Unit 1
MODULE
1

INTRODUCTION

I. Introduction

The increasing difficulty encountered in recent years in controlling insect pests has led to a searching inquiry into the conditions under which insecticides act, and the chemical, physical, and biological factors which govern their effects. Among these factors none are more important than the physiological processes which occur in the species whose control is desired. Thus insect physiology has an economic importance which makes its active development much more imperative than if it were of purely scientific interest alone. Nevertheless, few attempts have been made to apply the increasing knowledge of physiology to the problems of insect-pest control, and the accounts of such work are widely scattered in the biological literature. These conditions have made it seem worthwhile to attempt to interpret certain advances in this field in terms of their relations to insect toxicology and control.

II. Learning Objectives

At the end of this module, the students are expected to:

1. To explain the relationship between insect physiology and toxicology.
2. To define different terminologies related to insect physiology and toxicology.
3. To discuss the importance of knowing the insecticide use patterns.

III. Pre-Test

Question

For you, what is insect physiology?

Question

What is insect toxicology?

Question

How do you think does insect physiology relates to insect toxicology?

IV. Discussion

Definition of Terms

- Acaricide
  - Material toxic to mites (Acarina).
- Activator
  - Chemical added to a pesticide to increase its toxicity.
- Active ingredient (a.i.)
  - Toxic component of a formulated pesticide.
- Adherence
  - The ability of a material to stick to a particular surface.
- Adhesive (= Sticker)
  - Material added to increase pesticide retention; different commercial preparations of methyl cellulose are available for this purpose.
- Adjuvant
  - A spray additive to improve either physical or chemical properties (see also Supplement, Sticker, Adhesive, Spreader, Wetter and Emulsifier).
- Antibiosis
  - The resistance of a plant to insect attack by having, for example, a thick cuticle, hairy leaves, toxic sap, etc.
- Anti-feedant
  - A chemical possessing the property of inhibiting the feeding of certain insect pests.
- Asymptote
  - The point in the growth of a population at which numerical stability is reached.
- Bait
  - Foodstuff used for attracting pests; usually mixed with a poison to form a poison bait.
- Band application
  - Treatment of a band of soil in row-crops, usually covering plant rows, with either sprays or granules.
- Biocide
  - A general poison or toxicant.
- Browsing
  - The eating of foliage of bushes and trees.

- Carrier
  - Material serving as diluent and vehicle for the active ingredients; usually in dusts.
- Chemosterilant
  - Chemical used to render an insect sterile without killing it.
- Coarctate pupa
  - A pupa enclosed inside a hardened shell formed by the previous larval skin.
- Cocoon
  - A silken case inside which a pupa is formed.
- Compatibility
  - The ability to mix different pesticides without physical or chemical interactions which would lead to reduction in biological efficiency or increase in phyto-toxicity.
- Concentrated solution (c.s.)
  - Commercial pesticide preparation before dilution for use.
- Concentrate spraying
  - Direct application of the pesticide concentrates without dilution.
- Concentration
  - Proportion of active ingredient in a pesticide preparation, before or after dilution.
- Contact poison
  - Material killing pests by contact action, presumably by absorption through the cuticle.
- Control (noun)
  - Untreated subjects used for comparison with those given a particular crop protection treatment.
- Control (verb)
  - To reduce damage or pest density to a level below the economic threshold.
    - Legislative: the use of legislation to control the importation and to prevent any spread of a pest within a country.
    - Physical: the use of mechanical (hand picking, etc.) and physical methods (heat, cold, radiation, etc.) of controlling pests.
    - Cultural: regular farm operations designed to destroy pests.
    - Chemical: the use of chemical pesticides as smokes, gas, dusts, and sprays to poison pests.
    - Biological: the use of natural predators, parasites and disease organisms to reduce pest populations.

