Ak in dry water channel to rot and then apply irrigation.

Chillies:

Apply Aldrin 2lbs. With irrigation after transplanting.

Groundnut:

Aldrin 2 lbs. Mixed with ashes 6" deep in the soil one week before sowing.

Sugarcane:

Dip setts in 0.5% solution of DDT for 15 minutes and dry under shade before sowing.

Wheat:

Treat seed before sowing with sanitary fluid diluted 32 times with water.

Fruit Plants:

- i) Apply crude oil emulsion 0.5 lb. with a little arsenic in about 4 baskets of sub soil before planting.
- ii) Sanitary fluid 6 oz. Per tree to the trunk upto 7 high from ground.]

Buildings:

- i) Coal tar.
- ii) Wood work to be painted with coal tar, creosote or furnace oil and walls upto 2-3 ft.
- iii) Drench floors with soda arsenic solution to save furniture.
- iv) Shelves and almirahs with DDT or Aldrin.

FRUIT FLIES

(*Dacus* and *chactodacus* spp.)

Identification Characters:

These flies can be easily distinguished from ordinary flies by their triangular shaped abdomen and spotted wings.

Life Cycle:

The life history of all these flies is similar. Shining whitish cigar-shaped eggs are thrust into the skin of the ripening fruit; these hatch into footless maggots. Maggots feed on the fruit pulp by burrowing into it and damage the same; when full-fed, they generally drop to the soil, change into seed-like pupae under the soil and emerge as flies after a week or ten days. Maggots have the habit of jumping into the air.

Damage: Two or more different species of these insects are commonly met with on all pumpkin fruits, they maggots of these flies bore into the ripening fruits and very often cause appreciable injury, the fruits begin to rot & drop. All cucurbits, especially melons and bitter gourds suffer from these flies, especially from the species, *chaetodacus cucurbitae*.

Control:

control consists in preventive measures only. Damaged fruits should be promptly destroyed, and the flies trapped by poisoned syrups to prevent egg laying.

THE ARMY-WORM

(*Mythimnas separata*)

Identification Characters:

The army-worm is a pest of graminaceous crops all over the world. The adult moths of army-worm are

pale brown. Larvae are dull white and later turn green.

Life-cycle:

They live for 1-9 days and lay eggs singly in rows or in clusters on dry or fresh plants or on the soil. the eggs are round, light green, when freshly laid, and turn pale yellow and finally black. In the Punjab, they hatch in 4-11 days from march to May, and in 19 days in December-january. In the spring, the larval stage is completed in 13-14 days, but in the winter it is prolonged to 88-100 days. In the pre-pupal stage, the insect spins a cocoon. The pre-pupal stage lasts 1-11 days during January to May. The pupal stage is completed in 9-13 days in May and in 36-48 days in the winter months. The survival of the pupae depends on the soil moisture.

Damage:

The freshly emerged larvae feed on tender leaves in the central whorl of the plant. As they grow, they are able to feed on older leaves also and skeletonize them totally. The grown-up caterpillars throw out faecal pellets. Which are quite prominent. In the case of a severe attack by the army-worms, whole leaves including the midrib, are consumed and the field lookd as if grazed by cattle. The pest may also eat away ears, including the awns and immature grains.

Control:

Army-worms can be controlled by spraying the crop with a number of insecticides: Carbaryl/ Fenitrothion/ Trichlorfon 0.15 %; Malathion 0.05%. ULV spray is also effective. The pest can be suppressed by collecting and destroying the caterpillars.

the new queen.

1. To make one colony from 3-4 colonies, do as follows
- a) prepare a new hive.
 - b) Place one brood frame and one with honey and some bees from three colonies.
 - c) Put the new hives in place of fourth one and remove away the fourth hive.

The new colony will rear a queen in due course and swarming is checked.

Honey Flow:

During April to May in Punjab; so make a ample space for honey store and provide comb foundations well in time. Honey should be extracted leaving 15 lb. per hive for the bees to pass summer.

2. SUMMER MANAGEMENT

In this period, bees abscond and colonies become weak due to :

- a) adverse climate.
- b) Attack of wax moth, and
- c) Lack of bee flora.

So control absconding and unite bees by way of two queen system, multiple queen system, less handling better ventilation, ample honey, and watching bee enemies.

Two Queen System:

A condition of two colonies held together but working independently. Two parts of hive separated by queen excluder; each queen working in its own territory.

Multiple Queen System:

More than two queens in the same brood chamber without partition.

