

Insecticides

and their uses in Minnesota

J. A. Lofgren and L. K. Cutkomp



Agricultural Extension Service • University of Minnesota • Institute of Agriculture

Insecticides continue to be an essential part of insect control programs. Effective, safe, and economic insect control depends upon proper identification of the pest, a knowledge of its habits and biology, and an intelligent selection of the best combination of practices and chemicals available.

It is extremely important to store and use all pesticides properly to avoid injury to:

1. The person applying the chemicals;
2. Children and others who may come into contact with improperly stored chemicals or application equipment;
3. Treated crops or animals through overtreatment, through selection of the wrong formulation, or because of illegal chemical residues;
4. Adjacent crops and livestock because of drift;
5. Fish, wildlife, and other nontarget organisms in the treated area.

General Precautions for Using Pesticides

1. Always read the label before using sprays or dusts. Note warnings and cautions each time before opening the container.
2. Keep sprays and dusts out of reach of children, pets, and irresponsible people. They should be stored outside of the home, away from food and feed, and under lock and key.
3. Always store sprays and dusts in original containers and keep them tightly closed. Never keep them in anything but the original container.

J. A. Lofgren is professor and extension entomologist; L. K. Cutkomp is a professor in the Department of Entomology, Fisheries, and Wildlife.

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4. Never smoke or eat while spraying or dusting.
5. Avoid inhaling sprays or dusts. When directed on the label, wear protective clothing and masks.
6. Do not spill sprays or dusts on the skin or clothing. If they are spilled, remove contaminated clothing **immediately** and wash thoroughly.
7. Wash hands and face and change to clean clothing after spraying or dusting. Also wash clothing each day before reuse.
8. Cover food and water containers when treating around livestock or pet areas. Do not contaminate fish ponds.
9. Use separate equipment for applying hormone-type herbicides in order to avoid accidental injury to susceptible plants.
10. Always dispose of empty containers so that they create no hazard to humans, animals, or valuable plants.
11. Observe label directions and cautions to keep residues on edible portions of plants within the limits permitted by law.
12. If symptoms of illness occur during or shortly after spraying or dusting, call a physician or get the patient to a hospital immediately.

Provide for Safe Disposal of Empty Containers

For all empty containers of all types: Do not reuse the container. Completely empty the contents and bury the unused chemical at least 18 inches deep in an isolated location away from water supplies.

Glass containers: Break the container and bury the pieces at least 18 inches deep in an isolated location away from water supplies.

Fiber and paper containers: Burn the empty containers completely. Exercise extreme caution and stay well away from the smoke.

Metal containers:

One-gallon cans: Pour 1 pint of water into the empty can and add 1 tablespoonful of household detergent. Rotate the can carefully to wet all inner surfaces with the solution. Bury the rinse solution at least 18 inches deep in an isolated location away from water supplies.

Punch holes in the top and bottom of the can, crush the can, and bury deeply in an isolated location.

Five-gallon, thirty-gallon, and fifty-five gallon drums: Pour the following mixture into the empty container:

Five-gallon drums—2 quarts water, $\frac{1}{2}$ cup caustic soda (household lye), 2 tablespoonsful detergent.

Thirty-gallon drums—3 gallons water, 1 pound caustic soda (household lye), $\frac{1}{2}$ cup detergent.

Fifty-five gallon drums—5 gallons water, 2 pounds caustic soda (household lye), 1 cup detergent.

Rotate container carefully until all inner surfaces are thoroughly wet. Bury the rinse solution at least 18 inches deep in an isolated area away from water supplies.

Caution: Handle caustic soda (household lye) with extreme care. Do not get on skin, in eyes or on clothing. Read and carefully follow the precautions on the package.

Punch holes in the top and bottom of the container, crush the container, and bury deeply in an isolated area.

If the above rinse method cannot be used, punch holes in the TOP of the container and burn in a hot fire until all of the paint has been completely burned off the container. Extreme caution should be exercised to insure that the containers are completely empty and that persons stay well away from the smoke and fumes.

Do not attempt to burn more than five containers at one time.

Always read and follow the directions and precautions on the label of a pesticide container. Handle empty containers as carefully as those that are full.

Safety Precautions and First Aid

Precautions when using toxic phosphates

Use natural rubber gloves to prevent absorption through the skin. Remove and wash contaminated absorbent clothing.

Avoid breathing any wettable powder dust or contacting an emulsion. If this is unavoidable, use a respirator specifically made for phosphates. A list of respirators can be obtained by writing to the Department of Entomology, Fisheries, and Wildlife; Univer-

sity of Minnesota; Institute of Agriculture; St. Paul, Minnesota 55101.

Phosphate-poisoning symptoms and antidotes

Many organic phosphate insecticides (TEPP, parathion, methyl parathion, tetraethyl dithiopyrophosphate, EPN, demeton, Guthion, Phosdrin, phorate, Di-Syston, and schradan) are hazardous to man during mixing operations and application. Contact with recently treated plants or surfaces may also be hazardous. Certain organic phosphates have been found which are considerably less toxic; malathion, Dicapthion, Co-Ral, and ronnel are much less toxic and diazinon, Dylox, and Delnav are of intermediate toxicity.

All of the organic phosphates discussed, including the least toxic, produce similar symptoms in human beings. All require the same antidote. The symptoms may be produced by absorption through the skin, inhalation, or swallowing. Signs of poisoning include blurred vision (pinpoint pupils), abdominal cramps, tightness of the chest, digestive upsets, sweating and excessive salivation, restlessness, giddiness, headache, and twitching of the facial and eye muscles. *If any of these symptoms occur:*

1. Call physician immediately.
2. Remove contaminated clothing and wash skin thoroughly with soap and water.
3. If chemical has been swallowed, induce vomiting.
4. Keep patient quiet and warm.
5. Physician may administer atropine or 2-PAM as an antidote.

