Lesson 22

Title of the Experiment: Identify the types of insect pests and their damage
(Activity number of the GCE Advanced Level practical Guide - 35)

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Intended Learning Outcomes

After completing this practical, students should be able to:

1. identify and categorize various types of insect pests and their damage to crop plants
2. identify the type of insect pest by the symptoms of damage
3. recognize the life stages of phytophagous arthropods which may have caused the damage
4. explain the adaptations of insect mouthparts by the symptoms of damage
5. Define the terms pest, injury and damage in relation to pest management.

Introduction:

Pest: A pest is one that damages or destroys organisms useful or beneficial to man.

Pests may be animals or plants. Plant pests are generally called weeds. Animal pests may be

i. Non insect pests
ii. Insect pests

Insect pest: Insect pest is an Insect species or taxa that damage or destroy organisms useful or beneficial to man.

Non insect pests may be

i. Invertebrates
    - Nematodes
    - Field crabs
    - Mites
    - Snails and slugs
ii. Vertebrates
    - Birds – Black birds in sunflower, parrots in paddy
    - Elephants
    - Rats
    - Rabbits
    - Porcupines
    - Wild pigs
    - Bandicoots

Organisms that destroy are considered ‘pest’ when its population density exceeds the economic threshold level. The concepts of ‘Economic **Injury** Level’ and ‘Economic Threshold Level’ are considered keystones of the present Integrated Pest Management. **Economic damage** is the amount of injury which will justify the cost of artificial control measures. To understand this term, we distinguish between **injury** and **damage**. Injury is the effect of pest activities on host physiology that is usually deleterious. **Damage** is a measurable loss of host utility, most often including yield quantity, quality, or aesthetic. Therefore, **injury** is centered on the pest and its activities, and damage is centered on the crop and its response to injury.

'Economic Injury Level' (EIL) is defined as the pest density at which the cost of additional control equals the economic loss prevented by implementing the control measure. The Economic Threshold (ET) differs from the EIL in that it is a practical or operational rule, rather than a theoretical one. **Economic threshold level** be defined as "the population density at which control action should be determined (initiated) to prevent an increasing pest population (injury) from reaching the economic injury level." Population Equilibrium Level (PEL) is defined as the average density of a population over a period of time in the absence of permanent environmental changes.

Fluctuations of in insect populations

The number of insects in any population varies from time to time on account of many factors such as food, diseases, climatic conditions such as temperature, humidity, rainfall and the interventions of natural enemies and man. However, these insects do not act as pest all the time. For an insect species to be a pest, the population density of an insect species must exceeds a certain level. In general, three levels can be identified. (Figure 1)

