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Insecticide Resistance: Challenge for Entomologists

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Abstract:

Widespread and increasing insecticide resistance poses a threat for controlling pests. Failure to mitigate and manage insecticide resistance is likely to result in an increased burden of pest rising. Genetics and intensive application of insecticides are responsible for the rapid development of resistance in many insects. This article reviews history, causes and management of resistance. This article provides an insight into the knowledge essential for the development of both insecticide resistance management (IRM) and integrated pest management (IPM) strategies.

Keywords: Insecticides, Resistance, Management strategies.

Introduction:-

According to WHO, 'Resistance is the development of an ability in a strain of insects to tolerate dose of an insecticide, which would prove lethal to the majority of the individuals in a normal population of the same species'. A heritable alteration in a pest population's sensitivity to a certain pesticide or set of insecticides is known as insecticide resistance. In reality, insects are considered pesticide resistant when they continually fail to be sufficiently controlled by the registered rate of an insecticide. In areas with high levels of pesticide resistance, using insecticides at many times the usual rate may not have any impact on bug populations. Insecticide resistance is a rising problem for people who rely on pesticides to manage agricultural, veterinary, and medicinal insect pests. Every main family of insecticides has issues with different kinds of insects.

Resistance to insecticides was first documented in 1914 by A.L. Melander in the Journal of Economic Entomology. He described scale insects, still alive, under a 'crust of dried spray' of an inorganic insecticide. Between 1914 and 1946, another 11 cases of resistance to inorganic pesticides were recorded.

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The first report of resistance to insecticides appeared in 1908, when Sanjose scale become resistance to lime sulphur. The first report of insecticide resistance in India was reported by Pradhan *et al* in Singhara beetle, *Galerucellabirmanica* against DDT and HCH in Delhi in 1963. The next resistance was the development of resistance in *Spodopteralitura*,to HCH in 1965 and subsequently to malathion, endosulfan and carbaryl. The resistance in *Plutellaxylostella*, *Lipaphiserysimi*and*Helicoverpaarmigera* to a number of insecticides were also observed later on. The first report of DDT resistance was reported in mosquitoes *Culexfatigans*in 1952. The largest numbers of resistance species are present in order Diptera.

Numerous factors, including the insect's rate of reproduction, level of resistance, migration patterns, host range, persistence and specificity of the insecticide, as well as the rate, timing, and volume of insecticide applications, all affect how quickly insecticide resistance develops. Resistance develops more quickly in conditions like greenhouses, where mites and insects proliferate quickly, insect migration is minimal to nonexistent, and farmers may often use pesticides and insecticides from the same chemical class.

Causes of Insecticide Resistance

A decrease in an insect population's susceptibility to a pesticide is known as insecticide resistance. When used in accordance with the instructions on the product label and when issues with product storage, application, and unusual climatic or environmental conditions can be ruled out as causes of the failure, an insecticide repeatedly fails to achieve the expected level of control of insects. Insects can develop resistance to crop protection chemicals in a variety of ways, and pests frequently display multiple resistance mechanisms at once.

- There are several pest species that have enormous broods of young, such as insect pests. Due of this, mutations are more likely to occur, and communities of resistant individuals will spread quickly.
- Prior to agriculture, pest species had already been exposed to natural poisons. To defend themselves against herbivores, many plants, for instance, create phytotoxins. In order to co-evolve with their host plants, herbivores needed to develop the physiological ability to either detoxify or tolerate toxins.

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- Farmers' social dynamics: In this situation, it might be challenging for farmers to adopt the normative behaviors of their peers. It's a common error for farmers to rely too much on pesticides, and this mistake spreads as they adopt the norms of their surroundings.
- Policy makers' capacity to effect actual change in the path of resistance development may be hampered by their unfamiliarity with variations in regulatory enforcement.

Types of Resistance:-

- **Simple resistance:** when the species confirms resistance to only one insecticide and not to the related one e.g., Malathion resistant houseflies are not resistant to other organophosphates.
- **Cross resistance:** when the species confers resistance to two or more compoundshaving the same mode of action or similar metabolic path way and this involves the same gene showing resistance to different chemicals. e.g., the pest conferring resistance to DDT generally shows resistance to its analogs like DDD but not to the cyclodines (endosulfan) and lindane which have different cross resistance mechanism.
- **Multiple resistance:** The co-existence of different defence mechanism in the same strain. it occurs when resistance to various chemicals confirmed by different coexisting defense mechanisms in the same insect strain, with each mechanism apparently coded by a different gene rather than all mechanism controlled by a plenotrophic expression of the same gene.e.g., the multiple resistance pest species confers resistance to DDT, Cyclodienes and lindane.