If you have had these symptoms from organic phosphorous compounds, do not handle the compounds again until your physician determines by a blood analysis that your condition is satisfactory. Persons who often use these compounds should have analyses of the blood made at regular intervals.

Chlorinated-hydrocarbon first aid

For *chlorinated hydrocarbons* (such as aldrin, BHC, chlordane, dieldrin, DDT, endrin, heptachlor, lindane, methoxychlor, toxaphene, endosulfan):

1. If chemical has been swallowed, call physician immediately. If patient is conscious, induce vomiting with warm, salty water. Continue until vomit fluid is clear.
2. If chemical has been spilled on the skin or clothing, remove clothing and wash skin thoroughly with soap and water. *Do not use kerosene, gasoline, or other solvents.*
3. Keep patient quiet and warm.
4. Physician may administer sedatives such as phenobarbital or other barbiturates to keep patient calm or to control convulsions.

Minnesota poison information centers

These centers have been established by the Minnesota Department of Health. Their purpose is to provide information for physicians about pesticides and common household poisons, their antidotes, and treatments. Most of these centers operate on a 24-hour basis.

City	Address	Telephone
Bemidji	Bemidji Hospital	751-5430
Brainerd	St. Joseph's Hospital	2861
Crookston	Bethesda Hospital	281-4682
	St. Francis Hospital	281-2490
Duluth	St. Lukes Hospital 915 E. 1st Street	727-6636
Fergus Falls	Lake Region Hospital	736-5475 Night: 736-3255
Mankato	Immanuel Hospital	628-1605
Marshall	Lewis Weiner Memorial Hospital	532-2263
Minneapolis	Division of Special Health Services State Health Dept.	339-7751 Night: 339-1411
	Abbott Hospital	339-8414
	110 E. 18th Street	Extension 226
	Fairview Hospital	FEderal 332-0282
	2312 S. 6th Street	Extension 331
	Hennepin County General Hospital	330-3930
Morris	619 S. 5th Street	
	North Memorial Hospital	588-9451
	3220 Lowry Ave. N. Northwestern Hospital	332-7266
	810 E. 27th Street	
Rochester	St. Mary's Hospital	282-4425 Extension 591
St. Cloud	St. Cloud Hospital	251-2700
St. Paul	Ancker Hospital	222-7341
	495 Jefferson Avenue	Extension 240
	Bethesda Hospital	224-7561
	559 Capitol Blvd.	
	St. John's Hospital	776-8595
	403 Maria Avenue	Extension 531
St. Paul	St. Joseph's Hospital	222-2861
	69 W. Exchange	
	St. Luke's Hospital	222-6644
	300 Pleasant Avenue	
St. Paul	Children's Hospital	227-6521
	311 Pleasant Avenue	

Virginia	Virginia Municipal Hospital	741-3340
Willmar	Rice Memorial Hospital	235-4543
Worthington	Worthington Me- morial Municipal Hospital	376-4141 Night: 376-4142

Regulations on Sale and Uses

The sale and uses of insecticides are regulated by two federal acts and by corresponding state laws. The federal regulations cover the interstate phases of insecticide labeling and sales and the interstate movement of treated foods or agricultural products. The state laws cover these areas within the state.

The federal acts are the Federal Insecticide, Fungicide, and Rodenticide Act, with amendments, and the Food, Drug, and Cosmetic Act as amended. The Insecticide, Fungicide, and Rodenticide Act is administered by the USDA. It provides that all pesticides sold in interstate commerce be approved and labeled according to its provisions.

The Food, Drug, and Cosmetic Act, with amendments, is administered by the Food and Drug Administration. It provides for the establishment of tolerances for pesticides in or on agricultural commodities. This means that the applications of chemicals to crops and livestock must be done in such a way that their residues left in or on the commodities are within the established tolerances. This can be done by following *to the letter* suggestions as to dosage, time of application, crops or livestock to be treated, waiting periods between treatment and harvest, and other limitations stated in current recommendations and on current labels.

Forms of Insecticides

1. **Dusts** are dry powders ready for immediate use. They may contain $\frac{1}{2}$, 1, 2, 3, 4, 5, 10, or 20 percent of the actual chemical. The rest of the dust is a carrier, such as talc or pyrophyllite. Combination dusts with two or more insecticides or fungicides are available. Dusts should not be used in sprayers because they do not mix properly with water or oil.

2. **Wettable powders** are dry powders which may be mixed with water to make sprays. Formulations containing 15, 25, 40, 50, 75, and 80 percent of the actual ingredient are available. These powders contain a carrier plus a wetting agent which permits them to form suspensions when mixed with water. This formulation is useful on vegetation because it does not injure foliage as readily as do emulsions or oil solutions. High-volume hydraulic sprayers with mechanical agitators are best suited for handling wettable powders.

3. **Soluble powders.** Only a few organic insecticides, made of newer materials, dissolve in water. Powders of these chemicals are called soluble powders. They may be mixed with water in the same way as wettable powders and used in the same type of sprayers that handle solutions or emulsions.

