The Standard Pesticide User's Guide 5th ed

THE STANDARD PESTICIDE USER'S GUIDE

Fifth Edition

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Preface

This book is a revision of *The Standard Pesticide User's Guide* last revised and copyrighted in 1997. Almost every chapter has had some additions and deletions made to bring information up-to-date. Major revisions were made in Chapter 7, to give updated information on new laws and requirements; in Chapter 8 to show new labels and labeling information; Chapter 12 incorporates new equipment and techniques; and Chapter 15 expands on the entire area of transportation, storage, decontamination, and disposal of pesticides. Chapter 6 titled "Integrated Pest Management" (formerly Chapter 15) has been expanded and is recommended reading to help pesticide users understand this important concept and to show the role of pesticides in an IPM program. Additional information has been added to the appendixes and telephone numbers and other pertinent information have been updated.

This publication is a valuable source of information to those who are new to pesticides or wish to have an understanding of the importance of pesticides in our society. Teachers should find it very useful in conveying to their students that pesticides are highly regulated chemicals that deserve respect in their uses and for their roles in food and fiber production.

Recognizing that pesticides are an essential tool in helping to control most pests, the information in this book is oriented toward those who apply pesticides. It should prove especially useful to commercial pesticide applicators, as well as employees of city, county, state, and federal agencies. Golf course superintendents, grounds maintenance supervisors, and tree nursery managers need the kinds of information contained herein. Pesticide dealers, salespeople, and consultants should also find it helpful in their work.

The science of pesticide use has become a highly specialized field. Federal laws require that individuals applying certain designated pesticides be able to substantiate

or demonstrate that they have the knowledge and capabilities to use the materials safely and effectively. This book can help supply the necessary information for pesticide applicators to use pesticides in a responsible manner. Important information is presented throughout the 15 chapters as well as in the glossary and appendixes.

Information or suggestions for the use of specific pesticides for specific pest control problems are *not* included in this book. Specific control measures and recommendations have been intentionally omitted because they are subject to change and may soon become obsolete. Only current recommendations should be used, along with making sure that you are using the latest pesticide label. Pest control guides for the control of most pests are available through the State University Cooperative Extension Service in every state.

The information contained in this publication is supplied with the understanding that there is no intended endorsement of a specific product or practice, nor is discrimination intended toward any product or practice included in or omitted from this book.

ACKNOWLEDGMENTS

Information and illustrations for this book have been drawn from many sources, including publications from State Cooperative Extension Service Pesticide Programs across the United States. Some of these sources are listed in "Selected References" in Appendix A. Use of these materials is gratefully acknowledged.

I have made every effort to acknowledge all use of illustrations and materials, but may have missed an original source because of the extensive interchange of materials by Cooperative Extension Service writers, sometimes making the original source uncertain.

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Specimen labels have been supplied by the Agricultural Divisions of Novartis, FMC Corporation, and BASF Corporation. Use of the specimen labels for educational purposes is acknowledged and appreciated.

Some of the vertebrate pest illustrations are from "Furbearers of Colorado" published by the Colorado Division of Wildlife in cooperation, with the Colorado Department of Education. Weed illustrations in Chapter 5 are reductions from USDA Handbook Number 366, "Selected Weeds of the United States."

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Contents

1 Introduction to Pesticides

HISTORY

Historical records tell us that agricultural chemicals have been used since before the time of Christ. Ancient Egyptian records mention hemlock and aconite around 1200 B.C., and in 1000 B.C. sulfur was suggested by Homer for use on certain plants. The ancient Romans are known to have used burning sulfur to control insects. They were also known to have used salt to keep the weeds under control. The ninth-century Chinese used arsenic mixed with water to control insects. In the 1300s Marco Polo used mineral oil for treating mangy camels. Most of us have heard the phrase "the dose determines the poison." Actually, it was Paracelsus, a Swiss alchemist about 1500 A.D., who stated, "the right dose differentiates a poison from a remedy." Arsenic mixed with honey for ant bait (1669) appears to be the first use of an insect stomach poison. Not long after (1690), tobacco was used as a contact insecticide against pear insects, and in 1773 nicotine fumigation from heated tobacco proved to be effective on insect-infested plants. Early in the 1800s, pyrethrin and rotenone were discovered to be useful as insecticides for the control of many different insect species. Paris green, a mixture of copper and arsenic, was discovered in 1865 and was subsequently used to control the Colorado potato beetle. In 1882 a fungicide known as Bordeaux mixture, made from a mixture of lime and copper sulfate, was found to be useful as a fungicide for the control of downy mildew in grapes. Mercury dust was developed in 1890 as a seed treatment, and in 1915 liquid mercury was developed as a seed treatment to protect seeds from fungus diseases.

