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INCREASED FARM PRODUCTIVITY since World War II owes part of its success to the widespread use of chemicals to control pests, weeds and diseases in farm and forest crops. Non-farm use of chemicals has expanded also in such areas of pest control as private and public lawns, golf courses, trees and ornamental plants, utility and highway right-of-ways.

Chemicals must be toxic (poisonous) in order to kill pests, weeds and disease organisms. They require extremely careful use because their poisonous effects may extend beyond the immediate objective—to the user, to the crop or property being protected, to adjacent property, to useful plants, and to beneficial animal life. Thus they possess a built-in hazard that must be kept constantly in mind by those who use them.

The use of a variety of toxic chemicals for pest control has resulted in considerable concern among public health officials. The problem of chemical spray residues on food, for example, is widely discussed. (The use of pesticides and other chemicals on raw agricultural crops is regulated by the Federal Food and Drug Administration.) Also concerned are agencies and personnel interested in, or responsible for, the management of wildlife resources. Numerous examples have been reported of damage to birds, fish and other animals resulting from widespread spray programs.

Much has been said and written about the effects of pesticides on wildlife. In the controversy it is difficult at times to separate fact from fiction and reason from emotion. However, questions of values and priorities can not and will not be settled by heated arguments. It is not the purpose of this bulletin to summarize the losses resulting from spray programs, but rather (1) to review the general problem and (2) to suggest a reasonable approach to the solution of specific problems.

TO SPRAY OR NOT TO SPRAY

Most producers of farm crops, livestock or timber appreciate the recreational and aesthetic values of fish and wildlife. Many hunt, fish, or enjoy wildlife in natural surroundings. However, when a conflict of interest

is apparent, these same people must make decisions based on the relative values of the advantages and disadvantages of spraying with chemicals.

In Michigan it is impossible to raise certain crops profitably without using some pesticides. A Michigan orchardist or vegetable grower could not stay in business without insecticides and fungicides. The same can be said about people with investments in certain timber and Christmas tree enterprises. A farmer threatened with insect damage to his crops has reason to be concerned. He will generally use an insecticide to prevent loss to his crop, even though beneficial (bees, lady-bugs, etc.) and non-destructive insects, fish, game, and songbirds may be killed.

A home owner with a large elm tree on his property can become quite concerned about Dutch elm disease. Knowing that a 50-or a 100-year-old tree cannot be replaced in his lifetime, he may decide to spray it with DDT as a precautionary measure. His neighbor might be equally concerned about possible loss of songbirds from applications of concentrated DDT to the elm tree.

Such conflicting interests of farmers, beekeepers, tree growers, owners of elm trees, and naturalists must be considered in planning pest control programs. The views of each should be respected and evaluated in decision-making. When it seems obvious that chemicals must be employed, every practical precaution should be taken to minimize wildlife losses. The following discussion covers some general rules of treatment which, if followed, will reduce damage to wildlife without decreasing the effectiveness of the pesticide program.

NATURE OF PESTICIDES

Pesticides are known as *economic poisons* because they are designed to kill or control harmful insects, plant diseases, noxious plants and destructive mammals. Thus, by definition and action, pesticides are recognized as toxic chemicals.

For convenience, they may be divided into the following classes:

Insecticides – for insect control
Herbicides – for weed control
Fungicides – for plant disease control
Rodenticides – for control of mice, rats, and other rodents

INSECTICIDES

The newer insecticides fall mainly into two general groups: the *chlorinated hydrocarbons* and *organic phosphates*. (Note: Sevin–a relatively safe insecticide in the control of fruit insects–belongs to a third group, the carbamates. Under some circumstances it is quite poisonous to bees.)

Chlorinated hydrocarbon – This group includes DDT, BHC (benzene hexachloride), lindane, toxaphene, methoxychlor, heptachlor, chlordane, aldrin, dieldrin, endrin, and others. All of these compounds are quite stable chemically (their chemical structure is not easily changed) and can remain toxic for considerable lengths of time. For instance, under some situations DDT can persist in the top six inches of soil for many years, although in decreasing amounts from year to year. Hence, there is concern about cumulative effects of the chlorinated hydrocarbons in areas where they are applied year after year.

Organic phosphates – This group includes such chemicals as malathion, parathion, methyl parathion, demeton, Diazinon, Phosdrin, Thimet, Guthion, TEPP, EPN, and others. These chemicals vary widely in toxicity, some being extremely poisonous to birds and mammals. However, in contrast to chlorinated hydrocarbons, most organic phosphates break down and lose their toxicity in a relatively short time and do not build up in the soil.

HERBICIDES

Herbicides and fungicides when used in recommended amounts generally are not hazardous to wildlife. The best-known herbicide is 2,4-D, a chemical used in field crops for selective control of broad-leaved plants. It is a growth-regulating hormone which destroys plants by causing them to grow too rapidly. In experiments in Pennsylvania, 2,4-D was not found hazardous to rabbits.

Herbicides destroy plants and thus alter living conditions for wildlife. The resulting changes may be beneficial or harmful, depending on circumstances. Nests in browning shrubbery may be deserted, or the young birds may die from exposure. In some instances, herbicides have been used as tools in game management. When forest trees become mature, they lose their value as a source of food for deer and other wildlife. The large trees also suppress seedling trees and shrubs. Deer habitat has been improved by applying chemicals to mature trees of little commercial value, permitting growth of young trees and shrubs which provide deer food. Weed-killers also have been used experimentally to improve fish habitat.

Fungicides containing mercury, while capable of causing damage to fish and wildlife, have not caused appreciable animal losses in Michigan.

NATURE OF DAMAGE TO FISH AND WILDLIFE

Depending on kinds and quantities used and the time and method of application, pesticides may damage fish and wildlife in several ways:

(1) Animals can be killed by direct contact with toxic materials.
(2) Animals can die from eating food contaminated with chemicals.

