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Resistance Management Strategies to Recover Susceptibility in Insect-Pests

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SUMMARY

As we know that many newer chemicals (insecticides) were developed for control of different types of pests, but after some period of time these chemicals cannot control pests at satisfying level. Therefor there is needed to be that researchers as well as farmers should have general knowledge about development of Insecticide Resistance and also about Insecticide Resistance Management (IRM) Strategies. In this article we are putting some information about this topic.

INTRODUCTION

WHO "is the development of an ability in a strain of insects to tolerate doses of toxicant which would prove lethal to the majority of individuals in a normal population of the same species". The United Nations Environment Programme started in 1979 that pesticide resistance ranked as one of the fourth major environmental problems in the world. Development of resistance is the most serious bottlenecking the successful use of pesticide. Resistance to any foreign substance/chemicals included as a biological phenomenon. Resistance is a genetically inherited characteristic of insects. Development of insecticide resistance is an evolutionary process. Insecticide resistance is expressed as 10-fold, 20-fold or 50 fold. That's way study on the mechanism of insecticide resistance has become necessity of time for efficient control of insect pest infesting crops in field and storage. Presently, 570 pests have developed resistance against various pesticides (Ref. http://pesticideresistance.org). The large number resistance of species are present in order Diptera (34% of the total), Lepidoptera (15%), Mites (14%,) Coleopteran (13%), Homopterous (11%). 35% of the cases show resistance to organophosphats, 31% show resistance to Pyrethroids, Pyrethrins and DDT, 14% to cyclodiene organochlorines, 7% to carbamates, 4% to Neonicotinoids. Out of the resistant insect species, about 56% are of agricultural importance, 39% are of medical or veterinary importance, 5% are natural enemies and <1% are pollinators.

Types of Resistance

Simple resistance: When an insect develops resistant to one insecticide, but not to other insecticides.

Cross resistance: Many resistances are conferred by a single major genetic factor that differs between resistant and susceptible pests. When a single factor confers resistance to more than one pesticide, this is cross resistance. For example, a mechanism making insects resistant to parathion also dramatically reduces susceptibility to a number of other organophosphates. Therefore, when parathion becomes ineffective due to resistance, some other organophosphates also lose efficacy because of cross resistance.

Multiple resistances: With multiple resistances, two resistance mechanisms are acquired independently through exposure to two different pesticides. For example, some spider mites possess resistance to cyhexatin (Plictran) and dicofol (Kelthane). However, these resistances are acquired by two separate genetic modifications, and resistance of the pest to one product does not affect susceptibility to the other.

Monogenic resistance: Involvement of single gene in development of resistance.

Polygenic resistance: Involvement of several genes in in development of resistance.

Mechanisms of Resistance

Pre adaptive mechanism:

Genetic consideration

Post adaptive mechanism:

Physiological consideration-

- Conversion of insecticides to non toxic metabolites:
- Excretion of toxicants
- Dietary factors
- Storage of toxicants

- Alter target site mechanism
- Penetration mechanism

Behavioral and ecological aspects-

Pre adaptive mechanism:

It is also called as genetic mechanism of resistance because in this type, resistance genes are already present in the species population and insecticide acts only as selective agent that kill the susceptible population living only the individuals which have genes that are resistant to these pesticides. E.g. resistance in housefly to DDT due to kdr gene present on chromosome 3, which is responsible for low nerve sensitivity. American strain of housefly resistance to DDT due to kdr-O gene. Resistance in housefly to natural pyrethrin and synthetic pyrethroids due to kdr-NPR gene present on chromosome 3. Resistance in housefly to DDT due to DDTase gene present on chromosome 5 different from kdr, which produces DDT-dehydrochlorinase. In drosophila R factor present on chromosome 2 responsible for DDT and BHC resistance.

Post adaptive mechanisms:

This mechanism of resistance is further classified into-

- **Physiological consideration:**

Physiological resistance is any form of resistance that reduces toxicity through changes in basic physiology. In this form of resistance, the chemical is not broken down into a less toxic form, rather the insect accommodates the chemical by altering one or more functions.