        - Integrated: the very carefully reasoned use of several different methods of pest control in conjunction with each other to control pests with a minimum disturbance to the natural situation.
- Cover
    - Proportion of the surface area of the target plant on which the pesticide has been deposited.
- Crawlers
    - The active first instar of a scale insect.
- Defoliant
    - Spray which induces premature leaf-fall.
- Desiccant
    - Chemical which kills vegetation by inducing excessiv water loss.
- Diluent
    - Component of spray or dust that reduces the concentration of the active ingredient, and may aid in mechanical application but does not directly affect toxicity.
- Disinfect
    - To free from infection by destruction of the pest or pathogen established in or on plants or plant parts.
    - To kill or inactivate pests or pathogens present upon the surface of plants or plant parts, or in the immediate vicinity (e.g. in soil).
- Dispersal
    - Movement of individuals out of a population (emigration) or into a population (immigration).
- Diurnal
    - Active during the daytime.
- Dormant
    - Alive but not growing; buds with an unbroken cover of scales; quiescent; inactive; a resting stage.
- Dose; dosage
    - Quantity of pesticide applied per individual, or per unit area, or per unit volume, or per unit weight.
- Drift
    - Spray or dust carried by natural air currents beyond the target area.
- Ecdysis
    - The molting (shedding of the skin) of larval arthropods from one stage of development to another – the final molt leading to the formation of the puparium or chrysalis.

- Ecesis (= Oikesis)
  - The establishment of an organism in a new habitat; accidental dispersal and establishment in a new area.
- Economic damage
  - The injury done to a crop which will justify the cost of artifical control measures.
- Economic-injury level
  - The lowest population density that will cause economic damage.
- Economic pest
  - A pest causing a crop loss of about 5–10%, according to definition.
- Economic threshold
  - The pest population level at which control measures should be started to prevent the pest population from reaching the economic-injury level.
- Efficiency of a pest control measure
  - The more or less fixed reduction of a pest population regardless of the number of pests involved.
- Effectiveness of a pest control measure
  - This is shown by the number of pests remaining after control treatment.
- Emulsifiable concentrate (e.c.)
  - Liquid formulation that when added to water will spontaneously disperse as fine droplets to form an emulsion (= Miscible oil).
- Emulsifier
  - Spray additive which permits formation of a stable suspension of oil droplets in aqueous solution, or of aqueous solution in oil.
- Emulsion
  - A stable dispersion of oil droplets in aqueous solution, or vice cersa.
- Entomophagous
  - An animal (or plant) which feeds upon insects.
- Fecundity
  - Capacity to produce offspring (reproduce); power of a species to multiply rapidly.
- Formulation
  - Statement of nature and amount of all constituents of a pesticide concentrate.
  - Method of preparation of a pesticide concentrate.
- Fossorial legs
  - Modified for digging; in the habit of digging or burrowing.

- Frass
  - Wood fragments made by a wood-boring insect, usually mixed with the feces.
- Fumigant
  - Pesticide exhibiting toxicity in the vapour phase.
- Furrow application
  - Placement of pesticides with seed in the furrow at the time of sowing.
- Generation
  - The period from any given stage in the life cycle (usually adult) to the same stage in the offspring.
- Grub (White)
  - A scarabaeiform larva; thick-bodied, with a well-developed head and thoracic legs, without abdominal prolegs, usually sluggish in behaviour; general term for larvae of Coleoptera.
- Hemimetabolous
  - Insects having a simple metamorphosis, like that in the Orthoptera, Heteroptera, and Homoptera.
- Herbivorous
  - Feeding on plants (phytophagous).
- Holometabolous
  - Insects having a complete metamorphosis, as in the Diptera, Hymenoptera, Coleoptera, Lepidoptera.
- Host
  - The organism in or on which a parasite lives; and the plant on which an insect feeds.
- Hypermetamorphosis
  - A type of complete metamorphosis in which the different larval instars represent two or more different types of larvae.
- Imago
  - The adult, or reproductive stage of an insect.
- Inert
  - A material having no biological action.
- Infect
  - To enter and establish a pathogenic relationship with a plant (host); to enter and persist in a carrier.
- Infest
  - To occupy and cause injury to either a plant, soil or stored products.

- Insecticide
  - A toxin effective against insects.
- Instar
  - The form of an insect between successive molts; the first instar being the stage between hatching and the first molt.
- Larva
  - The immature stages of an insect, between the egg and p having a complete metamorphosis; the six-legged first instar the Acarina.
- Larvicide
  - Toxicant (poison) effective against insect larvae.
- Life table
  - The separation of a pest population into its different age components (e.g. eggs, larvae, pupae, adults).
- Miticide
  - Preferably called Acaricide.
- Molluscicide
  - Toxicant effective against slugs and snails.
- Monophagous
  - An insect restricted to a single host plant species.
- Mortality
  - Population decrease factor; death rate.
- Natality
  - Population ‘increase’ factor; birth rate.
- Nematicide
  - Toxicant effective against nematodes (= eelworms).
- Nocturnal
  - Active at night.
- Nymph
  - The immature stage of an insect that does not have a distinct pupal stage; also the immature stages of Acarina that have eight legs.
- Oligophagous (= Stenophagous)
  - An animal feeding upon only a few, closely related, host plants; or it may be an animal parasite.
- Ovicide
  - Toxicant effective against insect or mite eggs.
- Oviparous
  - Reproduction by laying eggs.

