Unit 1
MODULE
5

MOVEMENT OF INSECTICIDES IN THE ENVIRONMENT

I. Introduction

Insecticide is any toxic substance that is used to kill insects. Such substances are used primarily to control pests that infest cultivated plants or to eliminate disease-carrying insects in specific areas.

Insecticides can be classified in any of several ways, on the basis of their chemistry, their toxicological action, or their mode of penetration. In the latter scheme, they are classified according to whether they take effect upon ingestion (stomach poisons), inhalation (fumigants), or upon penetration of the body covering (contact poisons). Most synthetic insecticides penetrate by all three of these pathways, however, and hence are better distinguished from each other by their basic chemistry.

II. Learning Objectives

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

1. Discuss the different mode of action of insecticides.
2. Explain the harmful effects of insecticide residues in the environment.
3. Differentiate risk, hazard, and exposure from each other.
4. Name the different parts of a PPE.

III. Pre-Test

Questions

What are the different modes of action of an insecticide?

Question

What is the negative impact of insecticides in the environment?

Question

What are the different parts of a PPE?

IV. Discussion

Modes of Action and Penetration

The modes of action of various drugs and poisons have fascinated mankind since the age of witchcraft-medicine. As stated before, insect toxicology is part of a much broader field, pharmacology and toxicology, in which studies of drug action are known as pharmacodynamics. Study of the actions of insecticides may therefore be called the pharmacodynamics of insecticides, or simply the pharmacology of insecticides. Though the history of the pharmacology of insecticides is just as brief as that of modern biochemistry and physiology, it is already growing into one of the most important disciplines of insect toxicology. Its existence is necessitated by (1) the need for therapeutic measures for accidental poisoning, (2) the demand for logical explanation of these toxic actions and of their subsequent side effects in beneficial animals including man, and (3) the realization that it can provide a logical basis for developing even more useful compounds and can help in understanding the normal physiology and biochemistry of animals.

Target site and mode of action

Classification:

• The target site is the specific biochemical process affected by the insecticide

• Active ingredients which affect the same target site have the same mode-of-action (MoA)

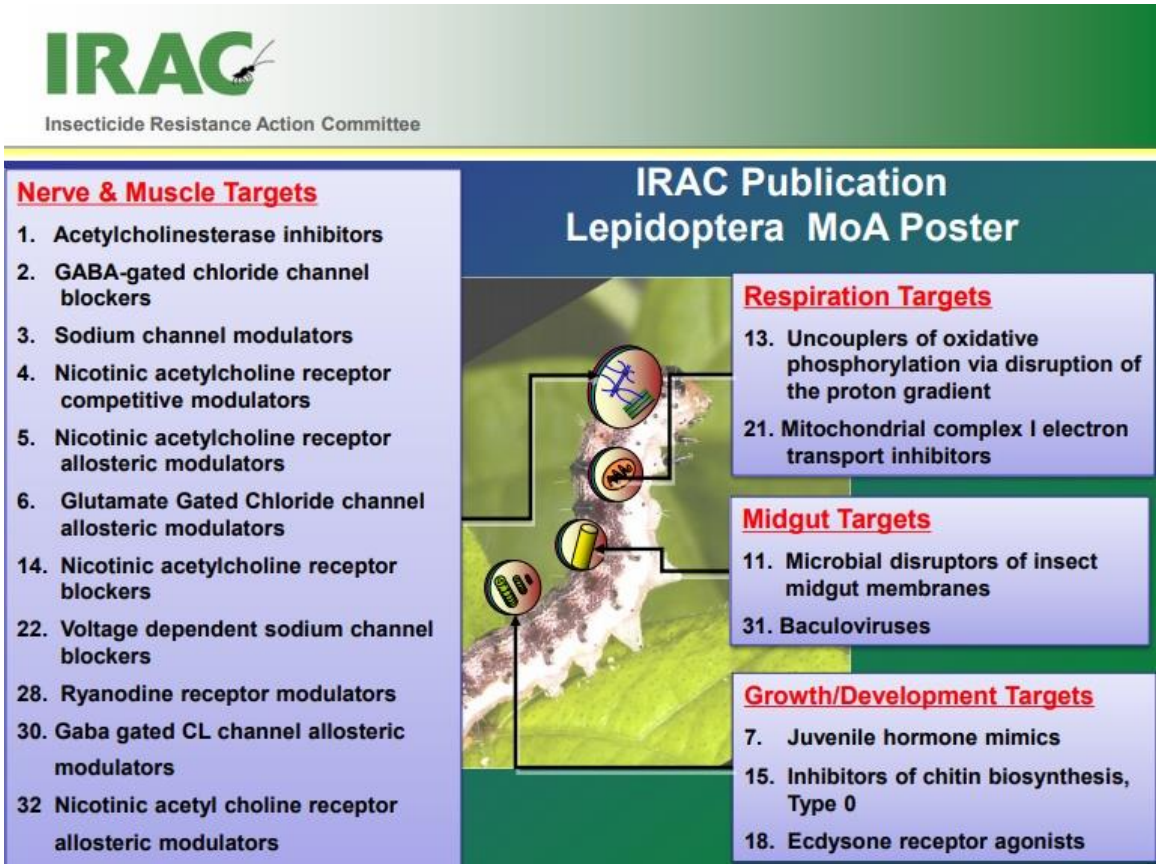
Example:

Organophosphates- Acetylcholinesterase inhibitors (MoA 1A)

Active Ingredients: Chlorpyrifos, Malathion, Phenthoate, Profenophos

Pyrethroids- Sodium channel modulators (MoA 3)

Active ingredients- Deltamethrin, Cyfluthrin, Lambdacyhalothrin, Permethrin, Cypermethrin



Stomach poisons are toxic only if ingested through the mouth and are most useful against those insects that have biting or chewing mouth parts, such as caterpillars, beetles, and grasshoppers. The chief stomach poisons are the arsenicals—e.g., Paris green (copper acetoarsenite), lead arsenate, and calcium arsenate; and the fluorine compounds, among them sodium fluoride and cryolite. They are applied as sprays or dusts onto the leaves and stems of plants eaten by the target insects. Stomach poisons have gradually been replaced by synthetic insecticides, which are less dangerous to humans and other mammals.

Contact poisons penetrate the skin of the pest and are used against those arthropods, such as aphids, that pierce the surface of a plant and suck out the juices. The contact insecticides can be divided into two main groups: naturally occurring compounds and synthetic organic ones. The naturally occurring contact insecticides include nicotine, developed from tobacco; pyrethrum, obtained from flowers of *Chrysanthemum cinerariaefolium* and *Tanacetum coccineum*; rotenone, from the roots of Derris species and related plants; and oils, from petroleum. Though these compounds were originally derived mainly from plant extracts, the toxic agents of some of them (e.g., pyrethrins) have been synthesized. Natural insecticides are usually short-lived on plants and cannot provide protection against prolonged invasions. Except for pyrethrum, they have largely been replaced by newer synthetic organic insecticides.

Fumigants are toxic compounds that enter the respiratory system of the insect through its spiracles, or breathing openings. They include such chemicals as hydrogen cyanide, naphthalene, nicotine, and methyl bromide and are used mainly for killing insect pests of stored products or for fumigating nursery stock.

Environmental contamination and resistance

The advent of synthetic insecticides in the mid-20th century made the control of insects and other arthropod pests much more effective, and such chemicals remain essential in modern agriculture despite their environmental drawbacks. By preventing crop losses, raising the quality of produce, and lowering the cost of farming, modern insecticides increased crop yields by as much as 50 percent in some regions of the world in the period 1945–65. They have also been important in improving the health of both humans and domestic animals; malaria, yellow fever, and typhus, among other infectious diseases, have been greatly reduced in many areas of the world through their use.