Conversion of insecticides to non-toxic metabolites:

Most prevalent type of resistance. Resistance to DDT in resistant strains is due to conversion of DDT to DDE by enzyme Ddtase in presence of glatuathione. In housefly methyl parathion and fenitrothion is detoxified by demethylation process. Similarly Diazinon and Diazoxon are converted to diethylphosphorothioic acid diethylphosphoric acid respectively by hydrolytic reaction. Housefly malathion is oxidized to malaoxon at faster rate.

Excretion of toxicants:

It plays important role in development of resistance. Faster the excretion slower is the susceptibility. Approximately 44% allethrin absorbed by DDT resistant flies was rapidly excreted as polar metabolite.

Dietary factors:

Two spotted mite more susceptible to malathion when feed on bean plant containing high level of phosphrous. Larvae of tobacco budworm resistant to DDT- diet contains high levels of ascorbic acid and lipids.

Storage of toxicants:

Chlorinated hydrocarbons and their metabolites are deposited in adipose tissues. Lipids are responsible for picking up insecticides and depositing. This type of mechanism only offers slight protection to insects.

Alter target site mechanism:

Most common mechanism i.e. alter site mechanism. Resistance to DDT, organophosphate and pyrethroid is due to target side resistance. Found in tobacco budworm, *Heliothis viredcens* and Colorado potato beetle. Indian meal moth resistant to *Bt* toxin is also an example of altered site resistance.

Penetration mechanism:

In case of housefly were penetration is slow due to outer cuticle hairs.

- **Behavioral and ecological aspects:**

It involves changes in behavior by which insects avoid insecticides. E.g. In mosquito Anopheles gambiae, an endophillic strain (indoor dwelling) was susceptible to DDT sprays applied to walls. An exophillic strain not inhibiting indoors became dominant because its behavior allowed avoiding exposure to the insecticide. This type of resistance mechanism is found in codling moth. Behavioral mechanism is also found in house flies. Late emerging house flies were more resistant to DDT than early emerging.

Management of Resistance

The prevention of resistance to any effective pest management tactic is practically impossible in many situations. However, its rate of development can be slowed by considering the operational factors that enhance it and modifying the pest management program accordingly. Frequent and indiscriminant use of chemical insecticides typically leads to the development of resistance and to a need for more powerful poisons. Basically three strategies that can be used to "manage" the resistance problem:

- Management by Moderation
- Management by Saturation
- Management by Multiple attack

Management by Moderation:

Management by moderation recognizes that susceptibility genes are a valuable resource and it attempts to preserve them by limiting the chemical selection pressure that is applied. Measures in this category include lower insecticide rates, infrequent applications, non-persistent chemicals, and preservation of refugia. It is apparent that these measures are conservative, and in most cases, must be supplemented by non-chemical measures such as insect-resistant varieties, improved timing of planting and harvesting, encouragement of biological controls, etc. While management by moderation comes close to meeting environmental standards and is less destructive to biological controls, it may not be appealing where high value crops must be protected, vectors of human disease suppressed, or newly introduced pests eradicated. In these cases, the saturation or multiple attack concepts may be more appealing.

Maturation by saturation:

The term "saturation" does not imply saturation of the environment with pesticides. It is intended to indicate saturation of the insect defenses by means of on-target dosages that are high enough to overcome resistance. This approach has more merit during the early stages of selection when resistance genes are rare, existing mainly in the heterozygous state. Formulations that could deliver high dosages on-target include microencapsulation, or the use of attractants, eradications and baited targets causing insecticide uptake at rates that are lethal to heterozygote. Another means of suppressing the insect defenses is the use of synergists. Piperonyl butoxide (PB) has been used for many years as a synergist of pyrethrins in household aerosol sprays, and more recently with pyrethroids in agricultural pest control *(e.g. Helicoverpa armigera, Leptinotarsa decemlineata*. By suppressing the insect's mixed function oxidase System, which is involved in the degradation of pyrethroids, PB effectively removes the selective advantage of this mechanism. The approach would not apply where alternative pathways of detoxication, [*e.g.* the pyrethroid resistance mechanism knockdown resistance *(kdr)*], are also present (Ranasinghe and Georghiou 1979). Each of these approaches could find application in specific situations. A strategy based on moderation would be appropriate in a forest environment. A saturation tactic might be feasible in a greenhouse, a grain elevator, in bait sprays, etc.

