Lecture 23: INSECT GROWTH REGULATORS

Insect Growth Regulators (IGRs) are compounds which interfere with the growth, development and metamorphosis of insects. IGRs include synthetic analogues of insect hormones such as ecdysoids and juvenoids and non-hormonal compounds such as precocenes (Anti JH) and chitin synthesis inhibitors.

Natural hormones of insects which play a role in growth and development are

1. **Brain hormone**: The are also called activation hormone(AH). AH is secreted by neuro secretory cells (NSC) which are neurons of central nervous system (CNS). It's role is to activate the corpora allata to produce juvenile hormone (JH).
2. **Juvenile hormone (JH):** Also called neotinin. It is secreted by corpora allata which are paired glands present behind insect brain. Their role is to keep the larva in juvenile condition. JH I, JH II, JH III and JH IV have been identified in different groups of insects. The concentration of JH decreases as the larva grows and reaches pupal stage. JH I, II and IV are found in larva while JH III is found in adult insects and are important for development of ovary in adult females.
3. **Ecdysone:** Also called Moulting hormone (MH). Ecdysone is a steroid and is secreted by Prothoracic Glands (PTG) present near prothoracic spiracles. Moulting in insects is brought about only in the presence of ecdysone. Ecdysone level decreases and is altogether absent in adult insects.

IGRs used in Pest management

a) **Ecdysoids**: These compunds are synthetic analogues of natural ecdysone. When applied in insects, kill them by formation of defective cuticle. The development processes are accelerated bypassing several normal events resulting in integument lacking scales or wax layer.

b) **Juvenoids (JH mimics)** : They are synthetic analogues of Juvenile Hormone (JH). They are most promising as hormonal insecticides. JH mimics were first identified by **Williams and Slama** in the year 1966. They found that the paper towel kept in a glass jar used for rearing a *Pyrrhocoris* bug caused the bug to die before reaching adult stage. They named the factor from the paper as **'paper factor'** or **'juvabione'**. They found that the paper was manufactured from the wood pulp of **balsam fir tree** (*Abies balsamea*) which contained the JH mimic.

Juvenoids have **anti-metamorphic effect** on immature stages of insect. They retain *status quo* in insects (larva remains larva) and extra (super numerary)

moultings take place producing super larva, larval-pupal and pupal-adult intermediates which cause death of insects. Juvenoids are **larvicidal** and **ovicidal** in action and they **disrupt diapause** and **inhibit embryogenesis** in insects.

Methoprene is a JH mimic and is useful in the control of larva of hornfly, stored tobacco pests, green house homopterans, red ants, leaf mining flies of vegetables and flowers

c) **Anti JH or Precocenes**: they act by destroying corpora allata and preventing JH synthesis. When treated on immature stages of insect, they skip one or two larval instars and turn into tiny precocious adults. They can neither mate, nor oviposit and die soon. Eg. EMD, FMev, and PB (Piperonyl Butoxide)

d) **Chitin Synthesis inhibitors:** Benzoyl phenyl ureas have been found to have the ability of inhibiting chitin synthesis in vivo by blocking the activity of the enzyme chitin synthetase. Two important compounds in this category are Diflubenzuron (Dimilin) and Penfluron. The effects they produce on insects include

Disruption of moulting
Displacement of mandibles and labrum
Adult fails to escape from pupal skin and dies
Ovicidal effect.

Chitin sysnthesis inhibitors have been registered for use in many countries and used successfully against pests of soybean, cotton, apple, fruits, vegetables, forest trees and mosquitoes and pests of stored grain

IGRS from Neem : Leaf and seed extracts of neem which contains azadirachtin as the active ingredient, when applied topically causes growth inhibition, malformation, mortality and reduced fecundity in insects.

Hormone mimics from other living organisms: Ecdysoids from plants (Phytoecdysones) have been reported from plants like mulberry, ferns and conifers. Juvenoids have been reported from yeast, fungi, bacteria, protozoans, higher animals and plants.

Advantages of Using IGRs

Effective in minute quantities and so are economical
Target specific and so safe to natural enemies
Bio-degradable, non-persistent and non-polluting
Non-toxic to humans, animals and plants

Disadvantages

Kills only certain stages of pest
Slow mode of action
Since they are chemicals possibility of build-up of resistance
Unstable in the environment

ANTIFEEDANTS

Antifeedants are chemicals that inhibit feeding in insects when applied on the foliage (food) without impairing their appetite and gustatory receptors or driving (repelling) them away from the food. They are also called gustatory repellents, feeding deterrents and rejectants. Since do not feed on trated surface they die due to starvation.

Groups of antifeedants

Triazenes: AC 24055 has been the most widely used triazene which is a oduorless, tasteless, non-toxic chemical which inhibit feeding in chewing insects like caterpillars, cockroaches and beetles.

Organotins. They are compounds containing tin. Triphenyl tin acetate is an important antifeedants in this group effective against cotton leaf worm, Colarado potato beetle, caterpillars and grass hoppers

Carbamates: At sublethal doses thiocarbamates and phenyl carbamates act as antifeedants of leaf feeding insects like caterpillars and Colarado potato beetle. Baygon is a systemic antifeedants against cotton boll weevil.

Botanicals: Antifeedants from non-host plants of the pest can be used for their control The following antifeedants are produced from plants.