(3) Nonfatal doses of some poisons may reduce egg production and lower chick survival among certain game birds, and possibly songbirds.

(4) Reduction or elimination of insects by pesticides may cause starvation of certain forms of wildlife, or force them to move from a chemically treated area.

DDT is well-known and widely used for insect control work. Its effect on fish and wildlife has received considerable attention in research work, resulting in some important information. Depending on a variety of factors, the chemical can be extremely harmful to fish and birds. An application of DDT in oil solution on a lake or stream at the rate of one pound per acre will kill many fish. Some fish may be affected with as little as 2/10 pound of DDT per acre. One application of DDT at the one pound per acre rate in a recent gypsy moth control program in Ingham County did not result in serious damage to songbirds, but repeated applications during the same year or following years could be a different story. This is where the lasting qualities of the chlorinated hydrocarbons must be considered. At concentrations recommended for Dutch elm disease control, DDT is likely to be very harmful to songbirds.* Warm-blooded animals, however, are less susceptible to DDT than fish, crayfish, and stream insects. Mammals can withstand higher concentrations of DDT than birds. As a general rule, fish and other aquatic organisms are most sensitive to chemicals, birds are less so, and mammals are least affected of the three groups.

There is considerable variation in the toxicity of insecticides to wildlife. Some (methoxychlor, chlorthion, and malathion) are apparently less toxic to birds and mammals than DDT; some (lindane, toxaphene, and chlordane) have toxicities similar to DDT; others (heptachlor, aldrin, endrin, dieldrin, and parathion) are much more toxic than DDT. However, high toxicity may not be as critical at times as the stability of chemicals with lower toxicities. For example, TEPP was found to be 250 times *more* toxic than DDT in laboratory tests with rats. However, because TEPP decomposes and loses its potency very rapidly in water, it is considerably *less* toxic to fish than DDT.

BEFORE SPRAYING

Before pesticide operations are undertaken, several decisions must be made. Someone must decide what chemical to use, and how and when

*Robins and other birds have decreased in numbers following repeated spraying with DDT for Dutch elm disease control on the Michigan State University campus and elsewhere. For details, see "Bird Mortality in the Dutch Elm Disease Program," published by Cranbrook Institute of Science, Bloomfield Hills, Mich.

to apply it. These decisions may be made by a federal or state agency in a large program; by a county board, city or community council; or by an individual farmer or home owner.

Regardless of who makes the decisions, the following facts cannot be ignored:

(1) PESTICIDES ARE POISONS.
(2) They kill harmful insects.
(3) They kill non-harmful insects.
(4) They kill insects used for food by wildlife.
(5) They can destroy fish, birds, and mammals.

It is therefore necessary to compare the value of the protection afforded by the spray with the value of possible damages.

If the decision is to spray, plans should include the following precautions:

1. Select a pesticide which will be least hazardous to wildlife and yet will accomplish desired results. For example, methoxychlor and malathion are less damaging to birds and mammals than DDT, but are effective against mosquitos and many other insects. *Methoxychlor is also effective for controlling beetles which carry Dutch elm disease.*
2. Use minimum dosages and the minimum number of applications recommended by the manufacturer on the container label, or by the Entomology Department at Michigan State University.
3. Treat minimum area possible. If large areas are to be sprayed or dusted, leave blocks, strips, or headwaters untreated where practical. This will allow wildlife populations to recover sooner.
4. Apply dormant sprays, if and when possible, before to mid-April to reduce losses of migrating birds due to direct contact with spray materials. Areas with high bird populations should have priority in the timetable of spring spraying programs.
5. Spray from the ground whenever possible. There is less hazard to wildlife from ground spraying than from aerial applications of pesticides. When aerial spraying is necessary, good ground-to-plane communication is necessary.
6. Reduce puddles and chemical concentrations on the ground by using fog or mist blowers when possible. Hydraulic sprayers use large amounts of water, producing more run-off than other types of equipment.

WHEN SPRAYING

In field operations, the following precautions will help reduce hazards to wildlife:

1. Follow instructions on label. Don't guess and don't add "one for good measure."

2. Avoid spraying on windy days when chemicals will drift.
3. Avoid creating puddles. Don't wash chemicals into sewers, lakes or streams.
4. Spray during daylight to avoid roosting birds. Early morning and late afternoon or evening spraying will reduce losses to bees. Air movements are generally at a minimum at this time, decreasing drift.
5. Because fish and other cold-blooded animals are sensitive to many insecticides, avoid direct or indirect contamination of water containing such animals.
6. Good public relations are a valuable asset to any pest control program. Foremen and crew should be well aware of the importance of the job they are doing and of the hazards involved.

SUMMARY

Pesticides are poisons used to eradicate or control undesirable plants or animals. Even with normal and proper use, some chemicals will kill desirable plants or animals; careless use will cause still more damage. It is therefore urged that before using pesticides, careful consideration be given to the hazards involved; and when spraying, that precautions be taken which will minimize losses of wildlife.

OTHER PUBLICATIONS

The following publications on use of pesticides are available from County Extension Offices or the Cooperative Extension Service, Michigan State University, East Lansing, Michigan:

DDT, How to Use on Vegetables, F-93

Dutch Elm Disease Control, F-195

Controlling Diseases and Insects on Ornamental Trees, E-269

Controlling Insects and Diseases on Vegetable and Truck Crops, E-312

Pest Control for Home Orchards and Small Fruit, F-17

Fruit Insects of Michigan, E-372

Home Invading Pests, F-300

Weed Control—Lawns, F-261

Weed Control—Fields, F-222

Chemical Weed Control in Fruits and Vegetables, F-241

Rat and Mouse Control, F-183