But the use of insecticides has also resulted in several serious problems, chief among them environmental contamination and the development of resistance in pest species. Because insecticides are poisonous compounds, they may adversely affect other organisms besides harmful insects. The accumulation of some insecticides in the environment can in fact pose a serious threat to both wildlife and humans. Many insecticides are short-lived or are metabolized by the animals that ingest them, but some are persistent, and when applied in large amounts they pervade the environment. When an insecticide is applied, much of it reaches the soil, and groundwater can become contaminated from direct application or runoff from treated areas. The main soil contaminants are the chlorinated hydrocarbons such as DDT, aldrin, dieldrin, heptachlor, and BHC. Owing to repeated sprayings, these chemicals can accumulate in soils in surprisingly large amounts (10–112 kilograms per hectare [10–100 pounds per acre]), and their effect on wildlife is greatly increased as they become associated with food chains. The stability of DDT and its relatives leads to their accumulation in the bodily tissues of insects that constitute the diet of other animals higher up the food chain, with toxic effects on the latter. Birds of prey such as eagles, hawks, and falcons are usually most severely affected, and serious declines in their populations have been traced to the effects of DDT and its relatives. Consequently, the use of such chemicals began to be restricted in the 1960s and banned outright in the 1970s in many countries.

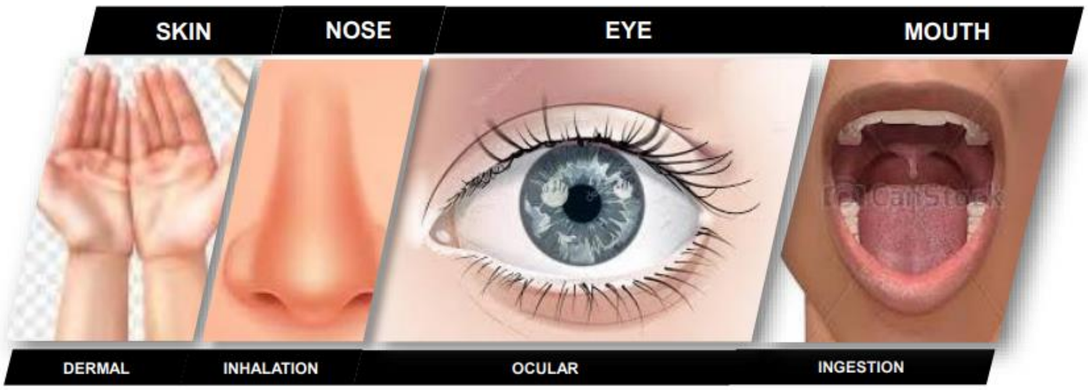
Cases of insecticide poisoning of humans also occur occasionally, and the use of one common organophosphate, parathion, was drastically curtailed in the United States in 1991 owing to its toxic effects on farm laborers who were directly exposed to it.

Another problem with insecticides is the tendency of some target insect populations to develop resistance as their susceptible members are killed off and those resistant strains that survive multiply, eventually perhaps to form a majority of the population. Resistance denotes a formerly susceptible insect population that can no longer be controlled by a pesticide at normally recommended rates. Hundreds of species of harmful insects have acquired resistance to different synthetic organic pesticides, and strains that become resistant to one insecticide may also be resistant to a second that has a similar mode of action to the first. Once resistance has developed, it tends to persist in the absence of the pesticide for varying amounts of time, depending on the type of resistance and the species of pest.

Insecticides may also encourage the growth of harmful insect populations by eliminating the natural enemies that previously held them in check. The nonspecific nature of broad-spectrum chemicals makes them more likely to have such unintended effects on the abundance of both harmful and beneficial insects.

Because of the problems associated with the heavy use of some chemical insecticides, current insect-control practice combines their use with biological methods in an approach called integrated control. In this approach, a minimal use of insecticide may be combined with the use of pest-resistant crop varieties; the use of crop-raising methods that inhibit pest proliferation; the release of organisms that are predators or parasites of the pest species; and the disruption of the pest’s reproduction by the release of sterilized pests.