- Parasite
  - An organism living in intimate association with a living organism (plant or animal) from which it derives material essential for its existence while conferring no benefit in return.
- Parasitoid
  - An organism alternately parasitic and free-living; most parasitic Hymenoptera and Diptera fall into this category as usually only the larvae are parasitic.
- Parthenogenesis
  - Reproduction without fertilization; usually through eggs but sometimes through viviparity.
- Persistence
  - The term applied to chemicals that remain active for a long period of time after application.
- Pest
  - An animal or plant causing damage to man's crops, animals or possessions.
- Pest density
  - The population level at which a pest species causes economic damage.
- Pest management
  - The careful manipulation of a pest situation, after extensive consideration of all aspects of the life system as well as ecological and economic factors.
- Pest spectrum
  - The complete range of pests attacking a particular crop.
- Pesticide
  - A chemical which by virtue of its toxicity (poisonous properties) is used to kill pest organisms. A term of wide application which includes all the more specific applications – insecticide, acaricide, bactericide, fungicide, herbicide, molluscicide, nematicide, rodenticide, etc.
- Pheromone (= Ectohormone).
  - A substance secreted by an insect to the exterior causing a specific reaction in the receiving insects.
- Phytophagous
  - Herbivorous; plant eating.

- Phytosanitation
  - Measures requiring the removal or destruction of infected or infested plant material likely to form a source of reinfection or reinfestation. (See Crop Hygiene.)
- Poison bait
  - An attractant foodstuff for insects, molluscs, or rodents, mixed with an appropriate toxicant.
- Polyphagous
  - An animal feeding upon a range of hosts.
- Pre-access interval
  - The interval of time between the last application of pesticide to an area and safe access to the area for domestic livestock, and man.
- Pre-harvest interval
  - The interval of time between the last application of pesticide and the safe harvesting of edible crops for immediate consumption.
- Proprietory name
  - Distinguishing name given by the manufacturer to a particular formulated product.
- Protective clothing
  - Clothing to protect the spray operator from the toxic effects of crop protection chemicals. This may include rubber gloves, boots, apron, respirator, face mask, etc.
- Pupa
  - The stage between larva and adult in insects with complete metamorphosis; a non-feeding and usually inactive stage.
- Quarantine
  - All operations associated with the prevention of importation of unwanted organisms into a territory, or their exportation from it.
- Repellant
  - A chemical which has the property of inducing avoidance by a particular pest.
- Residue
  - Amount of pesticide remaining in or on plant tissues (or in soil) after a given time, especially at harvest time.
- Resistance
  - The natural or induced capacity to avoid or repel attack by pests (or parasites). Also the ability to withstand the toxic effects of a pesticide or a group of pesticides, often by metabolic detoxification.
- Rodenticide
  - A toxicant effective against rodents.

- Roguing
  - The removal of unhealthy or unwanted plants from a crop.
- Run-off
  - The process of spray shedding from a plant surface during and immediately after application, when droplets coalesce to form a continuous film and surplus liquid drops from the surface.
- Seed dressing
  - A coating (either dry or wet) of protectant pesticide applied to seeds before planting.
- Semiochemicals
  - Chemicals produced by one organism that incite a response in another organism.
- Spray
  - Air-carried: spray propelled to target in a stream of air.
  - Coarse: dispersion of droplets of mass median diameter over 200 µm.
  - Concentrate: undiluted commercial pesticide preparation.
  - Fine: dispersion of droplets of mass median diameter from 50–150 µm.
  - Floor: spray applied to the litter on the ground surface.
  - High-volume: over 1200 1/ha on bushes and trees; over 700 1/ha on ground crops (or over 400 1/ha according to definition).
  - Low-volume: spray of 250–600 1/ha on bushes and trees; 50–250 1/ha on ground crops (or 5–400 1/ha).
  - Median-volume: 600–1200 1/ha on bushes and trees; 250–700 1/ha on ground crops.
  - Mist: dispersion of droplets of 50–100 µm in diameter.
  - Ultra-low-volume: less than 50 1/ha on ground crops; less than 250 1/ha on trees and bushes (or less than 51 1/ha according to definition).
- Spread
  - Uniformity and completeness with which a spray deposit covers a continuous surface, such as a leaf or a seed.
- Stability
  - The ability of a pesticide formulation to resist chemical degradation over a period of time.
- Sticker
  - A material of high viscosity used to stick powdered seed dressings on to seeds; two commonly used stickers are paraffin and methyl