4. **Emulsifiable concentrates** are liquids which contain the insecticide dissolved in a suitable solvent and an emulsifier. This permits the concentrate to mix with water to form an emulsion. These concentrates may contain many different amounts of the active ingredient, but the label will give this information plus the weight of active chemical per gallon. For example: 25-percent DDT emulsifiable concentrate contains 2 pounds actual DDT per gallon; 18.5-percent dieldrin emulsifiable concentrate contains 1½ pounds actual dieldrin per gallon; 57-percent malathion emulsifiable concentrate contains 5 pounds actual malathion per gallon, etc. Emulsions may be used in low-pressure low volume sprayers without mechanical agitation. Be sure the use on plants is specifically recommended or included on the label as emulsions damage some types of foliage. Some insecticides are available as "flowable" formulations; these may be handled in about the same way as emulsions.

5. **Oil solutions** are solutions, generally ready to use, of the insecticide in a suitable solvent and an oil carrier. Ready-to-use solutions usually contain from ½ to 10 percent active ingredients. Some solution concentrates are available for further dilution with oil or to form oil sprays such as those used by aerial spray equipment, foggers, and mist blowers. Oil solutions should not be used on plants or animals except for special uses with special formulations, such as certain fly sprays on cattle.

6. **Granulated material** is a ready-to-use preparation of the insecticide in or on particles of a carrier, such as attaclay or bentonite. The particles are usually from 25 to 60 mesh in size or from the consistency of granulated sugar to that of coffee grounds. Granules are particularly useful for controlling soil insects because they sift down through foliage and last longer than other formulations. The granules are also effective for corn borer control because they roll down into the whorl of the plant. They may be applied with fertilizer spreaders, seeders, or special granule applicators, ground or aerial.

7. **Aerosol and spray bombs** contain one or more insecticides, an oil solvent, and a propellant gas. These bombs produce a very fine mist (an "aerosol") or a coarse spray, depending on the purpose of the bomb. The fine mist aerosols are for the control of flying insects, such as flies and mosquitoes, in a closed room. The coarser spray bombs are used to apply a residual deposit of insecticide. You may use some spray bombs on certain plants, but check the labels carefully beforehand. Large aerosol cylinders are available for use in greenhouses, warehouses, etc.

8. **Miscellaneous.** In addition to the main insecticides, there are a number of special types. Baits, insecticide-fertilizer mixtures, insecticide-herbicide mixtures, mothproofing agents, etc. should be used according to recommendations and label directions.

Calculating Dosage and Rates of Application

Most recommendations are given in terms of amount of actual insecticide per acre, percent active ingredient in the finished spray, or as recipes using a given formulation in 1, 5, 25, or 100 gallons of water. The following formulas and tables will help you calculate proper dosages. This is extremely important in order to avoid waste, excessive residues, or injury to treated plants or animals.

1. To figure amount of emulsifiable concentrate needed for a required amount of actual chemical to be mixed in a spray tank:

$$\frac{\text{Acres to be sprayed per tank} \times \text{pounds actual needed per acre}}{\text{Pounds actual per gallon in concentrate used}}$$

Example:

How many gallons of 25-percent DDT emulsifiable concentrate (2 pounds per gallon) are needed to give ¾ pound actual DDT per acre, using a sprayer with a 50-gallon tank applying 10 gallons per acre (5 acres per tank)?

$$\frac{5 \times 0.75}{2} = 1.87 \text{ gallons of 25-percent DDT in 50-gallon tank}$$

2. To figure amount of wettable powder needed for a certain amount of actual chemical per acre:

$$\frac{\text{Acres per tank} \times \text{pounds actual needed per acre}}{\text{Pounds actual chemical per pound of powder used}}$$

Example:

How many pounds of 50-percent DDT wettable powder are needed to apply ¾ pound actual DDT per acre, using a sprayer with a 50-gallon tank applying 10 gallons per acre (5 acres per tank)?

$$\frac{5 \times 0.75}{0.5} = 7.5 \text{ pounds of 50-percent DDT in 50 gallons of water}$$

3. To figure amount of wettable powder needed to mix a spray containing a given percent of actual toxicant:

$$\frac{\text{Gallons of spray wanted} \times \text{percent actual toxicant wanted} \times 8}{\text{Percent active ingredient in powder used}}$$

Example:

How many pounds of 25-percent malathion wettable powder are needed to make 100 gallons of a 1-percent malathion spray?

$$\frac{100 \times 1 \times 8}{25} = 32 \text{ pounds}$$

4. To figure the percent actual toxicant in a spray mixture:

$$\frac{\text{Pounds of insecticide used} \times \text{percent active ingredient}}{\text{Gallons of spray} \times 8}$$

Example:

What percent DDT is in a spray in which 8 pounds of 50-percent DDT powder were used in 100 gallons of water?

$$\frac{8 \times 50}{100 \times 8} = 0.5 \text{ percent}$$

5. To figure the gallons of emulsifiable concentrate needed to mix a spray containing a given percent of active ingredient:

$$\frac{\text{Gallons wanted} \times \text{percent active ingredient wanted} \times 8}{\text{Pounds active ingredient per gallon of insecticide} \times 100}$$

Example:

How much 25-percent DDT emulsion concentrate (2 pounds per gallon) is needed to make 50 gallons of an 0.25-percent DDT spray?

$$\frac{50 \times 0.25 \times 8}{2 \times 100} = 0.5 \text{ gallon}$$

6. For small jobs, it is often necessary to figure how much insecticide to use for 1 gallon of spray.

If the recommendation is given in terms of 100 gallons, use the following formulas for 1 gallon.

With wettable powder:

1 level tablespoon per gallon of water = approximately 1 pound per 100 gallons of water.

With emulsion:

1 teaspoon per gallon of water = approximately 1 pint per 100 gallons of water.

