Pest Resistance to Pesticides

Controlling Pests with Pesticides

Humans have been controlling or attempting to control insect and other arthropod pests, plant pathogens, weeds, rodents, and other vertebrate pests for thousands of years. However, it has been only within the last 50 years that significant progress has been made in controlling pests of humans and our food, fiber, animals, and the structures in which we live and work. This significant advance has occurred because of synthetic (man-made) pesticides, including insecticides, herbicides, fungicides, rodenticides, and algicides. Early successes with the first pesticides, such as DDT, came swiftly. Was the war against pests won so easily?

Very soon after the rapid and astounding victories over mosquitoes and other biting flies, house flies, lice, and agricultural pests such as scale insects, a decline in the effectiveness of these new chemical weapons was observed. Application rates (ie., amounts used) were increased to regain the initial levels of control. However, the levels of control seemed to decline even more rapidly. The reduced levels of control, and eventual control failure in many instances, was found to be due to resistance of the pests to these chemicals.

What Is Pesticide Resistance?

Pesticide resistance is a genetically based phenomenon. Resistance occurs when a pest population— insects, for instance— is exposed to a pesticide. When this happens, not all insects are killed. Those individuals that survive frequently have done so because they are genetically predisposed to be resistant to the pesticide. Repeated applications and higher rates of the insecticide will kill increasing numbers of individuals, but some resistant insects will survive. The offspring of these survivors will carry the genetic makeup of their parents. These offspring, many of which will inherit the ability to survive the exposure to the insecticide, will become a greater proportion with each succeeding generation of the population.

Because of the rapid reproductive rate of many pests — a generation of many insects can take place in a few weeks — many generations can be produced in a single season or year. It's easy to see that repeated applications of an insecticide will quickly eliminate all susceptible insects in the population, essentially selecting out those individuals that are resistant. In a short period the entire population of insects will be resistant. The more times a population is exposed to a pesticide, especially a broad-spectrum pesticide, the more quickly resistance will develop. Resistance develops in a similar manner in other pests, such as plant disease agents, weeds, and rodents. Ironically, to produce a resistant population one must start with a pesticide that initially gives very good control.

The Pesticide Resistance Problem

Today, pests that were once major threats to human health and agriculture but that were brought under control by pesticides are on the rebound. Mosquitoes that are capable of transmitting malaria are now resistant to virtually all pesticides used against them. This problem is compounded because the organisms that cause malaria have also become resistant to drugs used to treat the disease in humans. Many populations

of the corn earworm, which attacks many agricultural crops worldwide including corn, cotton, tomatoes, tobacco, and peanuts, are resistant to multiple pesticides.

Because many generations of some pests can develop in a single year, it is easy to see how resistance can develop so quickly in so many pest species. Recent studies indicate there are now over 500 species of insects and mites resistant to pesticides. Over 270 weed species, over 150 plant pathogens, and about a half dozen species of rats are resistant to pesticides that once controlled them.

Multiple resistance—resistance to more than one pesticide and to pesticides in more than one chemical class—is increasing rapidly. There are over 1,000 insect/insecticide resistance combinations, and at least 17 species of insects that are resistant to all major classes of insecticides.

Pesticides should not be considered the sole or even the primary solution to a pest problem. However, pesticides are frequently an integral part of a pest management program. Pesticide resistance dramatically lessens our ability to bring pest numbers below damaging levels in such a program.

Combatting Resistance

After a pest species develops resistance to a particular pesticide, how do you control it? One method is to use a different pesticide, especially one in a different chemical class or family of pesticides that has a different mode of action against the pest. Of course, the ability to use other pesticides in order to avoid or delay the development of resistance in pest populations hinges on the availability of an adequate supply of pesticides with differing modes of action. This method is perhaps not the best solution, but it allows a pest to be controlled until other management strategies can be developed and brought to bear against the pest. These strategies often include the use of pesticides, but used less often and sometimes at reduced application rates.

The Decreasing Availability of Pesticides

More and more pest species are becoming resistant to pesticides at an increasing rate. For many reasons, the availability of pesticidal products that can be used in rotation against pests is decreasing. The costs of developing a pesticide (i.e., the cost of research and testing, product development, etc.) are significant. Millions of dollars are spent on chemicals that may never become marketable products. Regulatory actions have affected pesticide availability. The U.S. Environmental Protection Agency has banned and restricted many pesticides in the past two decades.

Another factor in the decreasing availability of pesticides, especially from the supply of existing pesticides, is the EPA's reregistration of pesticides. This reregistration program often requires additional testing of pesticides to determine if their use would possibly endanger the health of humans and our environment. It is difficult to argue with the basic rationale of those requirements. However, the cost of complying with EPA's reregistration requirements for testing, plus the subsequent reregistration fees, is having a heavy impact on the current and future availability of pesticides. Many pesticide manufacturers are simply declining to reregister their products because the reregistration costs will severely reduce or eliminate potential profits from future product sales. More important, many individual active ingredients are already lost. Between pesticide cancellations and the reregistration process, whole classes of active ingredients are at risk of being lost from future use.

NAPIAP's Role in Retaining Pesticide Registrations

In 1976, a cooperative, multiagency effort, the **National Agricultural Pesticide Impact Assessment Program (NAPIAP)**, was initiated. NAPIAP draws on the resources and expertise of a number of U.S. Department of Agriculture (USDA) agencies and their cooperators in the state Agricultural Experiment Stations, state Cooperative Extension Services, and state Departments of Agriculture. The primary function of NAPIAP is to manage and coordinate USDA and state activities in the development of information, analysis of pesticide use, and documentation of impacts related to registered pesticides used in U.S. agriculture. This effort supports better-informed regulatory decisions on pesticide registration.

In the registration process, NAPIAP works to provide benefit data for the risk/benefit analysis. NAPIAP provides primary leadership for a

national response to pesticide regulatory action. NAPIAP sponsors research projects in many pesticide-related topics, including the management of individual pesticides and pesticide resistant pest populations, and it conducts investigations into the genetic mechanisms of resistance.

NAPIAP's success in research and in retaining pesticide registrations to assist in overcoming the problem of pesticide resistance is due, in part, to the level of cooperation among the various agencies working to support the productivity of American agriculture in providing us with a nutritious, safe, and economical food supply for today and tomorrow.

Source
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printed March 1996

Acknowledgments
This publication was developed under a project of the Southern Extension and Research Activity- Information Exchange Group 1 (Southern Region Pesticide Impact Assessment Program). Partial Funding for the publication was provided by U.S. Department of Agriculture Extension Service National Agricultural Pesticide Impact Assessment Program special project 93-EPIX-1-145.