- a) It provides better situation.
- b) It provides ample honey store.
- c) Close watch on bee enemies.

3. WINTER MANAGEMENT

- i) protect by packing 3 inches grass etc., and place in wind protected place.
- ii) Keep strong colonies with plenty of honey and good queen.
- iii) Unite weak colonies with strong ones.

FEEDING OF HONEY BEES

During scarcity period, feed on honey or sugar syrup. Before winter two parts of sugar and one part of water, otherwise 50:50 put solution in air tight tin or in dishes with straws flowing on surface.

HONEY EXTRACTION

When honey flow has stopped and $\frac{1}{2}$ to $\frac{3}{4}$ cells capped; take out frames and remove the bees. Uncap combs with a hot uncapping knife and put frames in centrifugal honey extractor and revolve. Honey will come out by centrifugal force.

Allow the honey to settle down for 3-5 days and then bottle it.

ENEMIES OF BEES

1. Wax moth
2. Wasps: destroy bees at hive entrance and in the field, fumigate their nests.
3. Black ants: take honey, pollen and nectar, and fight with bees.
4. Bee eater or son Chiri. These are controlled by shooting.

ECONOMICS OF APICULTURE

1st Year

10 colonies @ Rs. 80.000	=	800.00
10 hives @ Rs. 140.00	=	1400.00
10 full supers @ Rs. 40.00	=	400.00
10 shallow supers @ Rs. 35.00	=	350.00
10 lbs. Comb foundation @ Rs. 20.00	=	200.00
1 md. Sugar	=	440.00
Bee appliances.	=	350.00

		3940.00
2nd Year		
10 lbs. Comb foundations	=	200.00
1 md. Sugar	=	440.00
		640.00
Income		
1st year	=	8000.00
200 lbs. @ Rs. 40.00		
(20.lbs. Per colony)		
10 swarms @ Rs. 90.00	=	900.00
.5 lbs. Bees wax @ Rs. 20.00	=	100.00
		9000.00
2nd year		
As in 1st year	=	9000.00
Expenditure	=	640.00
Net Income		8360.00

LAC CULTURE

The art of rearing lac insects for lac production is called lac culture or lac cultivation.

Lac: A product of lac insects produced only in Indo-Pakistan. Crude lac contains rosin and lac-dye. Previously lac was valued for its dye but after discovery of synthetic dyes, there is no demand for lac dye and now it is valued for rosin. Rosin is used for manufacture of paints, varnishes gramophone records, bangles, and ear-rings etc. Ships and aero planes are painted with lac to save from water and climatic effect. It is used for coloring wooden articles, Silver articles are filled with lac. No successful substitute for lac has been discovered so far.

BIOLOGY OF LAC INSECTS

Two broods i.e. Kharif and Rabi. Total duration of Kharif is 3 and rabi 8 months. Rabi is commercial crop and Kharif is a brood crop.

In one inch there is 100-150 cells of lac insects and from one cell about 250 larvae emerge out. Duration of swarming period is 2 weeks in Kharif and 3 weeks in Rabi. Larvae are scarlet-colored. They crawl on branches and then fix stylets in tissues and suck sap.

First instar larva has 3 pores in its cells and devoid of legs and antennae (Cell is spherical with typical margination) During 3 weeks in Kharif and 5 weeks in Rabi.

Male larva is cigar-shaped with 2 pores. After second instar, it undergoes a prepupal and a pupal stage, each of about 1 week duration.

Adult Male:

Winged and wingless male adults emerge in the beginning of September in Kharif crop, and in end of march or beginning of April in Rabi crop. Adult males die after mating. Adult stage is of 10 days in each crop. Males do not produce commercial lac.

Adult Female:

After fertilization enters theird instar and grows in size. Rosin and honey secretion greatly enhanced. preoviposition period is 4 weeks in Kharif and 12 weeks in Rabi. Eggs are laid in special chamber, the brood and the female dies within the chamber. Larvae crawl out from the anal opercular opening of mother cell.

HOW TO START LAC CULTIVATION

Locality:

temperature 40-110°F. Humidity 40-70%. Rainfall 30" and well distributed.

Sub- mountain areas of Punjab are best locality. Salt range, river belts and thick forests are also good.

Lac hosts:

17 plants were tried but only 5 proved successful. These 5 plants are described below:

1. *Zizphus jujuba* (Ber)

Lac of superior quality. Respond to pruning. Ber brood lac can be tried on all other hosts

2. *Ficus* sp. (Fig)

Best sp. Is *Ficus acrica*. Lac produced is light weight and of superior quality. It affords protection to brood in summer.

