PLANT PROTECTION - CPT 507

Definition of pests:

Pests are any form of plant or animal life that is injurious or potentially injurious to man, his properties, etc, e.g insects, vertebrates, weeds, pathogens such as bacteria, fungi, viruses, rickettsia,

Categories of pests:

a. Key / major / main pests. These are insect pests that are found every where particular crops are grown. They are usually the target of insect pest control. They cause significant losses on the crops that they attack, e.g. *Clavigralla tomentosicollis* on cowpea.
b. Occasional pests: These species cause economic damage to crops only at certain times of the year, period, season or places. They do not occur regularly because they are regulated by certain ecological factors, e.g. *Sylepta derrogata*
c. Potential pests: These pests do not cause any serious economic loss although they possess the innate capacity to do so. They assume the position of a key pest only when certain ecological balance that regulate them are disrupted for instance with the use of insecticides, *Bathycoelia thalassima*
d. Migrant pests: The insects cause serious damage outside their local habitat. They move together in large numbers causing serious economic loss to the crops attack, e.g *Locusta migratoroides*

Development of Pest Situations

Certain situations cause pest development. These can be categorized into 3: (a) Ecosystem concentration and simplification (b) Transportation (c) Man's attiude and demands.

(a) Ecosystem concentration and simplification: in the course of human development, man has simplified the ecosystem. This has caused pest situations in several instances. Examples of such simplifications include the following

i. planting of monocrops
ii. storage of large quantities of grains in a closed environment
iii. planting of improved varieties
iv. fertilization of crops
v. weeding which invariably removes competition
vi. spraying of insecticides

b. Transportation: with the advent of fast means of transportation, a lot of insects have moved from their places of origin to new places causing serious damage in the absence of their natural enemies.

Man's attitude and demands: The demand for blemish-free produce or high grade produce has led to the labeling of many insects as pests even when they are not.

Pest damage Assessment

Insect pest damage assessment is done in order to apportion loss occasioned by particular insect pests and to know when to initiate control measures.
In most cases it is impracticable to count all the pest present in a field, therefore pest population may be estimated by samples.

Sampling: Pests are usually sampled so that their abundance can be predicted, losses attributable to them measured ad the damage they cause prevented.

Sampling may be direct wherein insects are counted directly on the plant parts (e.g. flea beetles on okra leaves); or indirect where insect populations are estimated via the damage they cause (e.g. stem borers).

Insect Damage: loss of plant parts or organ as a result of insect injury
There are 2 types of damage: direct damage and indirect damage.
Direct damage is when the harvestable part of a crop is affected (e.g. cowpea pod)
Indirect damage is when the non-harvestable portion of the crop is affected (e.g. maize leaf)

Types of insect damage

a. Biting and chewing insects

1. holing of leaves thereby reducing photosynthetic areas
2. boring of the stem causing reduction in plant vigour
3. scrapping of leaf surface causing burning of leaves
4. rasping of leaf edges
5. mining of leaves
6. cutting of roots
7. destruction of buds or growing points
8. flower abortion
9. premature fruit fall

b. Piercing and sucking insects

1. cause loss of vigour due to removal of sap (wilting)
2. sucking of sap from leaves or stems
3. staining or discolouring of seeds
4. transmission of diseases

Indirect effects of insect infestation

1. make crops much more difficult to cultivate
2. may make crops develop spreading habit which makes weeding and spraying difficult
3. contamination of produce thereby reducing quality and marketability
4. Transmission of diseases

Insect pest forecasting:

Accurate forecasting of pest attacks helps control programme to be effective. It depends on the established relationship among the following factors

1. stage of development of the crop
2. stage of the development of the pest
3. environmental factors

CHARACTERISTICS AND CLASSIFICATION OF INSECTS

Insects belong to the phylum Arthropoda and the Class Insecta.