Table of equivalents

- 1 level tablespoon = 3 level teaspoons
- 1 fluid ounce = 2 tablespoons
- 1 cup = 8 fluid ounces
- 1 pint = 2 cups
- 1 quart = 2 pints, or 32 fluid ounces
- 1 gallon = 4 quarts, or 128 fluid ounces
- 1 gallon (United States) = 0.83 (approximately 4/5) gallon (British or Imperial)
- 1 gallon (British or Imperial) = 1.2 gallons (United States)
- 1 gallon water (United States) weighs 8.345 pounds
- 1 pound = 16 ounces or 453.59 grams
- 1 gram = 0.0353 ounce
- 1 ounce = 28.3 grams
- 1 kilogram = 35.27 ounces or 2.2 pounds
- 1 milligram per kilogram = 1 part per million

Dilution table—emulsifiable concentrates

Actual chemical per gallon of concentrate used	Desired pounds per acre of actual chemical						
	0.125 lb. (2 oz.)	0.25 lb. (4 oz.)	0.50 lb. (8 oz.)	0.75 lb. (12 oz.)	1 lb.	2 lb.	3 lb.
pounds	pints of emulsion concentrate to apply per acre						
1	1.0	2.0	4.0	6.0	8.0	16.0	24.0
1½	0.67	1.3	2.6	4.0	5.3	10.6	16.0
2	0.50	1.0	2.0	3.0	4.0	8.0	12.0
3	0.34	0.67	1.3	2.0	2.7	5.4	8.0
4	0.25	0.50	1.0	1.5	2.0	4.0	6.0
5	0.20	0.40	0.80	1.2	1.6	3.2	4.8
6	0.17	0.34	0.67	1.0	1.3	2.6	4.0
7	0.14	0.30	0.60	0.90	1.1	2.3	3.4
8	0.125	0.25	0.50	0.75	1.0	2.0	3.0

Dilution table—wetttable powders (for sprays)

Percent wetttable powder used	Desired pounds per acre of actual chemical							
	0.125 lb. (2 oz.)	0.25 lb. (4 oz.)	0.50 lb. (8 oz.)	0.75 lb. (12 oz.)	1 lb.	2 lb.	3 lb.	4 lb.
	amount of wetttable powder to use per acre							
15	13 oz.	1¾ lb.	3 lb., 5 oz.	5 lb.	6½ lb.	13 lb.	20 lb.	26½ lb.
25	8 oz.	1 lb.	2 lb.	3 lb.	4 lb.	8 lb.	12 lb.	16 lb.
40	5 oz.	10 oz.	1¼ lb.	1¾ lb.	2½ lb.	5 lb.	7½ lb.	10 lb.
50	4 oz.	8 oz.	1 lb.	1½ lb.	2 lb.	4 lb.	6 lb.	8 lb.
75	3 oz.	6 oz.	12 oz.	1 lb.	1 lb., 5 oz.	2 lb., 11 oz.	4 lb.	5 lb., 3 oz.

Dilution table—to obtain a finished spray containing a desired concentration of actual chemical

Formulation to use in 100 gallons of water	Desired concentration of finished spray, percent								
	0.01	0.03	0.06	0.1	0.25	0.5	1.0	2.5	5.0
Wettable powders (percent)									
15	½ lb.	1½ lb.	3 lb.	5½ lb.	13½ lb.	27 lb.	54 lb.		
25	⅓ lb.	1 lb.	2 lb.	3 lb.	8 lb.	16 lb.	32 lb.		
40	1/5 lb.	¾ lb.	1½ lb.	2 lb.	5 lb.	10 lb.	20 lb.		
50	1/6 lb. (2½ oz.)	½ lb.	1 lb.	1½ lb.	4 lb.	8 lb.	16 lb.	40 lb.	
75	1/10 lb. (1½ oz.)	⅓ lb.	¾ lb.	1 lb.	2½ lb.	5 lb.	10 lb.	25 lb.	50 lb.
Emulsifiable concentrate (pounds per gallon)									
1	1⅓ cup	1 qt.	½ gal.	3 qt.	2 gal.	4 gal.	8 gal.	20 gal.	40 gal.
1½	¾ pt.	⅓ gal.	⅓ gal.	½ gal.	1⅓ gal.	2⅓ gal.	5 gal.	13½ gal.	27 gal.
2	⅔ cup	1 pt.	1 pt.	3 pt.	1 gal.	2 gal.	4 gal.	10 gal.	20 gal.
4	⅓ cup	½ pt.	1 pt.	1½ pt.	½ gal.	1 gal.	2 gal.	5 gal.	10 gal.
5	2 fluid oz.	6 fluid oz.	¾ pt.	2⅓ cups	3 pt.	3 qt.	1¾ gal.	4 gal.	8 gal.
6	1¾ fluid oz.	⅔ cup	1½ cups	1 pt.	2¾ pt.	5 pt.	1½ gal.	3⅓ gal.	6¾ gal.
8	1 fluid oz.	¼ pt.	½ pt.	¾ pt.	1 qt.	½ gal.	1 gal.	2½ gal.	5 gal.

Description of Insecticides

Chlorinated Hydrocarbons

Aldrin is available in emulsions, wettable powders, and granule formulations of from 2 to 20 percent. It controls soil-infesting insects, grasshoppers, and numerous leaf-feeding insects. It has a shorter residual action than dieldrin, but a small percentage of the chemical converts to dieldrin on foliage and in soils containing numbers of micro-organisms. Aldrin is of moderate toxicity, and persistence in animal tissues is chiefly associated with the formation of dieldrin.