3. *Butia monospema* (Dhak)

Cannot be used as host in new areas otherwise the best host were already granting.

4. *Acacia arabica* (Kiker)

Inferior quality lac is produced. In Hyderabad, it is most important host.

5. *Albizzia labbek* (Siris)

Inferior quality lac and brood becomes specific.

TIME OF GROWING LAC

Two crops i.e., Kharif and Rabi in a year as the insect has two generations.

KHARIF:

Pruning is done from Jan. Mar. and it is essential because tissue becomes succulent and sap is easily sucked. Pruning should be done 6 months before incubation. Incubation is done in July. Crop matures in Oct. and healthy seed is taken for propagation.

RABI:

Inoculation is done in Oct. Crop matures in July.

Host plants should be divided in 2 blocks and only 1 block should be used during year.

METHODS OF PROPAGATION

A. **Natural:** Swarming on mother plant and larvae settle on the growth of infested branches. Infection is not uniform. This method is not to be practised.

B. **Artificial:** Only method which is under controlled

conditions. After pruning, 2-3 kg of brood is inoculated on each tree.

Stick method of inculation is the quickest and the most efficacious and economical. Healthy branches of infected trees i.e., brood sticks 9-12 long or out and tied below the fresh branches to be inoculated. If the branches are parallel, the brood sticks are tied across these branches. On swarming, larvae travel under-side of branches-upto 25 years old-then fix at a suitable place and start sucking sap.

First fortnight of July and second fortnight of october are the best inoculation seasons in Punjab.

HARVESTING

Harvesting of Rabi crop is done in August and of Kharif crop in November and February.

Harvesting or cropping should be done when swarming is over. Infested branches are cut and lac is scropaed off. Lac is dried in shade and stored after. Raw lac should not be stored for more than 6 months.

LAC PRODUCTS

1. Stick Lac (Raw lac):

Freshly scraped lac. It is crushed and washed, and impurities are separated.

Quality depends upon host, time of removal and scraping instruments. Best lac from dhak, fig, kiker, siris, respecitively.

2. Seed Lac:

It is washed stick lac. Average recovery of seed from stick lac is 50%. It is purest form of lac. By washing, dye is removed. Alcohol solubility confirms purity. It is highly adulterated in the market. Wood cement, lithographic link sealing wax lac dye are prepared from it.

3. Shell Lac:

Seed lac moulded in furnace acquires the forms of

flakes called shell lac and it is commonly used

ECONOMICS OF LAC CULTIVATION

A profitable cottage industry. One ber tree yields 10 Kg of stick. Lac priced @ Rs. 80.00 per Kg. Seed lac for 10 Kg of stick lac is 5-6 Kg Priced @ Rs. 350.00 per Kg

In Rawalpindi, only Kharif crop is recommended and thus leaves could be fed to cattle during Rabi as there is shortage of fodder.

In Lahore, Gujranwala, and Sialkot only Rabi crop is recommended. Insect does not suck and is hibernating in winter upto 15th March and then ber fruit is matured which can be consumed.

LAC INSECT ENEMIES

i) Temperature:

a) At temperature above 108°F, mortality on ber is upto 80%.

b) Temperature below 40°F is also harmful.

ii) Predators of Lac Hosts:

Eublemma ambilitis (Moore) and *Holococcera pulverea* are common predators. As a remedy, removal of brood lac sticks just after swarming has proved effective.

iii) Pests of Lac Hosts:

Fig borer, fig mite, ber-beetle, mealy bug, hairy caterpillar and leaf roller attack various host plants, and thus affecting lac insects.

SERICULTURE

The act of rearing silk moths for silk production is called sericulture.

Silk is produced by a number of species of the family *Bombycidae*, but silk produced by species other than *Bombyx mori* L. is of inferior quality and those species are attacked by a number of pests, hence do not give

satisfactory results.

Bomby mori. L. is univoltine, produces one crop in a year and feeds on mulberry leaves which are available locally. This insect require low temperature and little moisture, and this type of climate is found in sub-mountain tracts of this region.

Silk seed is available from Sericulture Inspector in each district @ Rs. 25.00 per oz, which contains 30,000 to 40,000 eggs. Seed is brought to plains in the end of February, and the mulberry trees sprout in beginning of march. For rearing 1 oz, of seed, at least 25 full grown mulberry trees are required.