1. Population Equilibrium Level or General Equilibrium Position
2. Economic Threshold Level
3. Economic Injury Level

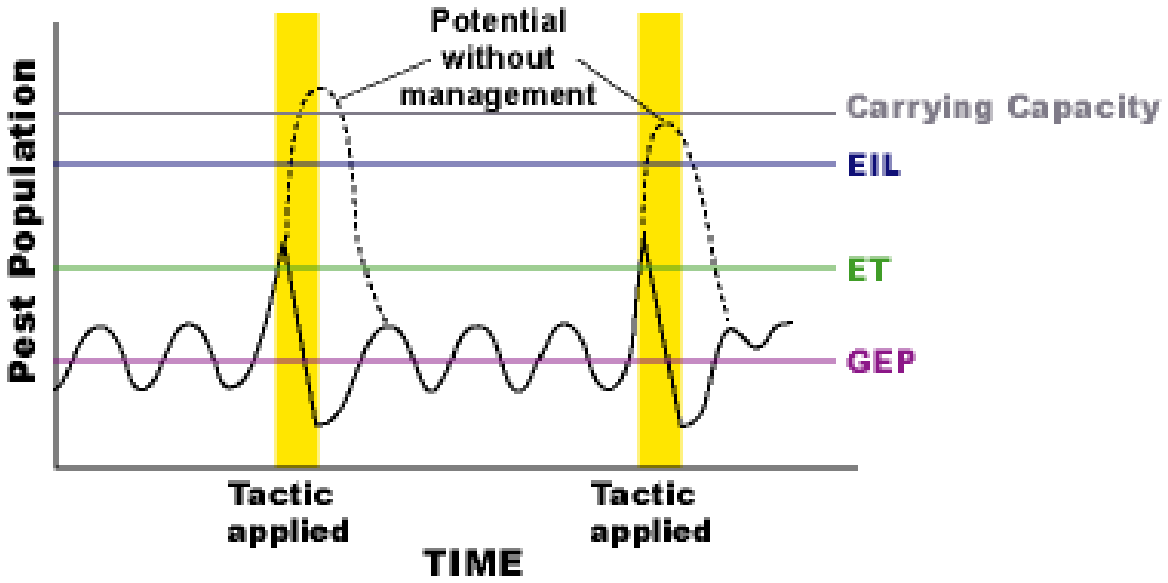


Figure 1: Fluctuation of insect population in agricultural field

1. **Population Equilibrium Level or General Equilibrium Position (PEL/GEL)**

   Average density of a population over a period of time in the absence of permanent environmental changes

2. **Economic Threshold Level (ETL)**

   The population density at which control action should be determined (initiated) to prevent an increasing pest population

3. **Economic Injury Level (EIL)**

   The pest density at which the cost of additional control equals the economic loss prevented by implementing the control measure.

Classification of pests based on nature, intensity or frequency of occurrence

Pests can be categorized in to 5 major groups according to the nature, intensity and frequency of occurrence. They are, regular pests, sporadic pests, potential pests, major pests and minor pests.

Regular pest: A pest that occurs every crop season and causes yield losses

Sporadic pest/Occasional pest: A pest that is irregular occurs here and there or at random but occasionally causes problems.

Potential pest: A pest that could cause significant economic loss if allowed to establish

Major pest: A more common and important pest

Minor pest: A pest that is not causing huge damage

Types of main insect pests include thrips, aphids, plant bugs, plant and leaf hoppers, beetles, weevils, grass hoppers and crickets, gall midges, termites, moths and butterflies and ants.

Thrips are tiny, slender-bodied insects. Wings when present are membranous, narrow and fringed with long setae (Figure 2). They have a simple rasping type mouthparts consisting a short cone-shaped beak consisting labium, labrum and the maxillae and inside the beak, is a stylet-like single mandible and a paired laciniae. They feed in the underside of the developing new leaves, flowers and buds by rasping off/lacerating the upper layer and sucking out the juice. Both larvae and adults feed by rasping/lacerating the plant tissue and sucking up the released plant juices. Thrips actually pierce plant tissue and ingest the fluids. Infested leaves develop characteristic longitudinal streaking, which gives the appearance of rasping damage. Affected leaves show symptoms such as developing a silvery color, or become distorted and curling upward.

Aphids are tiny, soft-bodied insects. (Figure 3) Their bodies are pear-shaped and have long antennae; they have two short tubes called conicles projecting from their hind end. Adults are wingless or they develop to winged form. Aphids usually occur in colonies on the underside of tender terminal growth of the plant. The nymphs and adults both use their piercing and sucking mouthparts to feed on plant sap.

Beetles range from minute to very large insects. Many are plant feeders such as leaf feeders, stem borers or bark borers. Their fore wings (first pair of wings) are modified as hard elytra that meet in the midline. The hind wings (second pair of wings) are membranous and larger than the elytra. Beetles have chewing (biting) type of mouthparts consisting a pair of mandibles. (Figure 4) The mandibles are a pair of hard, often large pincers-like or tooth-like structures used to grasp, crush, or cut food. Behind the mandibles is a pair of less powerful jaws, called *maxillae*. They are used for handling food and pushing it to the mouth. Beetles have two lips. The upper lip, called the *labrum*, is simply a flap that hangs down over the mouthparts and covers the mouth from the front. The lower lip, called the *labium*, covers the mouth from behind.

Modification of insect mouthparts Insect mouthparts are a set of structures surrounded its mouth and used for feeding. Structure of the mouthparts differ among insects, according to how they feed. There are two main types of mouthparts. One type is adapted for chewing (biting), and the other

for sucking. Some insects have combination of both. For example thrips have a combination of both. Typical biting and chewing mouthparts of an insect shows in Figure 5.