Pyrethrum: Extracted from flowers of *Chrysanthemum cinerarifolium* acts as antifeedants at low doses against biting fly, Glossina sp.

Neem: Extracted from leaves and fruits of neem (*Azadirachta indica*) is an antifeedant against many chewing pests and desert locust in particular

Apple factor: Phlorizin is extracted from apple which is effective against non-apple feeding aphids**.**

Solanum alkaloids: Leptine, tomatine and solanine are alkaloids extracted from Solanum plants and are antifeedants to leaf hoppers.

Miscellaneous compounds: Compounds like copper stearate, copper resinate, mercuric chloride and Phosphon are good antifeedants.

Mode of action: Antifeedants inhibit the gustatory (taste) receptors of the mouth region. Lacking the right gustatory stimulus the insect fails to recognize the trated leaf as food. The insect slowly dies due to starvation.

Advantages:

Affect plant feeders, but safe to natural enemies
Pest not immediately killed, so natural enemies can feed on them
No phytotoxicity or pollution

Disadvantages

Only chewing insects killed and not sucking insects
Not effective as sole control measure, can be included in IPM

INSECT ATTRACTANTS

Chemicals that cause insects to make oriented movements towards their source are called insect attractants. They influence both gustatory (taste) and olfactory (smell) receptors.

Types of Attractants:

1. **Pheromones**: Pheromones are chemicals secreted into the external environment by an animal which elicit a specific reaction in a receiving individual of the same species.
2. **Food lures :** Chemical present in plants that attract insect for feeding. They stimulate olfactory receptors.

List of natural and synthetic food lures

Insects	**Lure**
	Natural
Pests of cruciferae	Isothiocyanates from seeds of cruciferae
Onion fly (Hylemya antiqua)	Propylmercaptan from onions
Bark beetle	Terpenes from barks
Housefly	Sugar and molasses
	Synthetic
Oriental fruitfly (Dacus dorsalis)	Methyl eugenol
Melon fruitfly (Dacus cucurbitae)	Cuelure
Mediterranean fruitfly (Ceratitis capitata)	Trimedlure

3. **Oviposition lures**: These are chemicals that govern the selection of suitable sites for oviposition by insects. For example extracts of corn attracts *Helicoverpa armigera* for egg laying on any treated surface.

Use of Attractants in IPM

Insect attractants are used in 3 ways in pest management

a) Sampling and monitoring pest population
b) Luring pests to insecticide coated traps or poison baits

Examples of poison baits

For biting insects: Moistened Bran + molasses) + insecticides
For sucking insects : Sugar solution + insecticide
For fruitflies: Trimedlure/ Cuelure/ Methyl eugenol + insecticides
For cockroaches: Sweet syrup + white or yellow phosphorus
For sweet-loving ants : Thallous sulphste + sugar + honey + glycerine + water
For meat loving ants : Thallous sulphate + peanut butter

c) in distracting insects from normal mating, aggregation, feeding or oviposition

The female insects if lured to wrong plants for egg laying, the emerging larva will starve to death

Advantage of using attractants is that they are specific to target insects and NE not affected. But they cannot be relied as the sole method of control and can only be included in IPM as a component.

INSECT REPELLENTS

Chemicals that induce avoiding (oriented) movements in insects away from their source are called repellents. They prevent insect damage to plants or animals by rendering them unattractive, unpalatable or offensive.

Types of repellents

1. Physical repellents : Produce repellence by physical means

a) Contact stimuli repellents: Substances like wax or oil when applied on leaf surface changes physical texture of leaf which are disagreeable to insects
b) Auditory repellents: Amplified sound is helpful in repelling mosquitoes.
c) Barrier repellents: Tar bands on trees and mosquito nets are examples.
d) Visual repellents: Yellow light acts as visual repellents to some insects.
e) Feeding repellents: Antifeedants are feeding repellents. They inhibit feeding.

2. Chemical repellents:

a) **Repellents of Plant origin:** Essentials oils of Citronella, Camphor and cedarwood act as repellents. Commercial mosquito repellent 'Odomos' uses citronella oil extracted from lemongrass, Andrpogon pardus as repellent.

Pyrethrum extracted form Chrysanthemum is a good repellent and has been used against tsetse fly, *Glossina morsitans.*

b) Synthetic repellents: **Repellents synthetically produced.**

List of important synthetic repellents

Insects	Repellents
Mosquito, blood suckers	Dimethyl pthalate
Mites (chiggers)	Benzyl benzoate
Crawling insects	Trichlorobenzene
Phytophagous insects	Bordeaux mixture
Wood feeders	Pentachlorophenol
Fabric eaters	Naphthalene or mothballs
Bees	Smoke

Uses of repellents:

They can be applied on body to ward off insects
Used as fumigants in enclosed area.
Used as sprays on domestic animals
To drive away insects from their breeding place.

BIORATIONAL CONTROL

Controlling insects using chemicals that affect insect behaviour, growth or reproduction, is called biorational control.

Insect Growth Regulator,
Chitin synthesis inhibitor,
JH analogues, Anti JH,
Moulting hormone,
Pheromones
Allelochemics
Attractant, Repellent,
Antifeedant,
Chemosterilant,
Sterile male release

} All these methods are included in **Biorational method** of control

They are called biorational agents in pest control, because of their selective nature in killing only the target insects without affecting non target organisms.