Phylum: Arthropoda

- Their bodies and appendages are segmented externally
- Their appendages are modified for feeding
- They possess an exoskeleton i.e. cuticle covering that has chitin
- The body cavity is known as heamocoel instead of a coelom i.e. their body cavity is not entirely lined by mesoderm
- They have no cilia
- They possess a ventral nerve cord and a dorsal brain
- They have bilateral symmetry

Phylum Arthropoda is divided into three subphyla

a. Mandibulata: those with well developed mandibles for biting and chewing
b. Chelicerata: Those that utilize a pair appendage called 'chelicerae near the oral opening
c. Trilobitomorpha: those known from fossils whose none of their appendages was modified for feeding

Characteristics of Class Insecta

- The head, thorax, and abdomen are distinct
- Head has a pair of antennae (except in Protura)
- The mouth parts are for chewing, sucking or lapping; it also has the salivary gland
- The thorax typically has two (2) pairs of wings variously modified, reduced or absent
- The digestive tract has a fore-gut, mid-gut and a hind gut
- They have a slender mid-dorsal heart and an anterior aorta. There are no blood capillaries or veins; blood bathes the organ within the body
- Respiration is by means of tracheae from paired spiracles on the sides of the thorax and abdomen directly to the tissues (except in some Protura and Collembola which are primitive insects
- Excretion is by means of malpighian tubules which are attached to the anterior end of the hind gut (except in Collembola)
- The brain is of fused ganglia. They have double ventral nerve cord with segmented ganglia often concentrated anteriorly
- Sense organs usually include compound eyes. There are also chemoreceptors for smell and antennae

- Sexes are separate; development may be complete or incomplete
- They occur in all habitat

CLASSIFICATION OF INSECTS OF AGRICULTURAL IMPORTANCE

. Order Orthoptera:

- Possess chewing mouthparts
- Long legs
- Large compound eyes
- Pronotum of the thorax collar-like
- Wings present; flight is by the activity of the hind wings
- E.g. locusts, grasshoppers (*Zonozerus variegatus*)

Order Isoptera:

- They are social insects
- Similar wings
- Different castes
- E.g. *Amitermis evuncifer*

Order Hemiptera:

- True bugs
- Large compound eyes
- Mouth parts are for piercing and sucking
- Antennae often longer than the head
- E.g. *Clavigralla tomentosicollis*

Order Homoptera

- Large compound eyes
- Piercing and sucking mouth parts
- Antenna filiform or sentaceous
- E.g. *Aphis crassivora*

Order Lepidoptera

- Sucking mouthparts
- Wings are membraneous covered with overlapping scales
- Larva is called caterpillars and is the damaging stage
- E.g. *Busseola fusca*

Order Coleoptera:

- Beetles
- Chewing mouth parts
- Large compound eyes
- Thickened fore wings or elytra
- Larval stage is the destructive stage but many adults are also of economic importance
- E.g. *Callosobruchus maculatus*

IMPORTANT PESTS OF TROPICAL CROPS

Cassava

- Casava green spider mite *Mononychelus tanajoa*
- Cassava red spider mite *Oligonychelus gossypiella*
- Cassava mealybug *Phenacoccus manihoti*
- Whiteflies *Bemecia tabaci*
- Elegant grasshopper *Zonocerus variegatus*

Maize

- Stem borers: *Busseola fusca, Sesamia calamistis* and *Eldana sachharina.*
- *Zonocerus variegatus,*
- *Heliothis zea*
- *Sitophilus zeamais*

Cowpea

- *Ootheca mutabilis*
- *Aphis craccivora*
- *Maruca vitratta*
- *Clavigralla tomentosicollis*

Rice

- *Aspavia armigera*
- *Sesamia calamistis*
- *Chilo* spp
- *Diopsis thoracica*

Yam

- *Heteroligus meles* (yam beetle)
- *Zonocerus variegatus*

Okra

- *Podagrica* spp.
- *Sylepta derogata*
- *Aphis gossypii*
- *Disdercus superstitiosus*

Tomato

- *Bemisia tabaci*
- *Spodoptera littoralis*
- *Sylepta derogata*
- *Helicoverpa armigera*

Cocoa

Sahlbergella singularis
Distantiella theobromae
Helopeltis spp
Bathycoela thalasina

Citrus
Phenacoccus citri
Dacus spp
Batrocera invadens
Ceratitis capitata

Cashew
Analeptis trifasciata
Helopeltis spp

Kola
Balanogastris kolae
Phosphorus spp

METHODS OF PEST CONTROL

Cultural control: Making crop environment not conducive for insect pest establishment. It is preventive and does not decimate already existing pest population. Examples of cultural control: intercropping, crop sanitation, crop rotation, close season, manuring, early planting, early harvesting, etc.

