Field Crop Insects (Theoretical)

Lecture 01

Insects form a major class of organisms within the phylum Arthropoda. All arthropods have segmented bodies, with a hard exoskeleton or body shell and jointed limbs, but insects (class Insecta) are typified by the presence of three pairs of true legs, usually two pairs of wings and a body divided into three distinct regions: head, thorax and abdomen.

Pests

The definition of a pest can be very subjective, varying according to many criteria; but in the widest sense any insects (or plant) causing harm or damage to man, his crops or possessions, even if just causing annoyance, qualifies for the term pest. From an agricultural point of view, an insect or plant out of context is regarded as a pest (individually) even though it may not belong to a pest species. Thus a deer on a farm is a pest, but next-door in a game park it is not, and is in fact a valuable national asset there. Similarly, volunteer cabbage plants growing in a field with onions have to be regarded as 'weed' pests.

Development of pest status

This takes place through a number of different agencies that fall into two main categories, as follows:

(a) Ecological changes – There are really only three aspects of importance in considering crop pests, and these are:

(1) state of the pest population (i.e. numbers of pests present);

(2) nature of the damage done to the crop;

(3) value of the damage as assessed by human society. Thus each aspect of the way in which pests arise through ecological changes will relate to population numbers, for instance a species is only a pest at or above a particular population density.

(b) Economic changes – The definition of a pest relates clearly to the value of the damage done by the insect as assessed by human society, and so any changes in the value of the crop will affect the importance of the pest. Damage that is not important when prices are low or can be very serious when prices are high. Sometimes the converse situation is true, if an important food crop is in short supply then some pest damage may be tolerated.

Pest Ecology

The information provided has been separated off in an attempt to emphasize the need for a greater understanding of the complex ecological relationships between the insects and plants in the agricultural context. Here are also included various aspects of basic biology that have broad ecological relevance.

The environmental factors can be further defined as follows:

= Weather
(a) Temperature – ranges defined as tropical.
(b) Humidity – ranges from moist, moderate, to dry conditions.
(c) Water – includes groundwater, rainfall, etc.
(d) Light – intensity important for many organisms.
(e) Wind – important for dispersal, and drying effects.

= Food
(a) For insects.
(1) Organic remains.
(2) Plant material (phytophagous).
(3) Other insects – carnivores and parasites.
(b) For plants.
(1) Organic remains (mostly fungi and bacteria).
(2) Other plants – parasites and pathogens.
(3) Animals – insectivores (carnivores).
(4) Sunlight, water, carbon dioxide, minerals, chlorophyll.

= Other insects and plants (i.e. the community)
(a) Competition – intraspecific (within the species) – interspecific (between different species).
(b) Predation.
(c) Parasitism.
(d) Pathogens causing diseases.

Insect feeding on plants
The feeding process in insects involves different aspects, all of which have some importance in relation to control of pests.

The main aspects include:
(a) Recognition of food
(1) distant
(2) proximal
(3) contact
(b) Manipulation of food

Pest Damage
1- Direct effects of insect feeding
= Biting insects may damage plants as follows:

(a) Reduce the amount of leaf assimilative tissue and hinder plant growth; examples are leaf-eaters, such as adults and nymphs of locusts and *Epilachna* and larvae of *Plutella, Pieris, Plusia (*Lepidoptera*)* and sawfly larvae.
(b) Tunnel in the stem and interrupt sap flow, often destroying the apical part of the plant; these are stem borers and shoot flies, such as *Zeuzera* in apple branches, *Cephus* in wheat, *Ostrinia* in maize, *Atherigona* in maize and sorghum.
(c) Destroy buds or growing points and cause subsequent distortion or proliferation, as with Fruit Bud Weevils (*Anthonomus spp.)* on shoots of apple, pear, etc.
(d) Attack flowers and reduce seed production, as with the blossom beetles (*Meligethes spp.)* and Japanese Beetle.
(e) Injure or destroy seeds completely, or reduce germination due to loss of food reserves; examples are Hazelnut Weevil, Maize Weevil, Pea and Bean Bruchids, Pea Pod Borers, and Bean Pod Borers.
(f) Attack roots and cause loss of water and nutrient absorbing tissue, as with wireworms and various chafer larvae (Scarabaeidae) and other beetle larvae in the soil.
= Insects with piercing and sucking mouthparts may damage plants as follows.
(a) Cause loss of plant vigor due to removal of excessive quantities of sap, in extreme cases wilting and foliage distortion results, as in the stunting of cotton by *Bemisia* (Whitefly), and aphids on many plants.
(b) Damage floral organs and reduce seed production, for example Hemiptera (Wheat Shield Bugs, etc.).
(c) Cause premature leaf-fall, as do many diaspidid scales.

2- Indirect effects of insects on crops
(a) Insects may make the crop more difficult to cultivate or harvest; they may distort the plant and cause the plant to develop a spreading habit which makes weeding and spraying more difficult. They may delay crop maturity, as do the bollworms on cotton, and grain in cereals may become distorted or dwarfed.
(b) Insect infestation results in contamination and loss of quality in the crop; the quality loss may be due to reduction in nutritional value or marketability. Loss of yield in a crop is obvious but a nutritional quality loss is easily overlooked; this is the type of damage done to stored grain by *Ephestia cautella* and *Tribolium.* A major problem in the tropics is 'stickiness' of cotton lint caused by honeydew from Cotton Whitefly; the sticky cotton is difficult to gin, and its value is diminished.
(c) Transmission of disease organisms:
(1) Mechanical transmission, also termed passive transmission, takes place through feeding lesions in the cuticle. Sometimes the pathogen (usually fungi or bacteria) is carried on the proboscis of the bug or sometimes it is on the body of

the tunneling insects. Examples are seen in the case of the *Scolytus* beetles which transmit Dutch Elm and other fungal diseases.
(2) Biological transmission. Most viruses depend upon the activity of an insect vector for transmission. The vector is usually also an intermediate host, as is the case with most aphid and whitefly hosts. Diseases transmitted in this manner include Cucumber Mosaic and Tobacco Mosaic.

Development and Metamorphosis of Insects

Types of Metamorphosis

The most striking feature of insect's development is the marked change of body form which most insects undergo from young to adult, a process known as metamorphosis. All insects can be grouped into three categories, according to their type of development.

1. **Ametabola (Apterygota)**

There is no appreciable change in form with growth though smaller stages are not sexually mature. Moulting may continue until adult. Wings are never present.

2. **Hemimetabola (Exopterygota) or Gradual metamorphosis**

Metamorphosis is incomplete, i.e., young stages (nymphs) are similar in form to adults, possessing similar mouth parts and feeding in the same fashion. Nymphs may possess compound eyes. There is no pupal stage. Wings develop externally. Examples can be seen in several orders like Orphoptera, Hemiptera, dictyoptera, Homoptera, and Blataria and Heteroptera.

3. **Holometabola (Endopterygota)**

Metamorphosis is complete with both larval and pupal stages. Young stages (larvae) are very different in form from adults, possessing different mouth parts and feeding in a different fashion. Larvae never possess compound eyes. Wings develop internally in pupa.