Bandane, a new chlorinated hydrocarbon, is registered only for application to lawn or turf. It controls ants and white grubs when used at the same rate as recommended for crabgrass control. Chemically it contains several related compounds (isomers) of polychlorodicyclopentadiene. It must not be used where it might contaminate streams, lakes, or ponds. Children and pets are to be kept off treated areas until bandane is washed into the soil.

Chlordane is available in all common formulations, including dust and granules. However, commercial fertilizer-insecticide mixes are not common.

Chlordane is effective against such field pests as grasshoppers, cutworms, ants, and many soil insects. Dosages used are higher than for aldrin, dieldrin, or heptachlor. Solutions of chlordane may be used for spot treatments against household pests, such as roaches, silverfish, carpet beetles, and clothes moths. Proper household applications of chlordane are limited to coarse sprays applied to baseboards, closets, and similar areas where there might be crawling insects.

It is not recommended for indoor fogging. Chlordane is of moderate to low acute toxicity.

DDT is available in all of the previously mentioned forms except the fertilizer-insecticide mixture. It is sold as a dust, a 50- or 75-percent wettable powder, an emulsion concentrate, an oil solution, and in aerosol bomb form usually combined with pyrethrum or the synthetic counterpart, allethrin.

Although DDT is still widely used, it is not effective on grasshoppers, crickets, most plant- and animal-feeding mites, certain aphids (such as the cabbage aphid), most ants, the plum curculio, German and Oriental cockroaches, resistant houseflies, and Colorado potato beetles. Recommended concentrations of DDT wettable powders and dusts may be used safely on any plants except most cucurbits (certain varieties of squash, melons, and cucumbers). Here DDT may be used only with careful uniform dusting or with low concentrations of sprays or dusts. Tomatoes are also somewhat sensitive. Methoxychlor is safer on these crops.

With ordinary handling precautions, DDT is not hazardous during preparation and application. It is classed as a moderately toxic chemical based upon acute toxicity data.

DDT concentrates and accumulates in fatty animal tissues and in butterfat of milk. Therefore, it is inadvisable to apply DDT in any form on dairy cattle or in dairy barns. DDT can also get in milk if cows eat crops such as corn and alfalfa which have been sprayed with DDT. This chemical decomposes much more rapidly outdoors than indoors, but may last over 30 days outdoors under many environmental conditions.

Antiresistant DDT is a sulfonamide compound sometimes referred to as WARF Antiresistant DDT. The compound has *no* practical insecticidal properties of its own, but when combined with DDT provides effective control of DDT-resistant houseflies. A commonly used ratio is 1 part of Antiresistant DDT to 5 parts of DDT, although a 1:1 ratio has also been used effectively. Such a spray combination can be used only in situations where DDT is approved (this eliminates use in dairy barns).

Dieldrin differs chemically from aldrin in having an epoxy (oxygen-containing portion) group and in being more stable. It is available in all common forms, including oil solutions for household use, but is more costly than aldrin. It is effective against soil-infesting insects, grasshoppers, plum curculios, thrips, and other insect pests. Dieldrin is also approved for control of many household insect pests.

The persistence of dieldrin makes it valuable for long lasting insect control. However, this requires rather lengthy waiting periods between time of treatment and harvest on foliage applications. Dieldrin is of moderately acute toxicity. Although more toxic than DDT, it persists in lipids somewhat similarly to DDT.

Endrin is a chemical isomer of dieldrin. It is primarily available in emulsion and granule forms. Although very effective against a wide range of insects, endrin is especially good against sugar beet webworms, cabbage loopers, armyworms, and cutworms. It is also effective against some leafhoppers and plant bugs, and is better than most chlorinated hydrocarbons (except endosulfan) against aphids. Endrin has rather high acute toxicity and must be handled carefully. Chemically it is somewhat less stable than dieldrin when used in certain environmental conditions.

Heptachlor is a close chemical relative of chlordane. It is available in emulsion, wettable powders, and granule formulations. Heptachlor controls most soil-infesting insects, grasshoppers, mosquitoes, and other insects. Doses used are lower than chlordane and are comparable with aldrin. Small quantities of heptachlor usually convert to a persistent form known as heptachlor epoxide. Because of persistence on forage, restrictions must be followed where dairy cows might encounter treatment.

Kepone is a persistent chlorinated hydrocarbon insecticide which has been effectively used in bait form for imported fire ants (southern states only) and for German roaches. It has shown effectiveness against some wireworms when used in a corn meal bait. It has intermediate mammalian toxicity.

Lindane and benzene hexachloride are more poisonous to warm-blooded animals in a single dose than DDT. Lindane, however, is in the moderately toxic class and does not accumulate and persist in body tissues for a long time. Nevertheless, small amounts of lindane will appear in milk from dairy cows fed on treated forage or animals sprayed directly.

For most purposes, lindane is preferable to benzene hexachloride. Lindane contains at least 99 percent of the *gamma* isomer of benzene hexachloride. This is the most toxic of the BHC isomers to insects and certain mites. In addition, lindane does not have the taste or odor problem characteristic of benzene hexachloride that is readily picked up by dairy products.

Methoxychlor is a good replacement for controlling many insects where the use of DDT would be hazardous to animals, humans, or susceptible plants. It is a compound of low toxicity. Although sprays are not recommended on milking cows because small quantities appear in the milk, wettable powders can be rubbed into their hair for fly control.

Methoxychlor is safer to use on cucurbits and tomatoes than DDT and many other insecticides. Except for the plum curculio, it is ineffective against Minnesota insects that are difficult to control with DDT, including DDT-resistant flies. Methoxychlor should replace DDT on the parts of vegetables that are to be eaten. Nevertheless, as with all insecticides, the day-interval indicated for each insect problem must be observed. Methoxychlor is available in all the common formulations.