Mechanism of resistance to pesticides:

The development of resistance to insecticides may be due to the genetic variations already exist in the insect population which are screened out by the pressure of insecticides. Post adaptive resistance may develop due to behavioural or ecological or physiological considerations.

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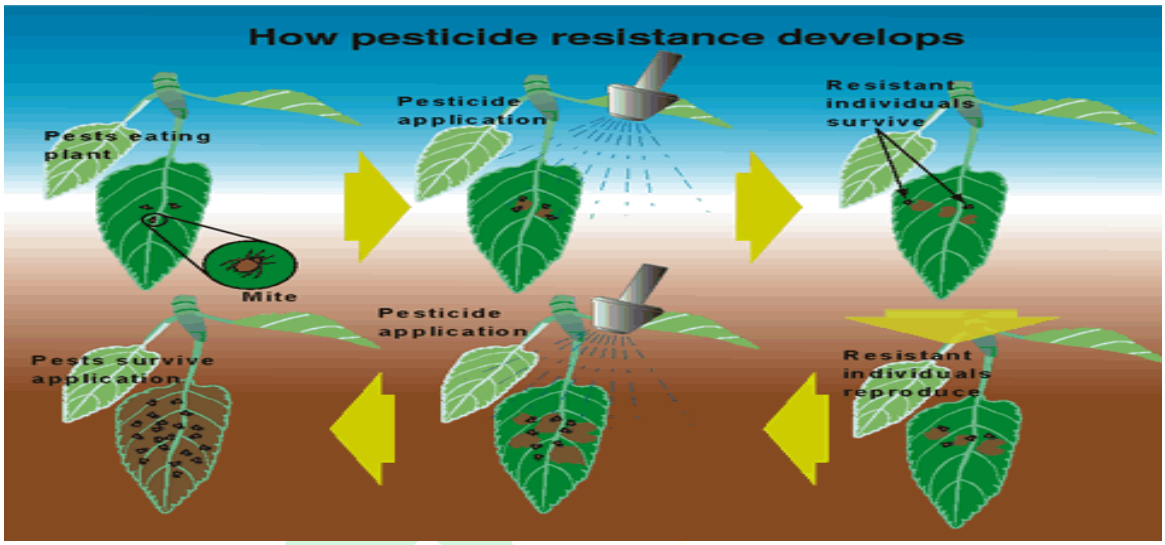

- **Pre adaptive mechanism:** It is also known as a genetic mechanism of resistance because, in this type of resistance, the resistance genes are already present in the species population and insecticides only act as selective killers, eliminating only the members of the susceptible population who carry the resistance genes. The genetic resistance is chromosomally determined e.g., In a housefly the resistance to DDT is due to resessive gene Kdr (Knockdown resistance)gene located on chromosome 3. This gene is responsible for nerve insensitivity found in certain DDT resistance strains. Kdr-NPR gene is responsible for resistance in housefly against natural and synthetic pyrethroids. The gene DDTase located on chromosome-5 is responsible for production of DDTase enzyme. DDT detoxification takes place due to this enzyme so responsible for resistance in housefly.
- **Post adoptive mechanism:** This mechanism of resistance is further classified into:-
    - **Lipoid content:** the insect strains contain higher lipoid content are comparatively resistant than normal ones. The lipoids pick up the insecticides particularly organochlorines and deposit them in different tissues. Brown, 1971 reported that the lipoid content was higher in the resistant flies particularly in their gangalia and tarsi. Increased lipoid was also reported in the adult of DDT resistant strain of *Nophelesatroparvus*.
    - This is due to the ability of resistant strains to detoxify the insecticides by the enzymes such as carboxyesterases and glutathiones transferase which are present in large quantities in resistant strains and absent or present in minute

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quantities in susceptible strains of insects. These enzymes are synthesized by microsomes. e.g., dehydrochlorinase detoxifies DDT into nontoxic DDE in DDT resistant houseflies.

- **Behavioural resistance:** -This is the ability of a species to avoid doses of toxic substances on treated surface which would otherwise be lethal e.g., mosquitoes avoid surface treated with DDT.

Insecticide resistance management strategies:

- Effective insecticide and miticide resistance management (IRM) strategies seek to minimize the selection for resistance from any one type of insecticide or miticide.
- Use recommended pest thresholds to minimize insecticide use.
- Delay the use of broad spectrum insecticides for as long as possible.
- These products reduce beneficial populations and can lead to flaring of other pests.
- Do not apply a first foliar spray from the same insecticide group as contained in a seed treatment.
- Avoid the continuous use of any one mode of action group – including Bt products.
- Rotate between chemical groups where possible.
- Do not exceed maximum acceptable use limits.
- Do not respray an apparent failure with a product of the same group.
- Comply with any use restrictions placed on insecticides used on other crops.