Management by Multiple Attack:

The multiple attack strategy is based on the premise that control can be achieved through the action of several independently acting stresses, including insecticides, each exerting selection pressure that is below the level which could lead to résistance. This approach includes the application of chemicals in mixtures and rotations. The strategy of using mixtures assumes that the mechanisms of resistance to each member chemical are different and that initially they exist at such low frequencies that they do not occur together in any single individual within a given population. Thus, insects that survive one of the chemicals in the mixture are killed by the other. The strategy of using rotations is based on data which indicate that during the early stages of selection, (resistant individuals may possess lower biotic fitness) the cost of resistance, than susceptible individuals. This lower fitness causes a gradual decline in the frequency of resistant individuals when the selecting insecticide is withdrawn, or is replaced by a neutral insecticide that is not affected by cross-resistance. The feasibility of using two insecticides in rotation, mixture, or sequentially for resistance management has been examined in several laboratories by means of cage experiments. As expected, the use of different insecticides and different species of insects has led to divergent conclusions. It is obvious that the success of each approach will depend on many factors, including the proper choice of chemicals based on their mode of action, the potential mechanisms of résistance to them, the prior exposure of the target population to insecticidal selection pressure, and the presence of a significant fitness differential between resistant and susceptible individuals.

Insecticide Resistance Management Strategies

General IRM strategies:

- Rotation of the insecticides.
- Use of synergists.
- Mixtures and alterations.
- Negatively correlated insecticides.
- Development of newer insecticides.
- Use of insect pheromones.
- Use of insect harmones.
- Use of Integrated Approach.

Bt crops:

- Refuge strategies

House hold pests & vector strategies:

- Fine scale mosaic strategies

CONCLUSION

Resistance management strategies can be recover the insecticidal susceptibility in insect-pests. Alteration of insecticide or use of insecticidal mixture can overcome the problem of resistance. Moderation should be the basic approach should be supplemented to integrated pest management measures. 'Refuges' or areas that are not treated with pesticides, may be important in sustaining the susceptibility to pesticides and therefore, decreasing the evolution of resistance.

REFERENCES

Anonymous, 2011a. The Arthropod Pesticide Resistance Database (APRD). 46th meeting of IRAC International, Brussels-Belgium.

Anonymous, 2011b. Insecticide Resistance: Causes and action. A joint effort between the southern region integrated pest management centre and Insecticide Resistance Action Committee (IRAC).

Anonymous, 2012. International Code of Conduct on the Distribution and Use of Pesticides Guidelines on Prevention and Management of Pesticide Resistance. (FAO): 1-57.

Anonymous, 2012a. Food and Agricultural Organisation. Guidelines on Prevention and Management of Pesticide Resistance.

Anonymous, 2012b. Insecticide Resistance Management Review Group. Insecticide Resistance Management Strategies. Crop Life Australia.

Bt Plant-Incorporated Protectants, 2001, Biopesticides Registration Action Document. IID39-IID153.

FAO, 2012. An example of resistance management using pesticide rotation and biological controls. *Onchocerciasis* Control Programme in West Africa. http://pesticideresistance.org.

Zhu, F., Lavine, L., O'Neal, S., Lavine, M., Foss C. and Walsh, D. 2016. Insecticide Resistance and Management Strategies in Urban Ecosystems. *Insects*, **7** (2): 1-26.