Mirex is a chlorinated hydrocarbon very closely related to Kepone. The compound does not contain the ketone grouping of Kepone. It is of low mammalian and bird toxicity in the form in which it is used. At present its effective use appears to be in bait form for ant control with safety to game animals. No uses on crops have been approved.

Perthane is a compound of low toxicity, similar to methoxychlor. Emulsions and wettable powders are used in agriculture, although approved uses are rather limited. It is sometimes used in combination with parathion for cabbageworm control. Oil solutions and preparations in aerosol bombs are useful to control the clothes moth, carpet beetle, and other household insects. The compound is one of the most recent DDT relatives to become commercially available.

TDE (or DDD) is low in acute toxicity to warm-blooded animals. Cumulative amounts occur similar to DDT. Emulsions and wettable powder are available. It is useful against the red-banded leaf roller in apple sprays and is effective against tomato hornworms and fruitworms on tomatoes. Other usages are rather limited. As with methoxychlor, TDE is not very effective on species which have developed resistance to DDT.

Telodrin is a chlorinated hydrocarbon of medium persistence. At present, although it is effective against a number of lepidopteran larvae and certain beetles, its use on crops is not permitted. It is included with highly toxic compounds. Mammalian toxicity is nearly that of endrin. Telodrin is ineffective against mites.

Endosulfan (Thiodan) is a sulfur-containing chlorinated hydrocarbon. Prepared formulations include a miscible formulation, a wettable powder, dusts, and

granular dusts. It has approval for use on some potato insects, including aphids. It is also effective on plant bugs present on vegetables and forage crops, and on the sugar beet webworm. Effectiveness on cyclamen mites makes it a potential greenhouse pesticide. Close to DDT in acute toxicity, it is of moderate toxicity to warm-blooded animals.

Toxaphene is a mixture of chlorinated camphene products. It is most commonly used in the emulsion forms. Dusts and 6- and 8-pound per gallon concentrates are also available. Toxaphene is effective against grasshoppers, plant bugs, cutworms, armyworms, and other insects. It has a fairly long residual effect. However, the day-interval period should be carefully checked, because it can be used close to harvest on certain vegetables but requires a longer waiting period on forage crops.

Organic phosphates

Fenthion (Baytex or Entex or Tiguvon) is a phenylated organic thiophosphate having a broad spectrum of activity and moderately high stability. It is highly toxic to mosquitoes, can be used as a residual spray for houseflies, and will be used on a number of fruit and vegetable insects. Emulsions containing 4 pounds of active ingredient per gallon and 25 percent wettable powders are available. Used as Entex, this insecticide will be used by pest control operators at a 3-percent concentration in an oil base. Effectiveness has been shown against many household pests. The compound has moderately high toxicity to warm-blooded animals; its acute toxicity may be somewhat less than that of DDT.

Butonate is an organophosphate which is low in toxicity to warm-blooded animals. The compound has not had extensive use but is promising for household pests such as flies, mosquitoes, roaches, and silverfish. Formulations have been prepared for use as liquid sprays or as aerosols. Some aerosol combinations have been prepared with synergized pyrethrins.

Ciodrin is a thiophosphate with low mammalian toxicity. The compound has been given approval for biting fly control on dairy cows. The compound is not considered to be a systemic insecticide. It persists as an effective material longer than other insecticides used for this purpose. It is slower in action than some phosphates, such as DDVP, but for certain purposes, such as face fly control, may be combined with DDVP.

Co-Ral is listed under animal systemics, page 10.

Compound 4072 is a chlorinated organophosphate (diethyl-1-(2, 4-dichlorophenyl)-2-chlorovinyl phosphate) which has shown a rather broad spectrum of activity. Its effectiveness against soil insects has been particularly important in the Midwest. Many phosphates are ineffective in the soil. The compound has label registration for control of western corn rootworms, which are resistant to commonly used chlorinated hydrocarbons.

Dichlorvos (DDVP or Vapona or dimethyl dichlorovinyl phosphate) is a highly active compound which gives rapid knockdown and kill of flies. It is principally available as a liquid bait formulation for housefly and specialized roach control. A lower concentration has been approved for face fly control on cattle. The compound is not very stable and is short lived in its effect. DDVP is moderately toxic to warm-blooded animals.

Dioxathion (Delnav) is an organic dithiophosphate with good persistent properties. It is a mixture of two chemical isomers available chiefly as 30- and 47-percent emulsion concentrates. Delnav is of moderate toxicity to warm-blooded animals; the toxicity is in the same general range as for diazinon and lindane. It is effective against a number of insects and currently is recommended for sheep ked, lice, hornflies, and ticks on livestock. Delnav has been approved for use as a dip or spray for nonmilking cattle, sheep, goats, and hogs. The biological activity is primarily as a contact or stomach poison, with very little fumigant activity at moderate temperatures.

Demeton is listed under plant systemics, page 10.

Diazinon is one of the more persistent phosphates showing rather broad application possibilities. This organic thiophosphate is valuable against a number of fruit pests, including mites; useful against a number of vegetable and forage crop pests; and widely used in housefly control where DDT-resistance is a problem. It is of moderate toxicity to warm-blooded animals. It is available in 2- and 4-pound per gallon emulsions, a 20-percent solution for dilution as recommended in the household, a 50-percent wettable powder, and 10-percent and 14-percent granules for corn rootworm and onion maggot control. Also, 1-percent granules have been prepared, particularly for fly control in barns.