The first synthetic, organic insecticides and herbicides were discovered and produced in the early 1900s; this preceded the subsequent discovery and production of hundreds of synthetic, organic pesticides, starting in the 1940s. Chlorinated hydrocarbons

(cyclodienes), such as chlordane, aldrin, dieldrin, endrin, and heptachlor, came into commercial production in the 1940s. Organic phosphates (parathion, malathion, etc.) began to be commercially produced during the 1950s. In the late 1950s carbamates were developed and included insecticides, herbicides, and fungicides. During the 1960s there were trends toward specific and specialized pesticides that included systemic materials, as well as "prescription" types of pesticides. Many of the new families of pesticides being used in the 1990s are so biologically active that they are applied at rates of grams or ounces per acre. These include the pyrethroids, sulfonylureas, and imidazolinones. Most of the newer compounds offer greater safety to the user and the environment. Presently, there are approximately 675 active chemical ingredients being formulated into about 20,000 registered commercial preparations. Approximately 200 leading active ingredients, of the total 675 basic active chemicals, represent 90% of the agricultural uses in the United States.

CURRENT CIRCUMSTANCES

Pesticides are used by people as intentional applications to the environment for the purpose of improving environmental quality for humans, domesticated animals, and plants. Despite the fears and real problems they create, pesticides clearly are responsible for part of the physical well-being enjoyed by most people in the United States and the Western world. They also contribute significantly to the existing standards of living in other nations. In the United States, consumers spend less of their income on food (about 10%) than consumers in any other country spend. The chief reason for this is more efficient food production. Chemicals have made an important contribution in this area. In 1850 each U.S. farmer produced enough food and fiber for himself and three other persons. More than 100 years later (1960) he was able to produce enough food and fiber for himself and 24 other people, for himself and 45 other people in 1970, and for himself and 78 others in 1990. In 1997, each farmer produced enough food and fiber for 129 people—94 in the United States and 34 abroad. By the year 2000 each farmer will need to produce enough for more than 135 people, as world population is estimated to be more than 6 billion. There is great pressure on the farmers of the world to increase agricultural production in order to feed and clothe this extra population.

At the present time the world food supply does not satisfy the hunger of the total population. As much as one-half of the world's population is undernourished. The situation is worse in underdeveloped countries, where it is estimated that as much as three-fourths of the inhabitants are undernourished.

Agricultural Losses

In spite of pest control programs, U.S. agriculture still loses possibly 25% to 30% of its potential crop production to various pests. Without modern pest control, including the use of pesticides, this annual loss would probably double. If that happened, it is possible that (1) farm costs and prices would increase considerably, (2) the average consumer family would spend much more on food, (3) the number of people who work on farms would have to be increased, (4) farm exports would be reduced, and

(5) a vast increase in intensive cultivated acreage would be required. It has been estimated that 400 million fewer acres are required to grow food and fiber than might otherwise be required. This is said to be due to modern technology, which includes the use of pesticides.

Pest Competition

In most parts of the world today, pest control of some kind is essential because crops, livestock, and people live—as always—in a potentially hostile environment. Pests compete for our food supply, and they can be disease carriers as well as nuisances. Humans coexist with more than 1 million kinds of insects and other arthropods, many of which are pests. Insects transmit 15 major disease-causing organisms to humans. Cockroaches alone cause allergic reactions among 8% of the population. More than 25,000 people seek medical attention for fire ant stings annually. Fungi cause more than 1500 plant diseases, and there are more than 1000 species of harmful nematodes. Humans must also combat hundreds of weed species in order to grow the crops that are needed to feed our nation. Rodents and other vertebrate pests can also cause problems of major proportion. Many of these pest enemies of humans have caused damage for centuries.