cellulose. A solution of methyl cellulose can be added to a spray to increase retention on plant foliage.

- Stomach poison
  - A toxicant (poison) which operates by absorption through the intestine after having been injested by the insect, usually on plant material.
- Susceptible
  - Capable of being easily infested or infected; not resistant.
- Systemic
  - A pesticide absorbed through the plant surfaces (usually roots) and translocated through the plant vascular system.
- Taxonomy
  - The laws of classification as applied to natural history; identification of plant and animal species.
- Tolerance
  - Ability to endure infestation (or infection) by a particular pest (or pathogen) without showing severe symptoms of distress.
- Toxicity
  - Ability to poison, or to interfere adversely with vital processes of the organism by physico-chemical means.
- Tracer
  - Additive to facilitate location of a deposit, by radioactive or fluorescent means.
- Translocation
  - The uptake of a pesticide into part of a plant body and its subsequent dispersal to other parts of the plant body.
- Trap crop
  - Crop of plants (sometimes wild plants) grown especially to attract insect pests, and when infested either sprayed or collected and destroyed. Trap plants usually grown between the rows of the crop plants or else peripherally.
- Vector
  - Organisms able to transmit viruses or other pathogens either directly or indirectly. Direct virus vectors include insects, mites and nematodes.
- Viviparous
  - Giving birth to living young (Aphidoidea).

Concept of Insect Physiology and Toxicology

It is desirable to study insect physiology to identify and understand systems that are unique to insects and not found in mammals, birds, reptiles or fish. If insecticides are developed that target those systems, and only those systems, there is a good chance that the insecticides will be non-toxic to other species and therefore safe to handle and safe for the environment in which they are used. For example there are some insecticides for use against fleas on domestic pets that target the pupal stage of insect development and prevent the fleas from reaching adulthood. These chemicals are of extremely low toxicity to mammals and therefore safe for the pets and their owners.

Insecticide Use Patterns

Indiscriminate use of insecticides in controlling insect pests of agricultural crops has been implicated in the development of resistance in disease vectors that breed within farming areas. Since vector control strategies are insecticide based, it is important to study insecticide resistance in farming areas such as irrigation sites where vectors are breeding. The indiscriminate use of insecticides in the area, the residue levels in soil and water samples from breeding grounds.

V. Activity

Post-Test

Give the correct word that is being described in each item. Choose the answer from the box below.

1. Amount of pesticide remaining in or on plant tissues (or in soil) after a given time, especially at harvest time.
2. An organism living in intimate association with a living organism (plant or animal) from which it derives material essential for its existence while conferring no benefit in return.
3. A pesticide absorbed through the plant surfaces (usually roots) and translocated through the plant vascular system.
4. The adult, or reproductive stage of an insect.
5. Material toxic to mites.
6. The interval of time between the last application of pesticide to an area and safe access to the area for domestic livestock, and man.
7. A toxicant effective against rodents
8. An organism alternately parasitic and free-living
9. A chemical which by virtue of its toxicity (poisonous properties) is used to kill pest organisms. A term of wide application which includes all the more specific applications.
10. Statement of nature and amount of all constituents of a pesticide concentrate.

Residue	Parasitoid
Systemic	Parasite
Imago	Pesticide
Acaricide	Pre-access Interval
Formulation	Rodenticide
Pupa	Pre-harvest Interval

VI. Summary

- Insect physiology is the study of insect anatomy or body parts and body systems along with its functions.
- Insect Toxicology deals with the scientific approach of controlling insect pest populations in the field through the use of chemicals.
- Insect physiology plays a big role in insect toxicology for it gives information about how insect systems work and helps toxicologists to develop substances that can only negatively affect the target pest and not harm other organisms and leave a harmful impact to the environment.

VII. References

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