Naled (Dibrom) is a bromine, chlorine-containing organic phosphate with a rapid effect as a contact insecticide. It has slight vapor toxicity and a short residual life. The compound has low mammalian toxicity. Emulsion concentrates (4 and 8 pounds per gallon) and dusts are available. Recommendations for control of various vegetable insects include a short day interval between application and harvest. Dibrom baits and sprays will also be used for fly control in dairy barns and poultry houses except for dust application to animals.

Dicaphon has appeared valuable for control of DDT-resistant houseflies and chlordane-resistant German roaches. It has been prepared in emulsion concentrates and wettable powders. It appears to have some potential use for household pests, but staining properties have delayed its advancement. Its uses on crop insects are still being studied. The compound has low acute toxicity.

Dimethoate (Cygon) is a moderately toxic phosphate which shows some systemic activity in both

plants and animals. It is registered for housefly control where resistance to DDT, malathion, and diazinon exists. It is sold as a concentrate containing 2.67 pounds active ingredient per gallon and as a 25-percent wettable powder. The acute oral toxicity to rats is in the moderate range and dermal toxicity is lower. It is useful against aphids on ornamentals and certain food crops.

Trichlorfon (or Dipterex or Dylox or Neguvon) is a chlorinated water-soluble phosphate available under the name Dipterex for applications in barns for housefly control. The granular form is commonly available. This product is also effective on chlordane-resistant German roaches. The name Dylox is used for formulations, such as 50-percent soluble powder and 5-percent dusts, for some agricultural pests, particularly webworms and chinch bugs. This chemical is about one-half as toxic as DDT to warm-blooded animals, with no indication of accumulation or storage in tissues. However, treated crops must not be fed to dairy cows. Neguvon will be formulated in several ways for ectoparasites and endoparasites of cattle and small animals.

Di-Syston is listed under plant systemics, page 11.

EPN is very effective in controlling most plant-feeding mites, except the clover mite. A wettable powder containing 25 percent EPN is available. It has been approved for use on European corn borer, and is also used in place of parathion on some insects. Although EPN is effective on plum curculio, dieldrin is usually recommended for this pest. It is about one-eighth as toxic as parathion but still classed as highly toxic.

Ethion is the common name of an organic thiophosphate which appears particularly promising for control of several fruit pests. It has been used on rosy apple aphids, bud moths, several mites, onion maggots, and scale insects. Some effective uses have included combinations with dormant oils on fruit trees and woody ornamentals. Ethion is prepared as a 25-percent wettable powder and in two types of 4-pound per gallon emulsifiables (one for usual use and the other for combining with spray oils). A 4-percent dust and granules are also available. Ethion has a rather long residual effect for a phosphate without any marked systemic activity. The compound is moderately toxic to warm-blooded animals.

Guthion is a dithiophosphate with a rather persistent insecticidal effect. It is sold as a 1½-pound per gallon emulsion, a 25-percent wettable powder, and as a 3-percent dust. Guthion must be handled with considerable care during mixing and spraying as it is of high acute toxicity to warm-blooded animals. It has been approved for use on several fruit and vegetable pests. It is also used on cotton and potato pests, particularly where the cotton boll weevil is resistant to chlorinated hydrocarbons. It is available as ethyl or methyl Guthion.

Malathion is an organic thiophosphate chiefly available as a 4- or 5-pound per gallon emulsion concentrate, a 25-percent wettable powder, and a 4-percent dust. Granules are not common but can be obtained. It is very useful on most aphid, mite, and scale problems on plants. Previously parathion would have been used routinely for these pests except for the hazard involved. Malathion is useful for small gardeners and is valuable for use in ground sprayers and dusters where more hazardous materials could not be used. It is approved as a grain protectant. The advantages include fairly rapid deterioration on crops so that short waiting periods are possible.

Malathion shows a fast and effective kill on DDT-resistant strains of houseflies, although some areas in the United States report some resistance of houseflies to malathion. The lasting period of effectiveness varies from about 1 to 2 weeks, depending on the mixture used and the environmental influences on the insecticide after it has been sprayed. It is of very low mammalian toxicity.

Phorate is listed under plant systemics, page 11.

Phosdrin is a very toxic phosphate containing two chemical isomers. It is a strong contact toxin, but is translocated in growing plants. It gives quick initial kill of sucking insects and several larvae, including cabbage loopers and red-banded leaf rollers. It is usually applied as a foliage spray. Comparatively short waiting periods are required between application and harvest because Phosdrin deteriorates quickly. It must be handled with care because of its high toxicity.

Phosphamidon (Dimecron) is a chlorinated organophosphate that produces rapid kill to many insects by contact. However, it has plant systemic activity which provides some residual effect to sucking insects. The compound deteriorates rapidly. Phosphamidon has rather high toxicity to mammals. A 4-pound per gallon spray concentrate is miscible with water. Recommendations for use include aphids, mites, and scale insects on fruit; aphids on peas and sugar beets; several potato insects; and certain pests of ornamentals.

Ronnel is listed under animal systemics, page 10.

Methyl Parathion is the methyl homologue of parathion and is less hazardous than parathion. It is sold chiefly as a 25-percent emulsion concentrate. It is approved for use against many aphids and other plant-feeding insects. It is also used for cotton boll weevils which may be resistant to chlorinated hydrocarbons. It is of high toxicity.