Materials/Equipment: Plant specimens showing insect damages

Insect box

Specimen slides

Microscope

Hand lens

Piece of cardboard, insect pins, marker pen, ink pen

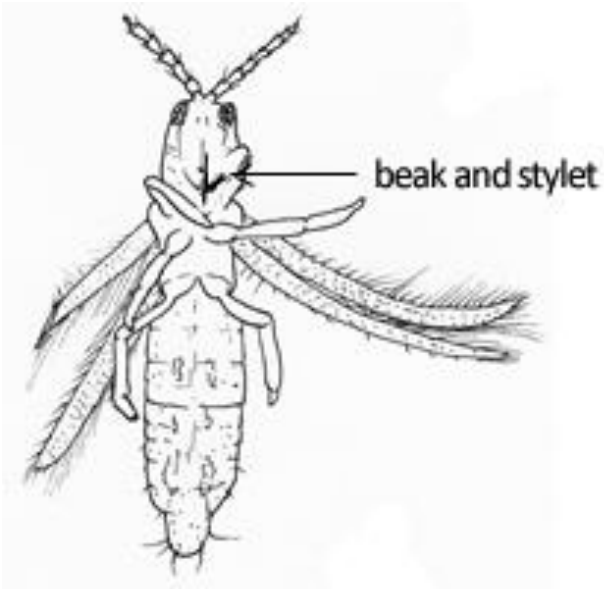


Figure 2: Thrip showing fringed wings and beak like mouthparts

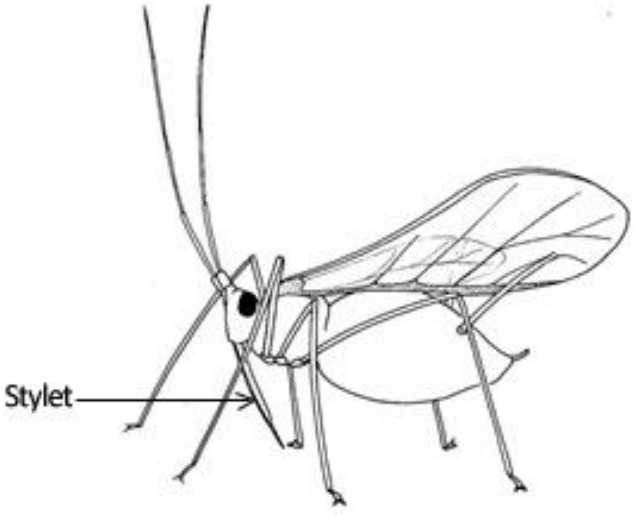


Figure 3: Winged aphid showing a sucking type mouthparts

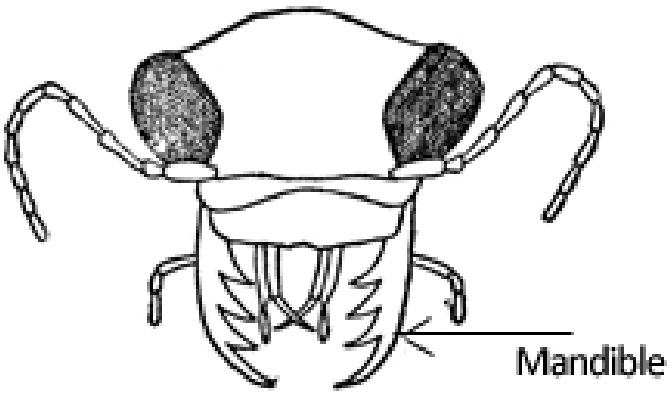


Figure 4: Biting/chewing type mouthparts of a beetle

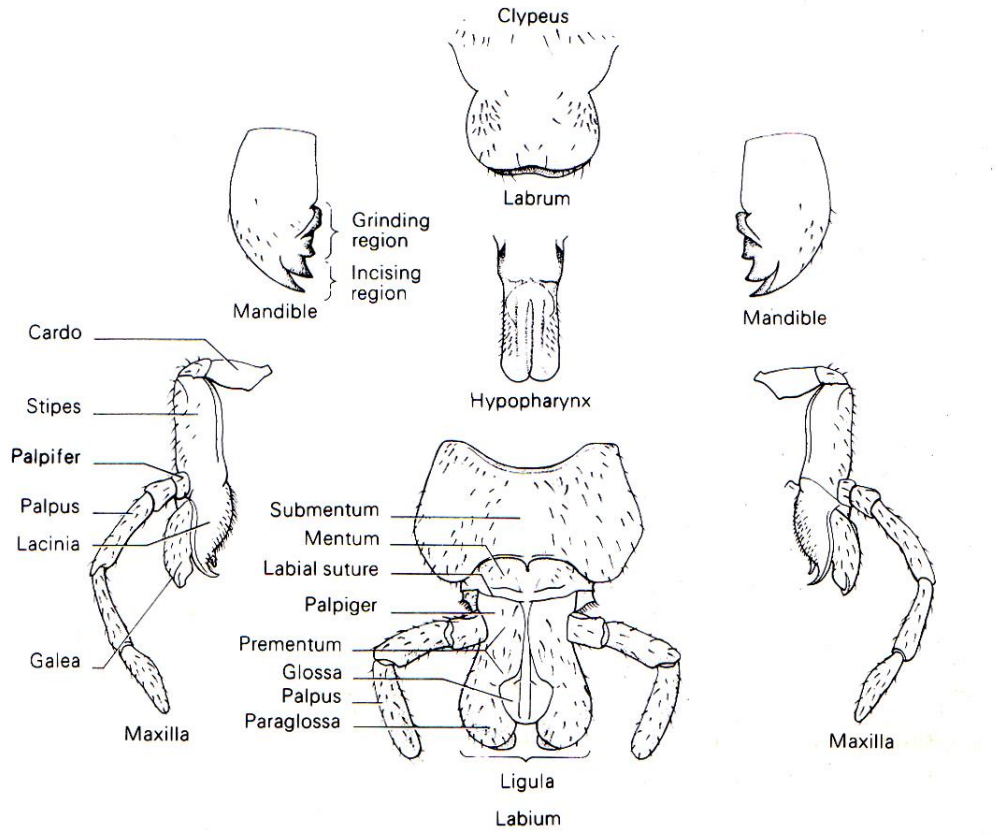
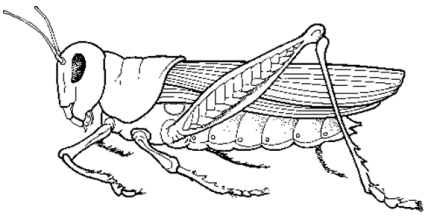
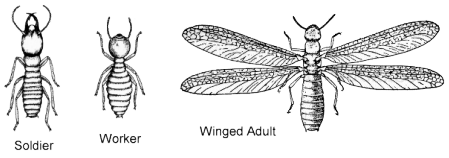
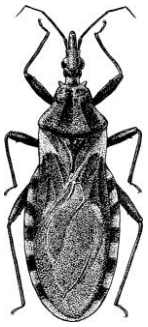
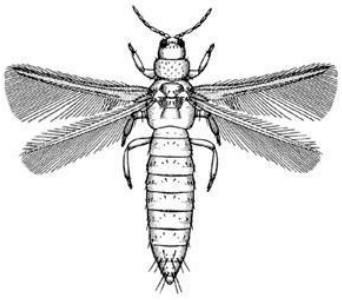


Figure 5: Typical biting and chewing mouthparts of an insect

Text Box 1

Order	Major Characters	Examples
Orthoptera	• Mouthparts are mandibulate type • Pronotum shield like, covering much of thorax • Front wings narrow, leathery (tegmina); hind wings fan-like • Hind legs usually adapted for jumping (hind femur enlarged)	Grasshoppers, crickets, katydids 
Isoptera	• Body may be darkly pigmented • Head well-developed, with chewing mouthparts and beaded antennae • Two pairs of membranous wings, all similar in shape and size; wings are shed after mating	Termites 
Hemiptera	• Piercing or sucking mouthparts • 2 pairs of wings. • Some species may be wingless and others have only forewings. • Wings are generally membranous but in some species the forewings may be hardened at the base.	true bugs 
Thysanoptera	• Head narrow anteriorly forming a conical mouth opening • Body cylindrical or spindle-shaped • Front and hind wings slender, rod-like, with a dense fringe of long hairs. • Many species are secondarily wingless.	Thrips 

Symptoms of damage caused by phytophagous arthropods

Insects' most common food habit is plant feeding that termed as phytophagy. Therefore such insects are termed as phytophagous insects. Phytophagous insects prefer to feed on specific part of the plant such as leaves, stems, roots, flowers, buds and fruits.

