Insecticide Resistance Management

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Pesticide resistance is the adaptation of pest populations to the treatment of a pesticide which results in a decreased susceptibility. The idea of Insecticide Resistance Management (IRM) is considered to have a current emphasis, yet the concept was described as long ago as 1914 by A. L. Melander in discussions of the resistance of Scale insects to insecticide treatments. It is an important concept because the consequences are extremely serious, since insecticides often offer the only effective means of management when pest populations reach high numbers.

The development of synthetic organic insecticides such as DDT was promising because of their attributes. They were effective, relatively inexpensive, and were broad spectrum in their effects on insects. DDT was first utilized in 1939, but resistance to the insecticide was documented by 1947. Long-term negative effects observed on wildlife resulted in a ban of DDT by 1972. Each subsequent introduction of a different class of insecticides, from chlorinated hydrocarbons, organophosphates, carbamates, and pyrethroids was followed in a relatively short period of time by cases of resistance to them.

The development of resistance to pesticides is having an influence on applicators, whether they are working to protect agronomic and row crops, working in vector control, or in urban pest management. A coalition of industry, research, and regulatory groups has formed the **Insecticide Resistance Action Committee (IRAC)** to respond to the problems associated with resistance. http://www.irac-online.org/

Economic consequences of resistance can be profound, particularly when insecticide applications are increased and more and stronger insecticides are applied to overcome resistance in pest populations. Environmental consequences must also be considered in the scenario when treatments must be done more frequently or at higher concentrations in situations where insecticides become less effective. These treatments lead

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to increased opportunities for contamination of soil, air, and water.

There are many examples of insect species developing resistance to widely used insecticides. Resistance in Whitefly populations in cotton in Arizona in the 1990's caused a 12-fold increase in chemical control costs over a five year period, and the number of insecticide applications went from two per season to as many as a dozen. Before the introduction of the new mode of action of neonicotinoid insecticides, a similar scenario of resistance occurred in Whiteflies feeding on ornamental plants.

Whiteflies
(Bemisia tabaci).

IRAC has estimated that additional treatments and alternative controls increases the total insecticide costs to tens of millions of dollars, nationwide. This has fueled fears that our current insecticide tools can be made ineffective unless new alternatives are developed.

How does insecticide resistance develop?

Insect pest populations develop resistance because of a number of factors and influences. (1) Insects, in general, are capable of producing a large number of offspring, and with this capacity is the increased opportunity of mutations leading to resistance. (2) Most insects are inherently exposed to natural toxins in their respective food sources, with the subsequent development of physiological capacity to detoxify chemicals encountered in the environment. (3) The heavy reliance on insecticides for pest management by applicators increases the selection pressure and can result in resistance, particularly when insecticides with the same mode of action are applied.

An example of this development of resistance in an insect is the story of the bedbug. The resurgence of bedbugs has made headlines in the press recently. There are many factors that have contributed to the increased observation of these insects worldwide, including increasing international travel and the reduced use of insecticides in sleeping areas of residences, hotels, homeless shelters, and hospitals. It should come as no surprise that bedbug populations are resistant to the current group of insecticides being used against them. Organophosphate insecticides such as Diazinon and Chlorpyrifos are no longer allowed to be used in urban pest management, leaving pyrethroids as the tools of choice. The pyrethroids are in the same mode of action category as was DDT (Group 3: Sodium channel modulators), which was the primary treatment insecticide used in earlier campaigns to eradicate bedbugs.

Bedbug feeding

Early Bedbug Insecticide Treatment

How do we manage these resistant insects?

In those areas that are currently affected by resistant insect species, everyone must change their pest management strategies in order to delay the onset of or mitigate existing pest resistance. Some of these strategies include:

- Avoid unnecessary insecticide applications; these place more selection pressure on insect populations
- Utilize non-chemical control techniques
- Leave untreated population refuges where susceptible pests can survive and insert their genetics into populations
- Alternate insecticides with a different mode of action (See IRAC)
- Apply insecticides in tank-mixes or sequentially that include multiple modes of action
- Utilize host-plant resistance and rotate to different crops
- Improve sanitation

It is important to monitor pest populations regularly. Any changes in insect populations that may indicate the presence or development of resistance should be dealt with promptly, utilizing the strategies listed above. Another management strategy is to apply a lethal rate of an insecticide. It may be tempting for an applicator to reduce insecticide rates to decrease cost but this practice can contribute to resistance. One chemical treatment with no documented resistance is methyl bromide; the lethal nature of this fumigant gas results in zero survivors capable of passing on resistance.

Conclusion:

Insecticide resistance will continue to be an issue, because resistance can never be halted. Utilizing an integrated resistance management plan allows us to delay and manage resistance.

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