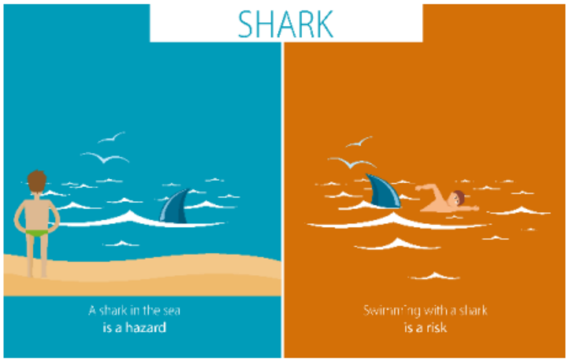
Hazards to Non-Target Organisms

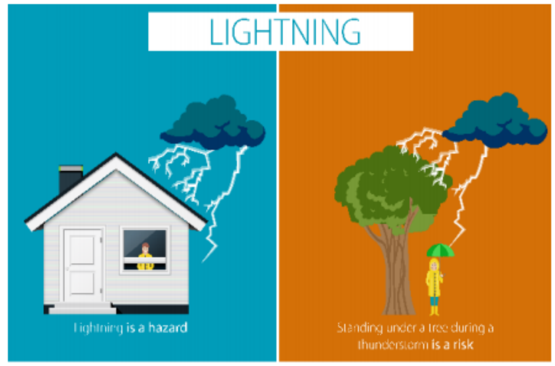


Insecticides are harmful to those non-target organisms that came into contact with it. The usual entry points of insecticides are through skin, nose, eye, and mouth. Non-target organisms get exposed to these substances from spray drifts, spillage, leaks, residues on foliage, and residues on food.

Definition of Risk, Hazard, and Exposure

- **Risk** - refers to the inherent properties of a substance that make it capable of causing harm to human health or the environment is the possibility of a harmful event arising from exposure to a chemical or physical agent, for example, under specific conditions
- **Hazard** - refers to the inherent properties of a substance that make it capable of causing harm to human health or the environment.
- **Exposure** - describes both the amount of, and the frequency with which, a chemical substance reaches a person, group of people or the environment.





Personal Protective Equipment (PPE)

"PPE is any clothes, materials or devices that provide protection from pesticide exposure during handling and application." (FAO: Food and Agriculture Organization-UN)

V. Activity

Post-Test

True or False. Write true if the statement is correct and false if it's not on the blank.

1. True or False___ Pesticide containers must never be reused for another purpose.
2. True or False___ It is only important to read the directions on personal protective equipment the first time you purchase that type of equipment (respirator, chemical–resistant clothing, etc.)
3. True or False___ Pesticides should be stored in a dry, cool area that does not freeze.
4. True or False___ All pesticide labels that are not part of the container should be stored together in an easily accessible drawer.
5. True or False___ It is necessary to follow at least 95% of the label requirements to go through with the application.
6. True or False___ Children, pets, toys, and food should always be kept away when mixing and applying pesticides.
7. True or False___ Leather and cotton gloves are good choices for protection when applying pesticides.
8. True or False___ Rodent and insect baits should always be placed in areas where small children and pets cannot reach them.
9. True or False___ The pesticide label should be read before purchase, before application, and when storing and disposing of the pesticide.
10. True or False___ Pesticides should be measured and mixed in a well–ventilated area, away from children, pets, toys, and food.
11. True or False___ There are no safety concerns if the pesticide is naturally occurring in the environment.
12. True or False___ If work clothes are only slightly contaminated by pesticide spray, it is acceptable to wash them with other clothing.

VI. Summary

- Insecticides can be classified in any of several ways, on the basis of their chemistry, their toxicological action, or their mode of penetration. In the latter scheme, they are classified according to whether they take effect upon ingestion (stomach poisons), inhalation (fumigants), or upon penetration of the body covering (contact poisons).
- Crop Protection Products are formulated to be toxic.
- Responsible use of Crop Protection Products is beneficial.
- It is important to understand and follow the instructions in the product label.
- Wear PPEs to avoid exposure to CPPs.

VII. References

Matsumura F. (1975) Modes of Action of Insecticides. In: Matsumura F. (eds) Toxicology of Insecticides. Springer, Boston, MA. https://doi.org/10.1007/978-1-4613-4410-0_4

Internet Source:

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