Some good examples of specific increases in yields resulting from the use of pesticides in the United States are corn, 25%; potatoes, 35%; onions, 140%; cotton, 100%; alfalfa seed, 160%; and milk production, 15%.

Modern farm technology has created artificial environments that can worsen some pest problems and cause others. Large acreages, planted efficiently and economically with a single crop (monoculture), encourage certain insects and plant diseases. Advanced food production technology, therefore, actually increases the need for pest control. Pesticides are used not only to produce more food but also food that is virtually free of damage from insects, diseases, and weeds. In the United States, pesticides are often used because of public demand—supported by government regulations—for uncontaminated and unblemished food.

Environmental Concerns

In the past, pest problems have often been solved without fully appreciating the treatments and effects on other plants and animals or on the environment. Some of these effects have been unfortunate. Today, scientists almost unanimously agree that the first rule in pest control is to recognize the whole problem. The agricultural environment is a complex web of interactions involving (1) many kinds of pests, (2) relationships between pests and their natural enemies, and (3) relationships among all these and other factors, such as weather, soil, water, plant varieties, cultural practices, wildlife, and people.

Pesticides are designed simply to destroy pests. They are applied to an environment that includes pest, crops, people, and other living things, as well as air, soil, and water. It is generally accepted that pesticides specific to the pest to be controlled are very desirable, and some are available. However, these products can be expensive because of their limited range of applications.

Unquestionably, pesticides will continue to be of enormous benefit to humans. They have helped to produce food and protect health. Synthetic chemicals have been the

front line of defense against destructive insects, weeds, plant diseases, and rodents. Through pest control, we have modified our environment to meet esthetic and recreational demands. In solving some environmental problems, however, pesticides have created others of undetermined magnitude. The unintended consequences of the long-term use of certain pesticides have been injury or death to some life forms. Much of the information on the effects of pesticides comes from the study of birds, fish, and the marine invertebrates, such as crabs, shrimps, and scallops. It is clear that different species respond in different ways to the same concentration of a pesticide. Reproduction is inhibited in some and not in others. Eggs of some birds become thin and break, while others do not.

Residues of some persistent pesticides apparently are *biologically concentrated.* This means that they may become more concentrated in organisms higher up in a food chain. When this happens in an aquatic environment, animals at the top of the chain (usually fish-eating birds) may consume enough to suffer reproductive failure or other serious damage. Research has shown that some pesticides decompose completely into harmless substances fairly soon after they are exposed to air, water, sunlight, high temperature, or bacteria. Many others also may do so, but scientific confirmation of that fact is not yet available. When residues remain in or on plants or in soil or water, they usually are in very small amounts (a few parts per million or less). However, even such small amounts of some pesticides or their breakdown products (which also may be harmful) sometimes persist for a long time.

Pesticides, like automobiles, can create environmental problems, but in today's world it is difficult to get along without them. Those concerned about pesticides and pest control face a dilemma. On the one hand, the modern techniques of food production and the control of disease-carrying insects require pesticides. On the other hand, many pesticides can be a hazard to living things other than pests, sometimes including people.

Human Concerns

No clear evidence exists on the long-term effects on humans from the accumulation of pesticides through the food chain, but the problem has been relatively unstudied. Limited studies with human volunteers have shown that persistent pesticides, at the normal levels found in human tissues at the present time, are not associated with any disease. However, further research is required before results are conclusive about present effects, and little information exists about the longer-term effects. Meanwhile, decisions must be made by extrapolating from the results of tests that have been done on experimental animals. Extrapolation is always risky, and the judgments concerning the chronic effects of pesticides on people are highly controversial.

Public concern about the possible dangers of pesticides is manifested in legal actions initiated by conservation groups. Pesticides, like virtually every chemical, may have physiological effects on other organisms living in the environment, including people. The majority of the established pesticides have no adverse effect on people, animals, or the environment in general as long as they are used only in the amounts sufficient to control pest organisms. Pest control is never a simple matter of applying a pesticide that removes only the pest species. For one thing, the pest