Pest Resistance to Pesticides

How to manage resistance to pesticides

It is abundantly clear that one of the major production constraints in any agro-ecosystem is the direct or indirect damage caused by pests (insects, fungi, bacteria, weeds, rodents, etc).

Pesticides have been and are still the major combat weapons that people use to subdue the population of pests from reaching economically damaging levels.

However, the number of pests that have developed or are developing resistance to various groups of pesticides has increased at an alarming rate since the turn of the last century.

In other words, the ability of certain individuals to tolerate or avoid pesticides that would prove lethal or reproductively degrading to the majority of individuals in a normal population, a term known as resistance, is becoming a serious production problem in agriculture.

The first instance of resistance to pesticide was noted in 1908 with the San Jose Scale (Quadraspidiotus perniciosus) against lime-sulfur; however, resistance really became a concern in the late 1940s with the use of organo-chlorine insecticides. In 1946 house flies were discovered resistant to DDT.

The number of instances of resistance development has gone up exponentially since the end of 1950s.

By the end of 1990s, approximately 600 arthropods species, more than 250 species of plant pathogens, 280 species of weeds, and several species of nematodes and rodents were proven resistant to one or more pesticides of the major groups.

How does resistance to pesticides develop?

Resistance to pesticides is the result of the selection pressure of pest strains tolerant to doses of pesticides that would kill the majority of the normal pest population. These strains tend to be rare in the normal population, but widespread use of pesticides can reduce the normal susceptible population thereby providing the resistant individuals with a competitive advantage. The resistant individuals multiply in the absence of intra-specific competition, and over a number of generations quickly become the dominant proportion of the population.

This implies that resistance is pre-adaptive, i.e. acquired from parents and never acquired through habitation during the lifetime of an individual. For instance, it is not possible to produce resistance within a single generation by exposing pests to sub-lethal doses of a pesticide.

There are two basic mechanisms for development of resistance:

1. detoxification of the active ingredient within the biochemical pathway;

2. tolerance of the pest due to decreased sensitivity to the active ingredient at its site of action.

The rate of resistance development also depends on genetics of the resistance factor. In some cases, resistance originates with mutations occurring in populations, resulting in new genotypes some of which are predisposed to resist adverse factors. If the character required for resistance can be obtained through expression of a single gene (monogenic resistance), resistance may occur after only a few generations. For example, monogenic resistance occurred to insecticides by Musca domestica only after a few years of use. However, if many genes are required (polygenic resistance) development of resistance may be much slower.

Table 1. Doubling periods of the number of species resistant to different categories of insecticides(after Giliomee, 1997).

Insecticide Group	Years
DDT/Methoxychlor	6.3
Lindane/Cyclodienes	5.0

Organophosphates	4.0
Carbamates	2.5
Pyrethroids	2.0

Prevention of resistance to any pest management tactic is impossible; however, its rate of development can be slowed by considering operational factors that enhance it and modifying the pest man agement program accordingly.

Some of the common management routines for resistance management are:

- Use of combined tactics to achieve suppression (e.g. integrating ecological tactics, use of natural enemies, use of resistant plants and use of plant protection chemicals) so that undue reliance is not placed on any one tactic. This is called tactic diversification.
- Use of passive tactics, example, proper irrigation and fertilization to produce vigorous plants which can better tolerate pest injury.
- Modification of use patters - this includes such methods as use of appropriate dosages, less frequent applications, leaving some populations untreated, preserving refugia, etc; or the use of multiple tactics such as use of pesticide mixtures (one component of the mixture could be a 'single-site' and the other a 'multi-site' product), and rotating pesticides (usually consists of a few, 2-3 consecutive applications known as block spray, then switching to a chemical with different mode of action and from a different chemical class).
- Reduce the number of pesticide applications through establishment of better monitoring and forecasting methods.

In conclusion, given the fast rate at which pests are developing resistance to pesticides and the very slow rate at which new molecules are coming to the market, it is imperative that tactics to pest control takes a management approach than relying on a single method. With the increase in the number of sub-standard and adulterated products in the market (major recipes for resistance developments), it is important for growers to be mindful of the type of pesticides they are using in curbing pest population. An integrated management program does provide effective and sustainable solution to pest problems and helps in managing resistance development.

By: Waktoka Wakgari(PhD),

PO Box 122804, Addis Ababa, Ethiopia;

Tel. +251 911 129872;

E-mail: wwakgari@yahoo.com