Biological control: The use of living organism to destroy, repel, replace and exsting pest population. This method is hinged on the fact that all organisms have their natural enemies. Biological control agents include: predators (e.g. lady birds), pathogens (e.g. *Bacillus thuringiensis*), parasites (e.g. nematodes) and parasitoids (*Gyranusoides tebygi*).

Chemical control: The use of natural or syntheic compounds to kill, repel, attract or decimate pest population. There are 2 major categories of insecticides: organic (which contains carbon atoms in their molecules) and inorganic (those that do not contain carbon in their molecules).

Legislative control: This is the enactment of laws to prevent entry, spread of pests into free areas. This cannot be undertaken by individuals but by the government.

Integrated pest management (IPM) is an integrated approach of crop management to solve ecological problems when applied in agriculture.

These methods are performed in three stages: *prevention*, *observation*, and *intervention*. It is an ecological approach with a main goal of significantly reducing or eliminating the use of pesticides while at the same time managing pest populations at an acceptable level.

An IPM system is designed around six basic components: The US Environmental Protection Agency has a useful set of IPM principles.

1. **Acceptable pest levels:** The emphasis is on *control*, not *eradication*. IPM holds that wiping out an entire pest population is often impossible, and the attempt can be econmically expensive, environmentally unsafe, and frequently unachievable. IPM programmes first work to establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. These thresholds are pest and site specific, meaning that it may be acceptable at one site to have a weed such as white clover, but at another site it may not be acceptable. By allowing a pest population to survive at a reasonable threshold, selection pressure is reduced. This stops the pest gaining resistance to chemicals produced by the plant or applied to the crops. If many of the pests are killed then any that have resistance to the chemical will form the genetic basis of the future, more resistant, population. By not killing all the pests there are some un-resistant pests left that will dilute any resistant genes that appear.
2. **Preventive cultural practices:** Selecting varieties best for local growing conditions, and maintaining healthy crops, is the first line of defense, together with plant quarantine and 'cultural techniques' such as crop sanitation (*e.g.* removal of diseased plants to prevent spread of infection).
3. **Monitoring:** Regular observation is the cornerstone of IPM. Observation is broken into two steps, first; inspection and second; identification. Visual inspection, insect and spore traps, and other measurement methods and monitoring tools are used to monitor pest levels. Accurate pest identification is critical to a successful IPM program. Record-keeping is essential, as is a thorough knowledge of the behavior and reproductive cycles of target pests. Since insects are cold-blooded, their physical development is dependent on the temperature of their environment. Many insects have had their development cycles modeled in terms of degree days. Monitor the degree days of an environment to determine when is the optimal time for a specific insect's outbreak.
4. **Mechanical controls:** Should a pest reach an unacceptable level, mechanical methods are the first options to consider. They include simple hand-picking, erecting insect barriers, using traps, vacuuming, and tillage to disrupt breeding.
5. **Biological controls:** Natural biological processes and materials can provide control, with minimal environmental impact, and often at low cost. The main focus here is on promoting beneficial insects that eat target pests. Biological insecticides, derived from naturally occurring microorganisms (*e.g.*: *Bt*, entomopathogenic fungi and entomopathogenic nematodes), also fit in this category.
6. **Responsible Pesticide Use:** Synthetic pesticides are generally only used as required and often only at specific times in a pests life cycle. Many of the newer pesticide groups are derived from plants or naturally occurring substances (*e.g.*:

nicotine, pyrethrum and insect juvenile hormone analogues), but the toxophore or active component may be altered to provide increased biological activity or stability. Further 'biology-based' or 'ecological' techniques are under evaluation.