Incubation of eggs should be started 15 days before sprouting of trees because by the time larvae hatch, tender leaves are available.

Eggs should be incubated in an incubator or in a room which is clean and where a temperature of 77 °F could be maintained. The temperature should be raised every day by 1°F. The eggs in the room should be placed on a white paper in thin film on a rack or stool etc. Minimum temperature is 75°F. Eggs should be covered for safety and disturbed twice or thrice daily, so that they get heated uniformly on all sides, Proper humidity is also to be maintained by keeping 2-3 buckets full of water.

Eggs hatch in 10-12 days, and hatching continues for 2-3 days. Young larvae secrete silk and try to entangle egg shell. Therefore, it is better to place a netting over the eggs and tender leaves over that. Thus they will crawl in for the leaves and can be removed along with netting cloth to some other place. Larvae should not be touched with hands. Caterpillars hatching during every 24 hours should be kept separately, as the art of rearing depends on synchronizing of mulberry leaves sprouting and the eggs hatching dates. There should be plenty of space. Space requirements for 1 oz.

Seed are as under:

1 st stage larvae	24 sq ft
2 nd stage larvae	40 sq ft
3 rd stage larvae	80 sq ft
4 th stage larvae	160 sq ft
5 th stage larvae	300-500 sq ft

Congestion is harmful. During first two stages chopped leaves should be provided as the mouth parts are not well developed. Leaves should not be dusty, wet or absolutely dry. Larvae are fed 4-7 times a day from 7 am. To 10 p.m. at intervals of 3-5 hours between each feeding.

HOW TO GET LEAVES

Leaves are collected twice a day, once at 10 am. When dew has gone dry and then towards evening. Morning leaves are fed during day and evening leaves during night upto 7.

The caterpillar pass through 5 moults. In the beginning of every moult, they stop feeding and keep 1/3 of anterior body raised up and withdraw thoracic legs. Do not feed them at that time and at hatching stage the larvae of the same age should be kept in one tray.

After moulting as soon as they begin to move, start feeding.

1st install	6 days
2 nd install	5 days
3 rd install	7 days
4 th install	9 days
5th install	9-10 days

QUANTITY OF FOOD

1st stage for 1 oz, seed	=	10Kg
2 nd stage for 1 oz, seed	=	20Kg
3 rd stage for 1 oz, seed	=	30 Kg
4 th stage for 1 oz, seed	=	6 mds.
5 th stage for 1 oz, seed	=	25 mds.

Total = 32.5 mds.

Sanitation is essential for rearing. Refused leaves and excreta must be removed. The trays should be cleaned 2 days after each moult. As they pupate under shelter, the 5th instar leaves should be provided Toria paller in the form of archways for pupation. As soon as they get shelter, they start secreting silken threads which are spun in the form of cocoon. One caterpillar spins 400-500 ft long thread. Then the adults will come out of the pupa by cutting a hole in the cocoon. Therefore, to save silk cocoon pupa is to be killed inside before changing into adult. The process of killing is called stifling (suffocation). It is done by 2 ways:

i) By sun heat: Expose cocoons for 2-3 days, cover with black cloth and thus pupa will be killed.

ii) By steam: Pass steam over the cocoons to kill pupa.

ECONOMIC IMPORTANCE

By successful rearing we get 35-40 Kg of fresh cocoons from one oz, of seed and on drying they will weigh 13-16 Kg. Cocoons can be sold @ Rs. 5000.00 to Rs. 7000.00. However, there is a definite income of Rs. 2000.00 to Rs. 2500.00 per season.

DISEASES OF SILKWORM

Silkworm is liable to infectious diseases.

1. **pebrine Disease:** Most serious in caterpillars and is heritable. Eggs laid by infected moths are infected and larvae from such eggs die before reaching maturity. Healthy seeds should be reared after microscopic examination.

In its symptoms, black spots on the body and inside oval carpuscles in the serum or blood are appeared.

2. **Muscardine or Calcine:** A contagious disease

which is caused by growth of a fungus. General appearance becomes mealy.

3. **Flacherie or Flaccidity:** Fatal disease prominent after 4th moult. All of a sudden larvae stop spinning become sluggish and die off.

4. **Grasserie:** Larvae become restless and yellowish in color. If the body is punctured, yellow fluid comes out and on microscopic examination. It is neither contagious nor hereditary nor caused by any living being and not serious.