Symptoms of damage caused by phytophagous insects:

Leaf eating

Adults of leaf beetles and caterpillers (larvae of butterflies or moths) chew the plant tissue off one side of the leaf while leaving the opposite leaf cuticle and the veins intact. The damaged leaf then looks like a lacy skeleton of a leaf. Most caterpillars and adult beetles chew through the entire leaf. The damage may appear as tiny or large holes in the leaf or as irregularly shaped leaves with pointed edges. If plant leaves are still growing when the insect feeds, the damage may later appear to have smooth edges around the feeding holes. Only insects cause these types of damage.

Leaf mining

Larval stages of some flies (leaf miner) feed inside the leaves between the upper and lower leaf surfaces, making an irregular pattern of tunnel or a mine. It leaves only a very thin transparent cuticle covering the mined areas. Feeding larva or the inactive pupa often found in the end of the occupied mine.

Leaf rolling and folding

Some caterpillars, use a silken thread to fold or roll the occupied leaf. Feeding caterpillars may also be found inside the rolled leaves. Some caterpillars make leaf nests by threading several leaves together.

Leaf curling

The saliva of some sucking insects, especially aphids, may cause plant leaves to twist or curl.

Making leaf spots

Leaf spots are most frequently caused by plant pathogens. However, leaf spots also be caused by sucking insects, such as plant bugs, leaf hoppers and plant hoppers as feeding punctures. When the insect's saliva is toxic to the plants, a dead spot may develop around the point where the insect feeds.

Formation of galls

Although stem and leaf galls are formed by pathogens, insects such as gall midges can form galls in stems and leaves. The developing larva feeding inside the leaf meristem tissues accelerate to enlarge the occupied leaf to form a gall. Example: rice gall midge

Stem/wood boring

Some insects bore deep in the plant tissues making galleries in main stem or branches or hollowing it out completely. Entry hole similar to the diameter of the insect appear on the stem as circular opening. Example: Yellow stem borer moth of rice, Black beetle of coconut

Fruit/nut/seed boring

Some insects bore into fruits and eat the tissues of ripened or ripening fruits, such as melon fruit fly. Some insects bore into seed in storage such as cowpea beetle, rice weevil.

Secreting honey dew

Honeydew is a sugar-rich sticky liquid, secreted by sucking insects such as aphids and some scale insects as they feed on plant sap. Honeydew injury occurs when excess honeydew drips onto and

congregates on lower leaves and fruit. A black mold fungus (sooty mold) grows on the honeydew and it reduces the photosynthesis of affected area.

Bronzing

Leaves infested with mites may appear as bronze discoloration.

Methodology/Procedure:

Activity I:

Observe the insect specimens listed in the table 1 for the modifications to their mouthparts under a stereo microscope and describe the type of damage that each can be caused by these insects to plants.

Table 1: Insect pests and the modification to their mouthparts

Name of insect	Modifications to mouthparts	Expected damage to the plant
Beetle		
Aphid		
Thrip		
Plant bug		

Activity II:

Collect plant specimens showing symptoms of various insect damages and recognize the type of damage and the insects responsible for each damage.

Table 2: Types of damage symptoms of insect pests

Plant specimen	Type of damage	Insect responsible for the damage

Activity number III

Observe the prepared slide of cockroach/beetle mouthparts under the low power of compound microscope. Make a good line drawing of each part and label by referring to Figure 5).

Activity number IV

Collect plants/parts of plants with any kind of damage which you suspect to have been caused by phytophagous arthropods from your home garden. Bring these specimens to laboratory. Examine the specimens carefully under hand lens or dissecting microscope. Sketch the plant parts with injuries or blemishes. Try to identify the insect/mite species (common name/order) and the life stages which may have caused the damage.

References:

Pedigo L.P., and Rice M.E. (2005) Entomology and Pest Management (5th Edition), Prentice Hall Publication

Howell V. D., Doyen J.T. and Purcell A.H (1998) Introduction to Insect Biology and Diversity (2nd Edition), Oxford University Press)