**WE WANT TO UNITE THE WHOLE WORLD
UNDER THE SUPEREME COMMAND OF
HAZARAT MUHAMMAD (P.B.U.H.)**

By Professor Dr. Mohammad Tahir-ul-Qadri

**MUSTAFAYI STUDENTS MOVEMENT
UNIVERSITY OF AGRICULTURE FAISALABAD**

INSECTICIDE APPLICATION EQUIPMENTS

The insecticide application equipments are divided into two categories:

Ground Application Equipments

A. These are the equipments with the help of which we apply the insecticide on ground by standing on ground.

Aerial Application Equipments

B. It consists of sprayers, dusters, granule applicators and soil applicators.

1. **Sprayers:** These are the machines by which the liquid insecticides are applied in the form of thin coating on the surface of objects. These are of following types:

- i) Hand atomizers (e.g, lady hand sprayer)
- ii) Knapsack sprayers
- iii) Wheelbarrow sprayers
- iv) Power sprayers
- v) Air sprayers
- vi) Hydraulic sprayers

2. **Dusters:** These are the machines which apply the powder insecticides in the form of thin coating on the surface of objects. These are of following types:

- i) Hand operated dusters
 - a) Shaker type dusters
 - b) Crank or rotary dusters.
- ii) Power operated dusters e.g., Viller's power duster.

3. **Granule Applicators:** These are the machines which scatter the granular insecticides in the field. These are of two types:

- i) Hand operated granule applicators
- ii) Power operated granule applicators

4. **Soil Applicators:** These are the machines which apply the insecticides into the soil e.g., soil injector.

PRACTICAL QUANTITATIVE MEASUREMENTS OF PESTICIDES

SOME IMPORTANT TERMS

1. Formulation

The particular form of a pesticide in which it is manufactured and marketed is called its formulation. It is mixture of an active ingredient with one or more materials. Such as carrier or diluent. To make it save for storage, dilution and application.

Thiodan 35EC means formulation of Thiodan is 35 EC which shows 35% of active ingredient. Rest 65% is carrier or inert material which makes emulsifier with the poison.

Dusts, baits fumigants, aerosols and granules are usually applied at each strength purchased, while the emulsifiable concentrates, wettable powder and suspension concentration are diluted with water before use.

ABC 40 EC means an insecticide ABC with the formulation of 40% Em, Emulsifiable Concentrates,

ABC 40 WP means an insecticide ABC with the formulation of 40% Wettable Powder.

ABC 40 SC means an insecticide ABC with the formulation of 40% Soluble Concentrates.

2. Concentration

Amount of active ingredient or active material in a given volume or weight after formulation of mixture. It is also measured in percentage.

3. Dose

It is the amount of actual poison in volume. Unit area present in the given amount of insecticides. It is measured in the unit of a.i. (active ingredient) or a.m.

(active material).

4. **Total Quantity of Poison (T.Q.P).**

It is the second dose which consists of the amount of insecticide including poison as well as carrier. It is measured in the units of volume (like ml, lbs, gallons etc.).

5. **Total Quantity of Spray Material**

It is the amount of total material to be applied in field including poison, carrier and water added to insecticide for spraying purposes. It is also measured in the units of volume.

EXAMPLES

1. Calculate the quantity of given formulation of Aldrin 20% active material and total quantity of spray material to be used in an acre field when the recommended dose is 0.5 lbs active material/acres to be applied at a concentration of 0.01% Calculate the quantity of poison.

Data

Formulation of Aldrin	=	20%
T.Q.S.M.	=	7
Dose	=	0.5 lbs a.m
Concentration	=	0.1%
T.Q.P	=	?

Solution

According to formula

$$\begin{aligned} \text{T.Q.P.} &= (\text{Dose} / \text{Formulation}) \times 100 \\ \text{T.Q.P.} &= (0.5 / 20) \times 100 \\ &= 2.5 \text{ lbs.} \end{aligned}$$

2. Calculate the does of the ABC 2.5 WP poison against the insect pests of vegetables. The recommended dose is 200 ml active material at a concentration of 0.07%.

Data

Formulation	=	2.5%
Dose	=	200 ml a.m.

Concentration = 0.07%
 T.O.P. = ?
 T.O.S.M. = ?

olution

According to formula;

T.O.P. = (Dose / Formulation) \times 100
 T.O.P. = (200 / 2.5) \times 100 = 8000 ml =

liter.

T.O.S.M. = (Dose / Concentration) \times 100
 = (200 / 0.07) \times 100 = 285727 ml
 = 285.717 liter.

**E.P.M. is the educational project of
 Mustafavi students movement**