Parathion is an organic thiophosphate which is highly effective against insects and mites. It is available as a 2-pound (25-percent) or 8-pound per gallon emulsion concentrate, or as a 15- or 25-percent wettable powder. Dusts of 1 or 2 percent and 10-percent granules may also be obtained. The lasting effect against insects is generally a matter of a few days, usually shorter than with most of the chlorinated

hydrocarbon insecticides. It is very hazardous to human beings, particularly during mixing and spraying operations or when the chemical has recently been applied to a crop. To minimize the hazard, most applications should be made by qualified aerial spray operators.

The hazards in using parathion can scarcely be overemphasized. Read carefully what precautions to take to prevent phosphate poisoning and the symptoms which can result from it. *Parathion should not be used by home gardeners!*

Schradan is listed under plant systemics, page 11.

Tetraethyl pyrophosphate (TEPP) is sold for direct dilution in water. A wetting agent is necessary, but most products have this in the solution to be diluted. Most of the products contain 20 or 40 percent TEPP. Large aerosol bombs containing TEPP are also available for insect and mite control in greenhouses.

TEPP, although extremely toxic, decomposes rapidly in the presence of moisture or when mixed as a water spray. It must be used promptly after mixing because most of its effectiveness is lost in 4 to 6 hours. Thus, it becomes harmless on the plant after a day or two.

Tetraethyl dithiopyrophosphate is closely related to TEPP, but is more stable and a little safer on plants. Although slightly less hazardous, it requires the same precautions. It is prepared in bomb form for greenhouse use only.

Carbophenothion (Trithion) is a new monochlorinated thiophosphate compound which has shown great effectiveness against aphids and most plant-feeding mites. It has been most extensively used on the west coast. However, due to its effectiveness on several other insects, it will probably be used widely throughout the United States. Current recommendations are on fruit pests and onion maggot.

Formulations include a 25-percent wettable powder, a 4-pound per gallon emulsifiable (flowable) concentrate, granules, and a 2- or 3-percent dust. A 4-pound per gallon formulation for use only in oil sprays especially for scale insects or aphids is also available. Trithion is not systemic in activity, but has a long residual for a phosphate compound. It is of moderate toxicity when ingested, but of low toxicity by skin absorption.

VC-13 is a chlorinated organic thiophosphate with insecticidal and nematocidal properties. It is still in the experimental stages but is effective on a number of pests. One approved use is as a soil insecticide for control of onion maggots. VC-13 is available as an emulsifiable product and as granules. The compound has moderately low acute toxicity, in about the same range as DDT. It is relatively stable, except under alkaline conditions.

Animal systemics

Coumaphos (Co-Ral) is an animal systemic which controls cattle grubs and lice. It is a thiophosphate

with a coumarin ring structure. Wettable-powder formulations are sprayed directly on the animals. Approval for use on nonmilking cattle has been given and hornfly and screwworm recommendations have been completed. Co-Ral dusts are also available for use on poultry mites and lice. Late fall applications are most effective for grub control.

Dimethoate is listed under organic phosphates, page 9.

Famophos is a thiophosphate compound which has shown systemic effectiveness in cattle against cattle grubs and screwworms. Its commercial use in cattle has not yet been approved.

Ronnel (Korlan, Trolene), a chlorinated organic thiophosphate, is sold as Korlan for control of houseflies, roaches, fleas, bedbugs, cattle lice, and other pests. Formulations include 12- and 24-percent emulsion concentrates, a 25-percent wettable powder, and a pressurized livestock bomb. A purified product known as Trolene is used as an animal systemic in which prepared boluses or treated feeds are given to cattle, particularly for cattle grub control. Ronnel has low mammalian toxicity.

Ruelene has been developed as an important animal systemic of rather broad parasitocidal activity. Both external application of it to cattle and as a medicated feed treatment have largely accomplished the control of cattle grubs. A "pour on" method has been as effective as spraying with high pressure equipment. However, such an external treatment does not appear adequate to control cattle roundworms. Drench treatments (oral) have been effective in cattle, goats, and sheep.

Emulsions for spraying, oil solutions for the "pour on" method, and liquid concentrates for drenching animals are available. Dosages used are approximately one-tenth that which might cause serious illness or death. Mammalian toxicity is low.

Plant systemics

Bidrin is a vinyl phosphate (formerly SD 3562) with contact and systemic properties. It is approved as a foliage spray on certain cotton insects. The material is quite toxic and must be handled with care. At present there are no registered uses in Minnesota.

Demeton (Systox) contains two thiophosphate isomers which are extremely active as contact, fumigant, and stomach poisons and have a pronounced systemic action within a plant. Most sucking insects can be controlled with demeton. It is a highly toxic phosphate and must be handled with great care. Demeton is chiefly sold as an emulsifiable concentrate. Most applications are made by foliage treatment. Pests of ornamentals and of certain vegetables and fruits are included in control recommendations.

Dimethoate is listed under organic phosphates, page 9.

Di-Syston is an organic thiophosphate insecticide, closely related to phorate. Principal recommendations include soil treatment, especially on potatoes, alfalfa, and cotton. Seedlings are protected from sucking insects and mites for several weeks. Di-Syston is supplied in 5- and 10-percent granular formulations. It is highly toxic.

Phorate (Thimet) is a fairly close chemical relative of demeton and is very similar to Di-Syston. It is used to greatest advantage as a seed treatment for cotton, alfalfa, and sugar beets. It may also be used in the soil for protection of potatoes and for rootworm control in corn. These treatments protect the plants against early season insect and mite attack. The material is not recommended for use as a foliar insecticide although it has some contact toxicity. Formulations include emulsions, high concentrate powders (charcoal base), and granular preparations on sand or attapulgite clay. The compound is highly toxic to mammals.

Phosdrin and Phosphamidon are listed under organic phosphates, page 9.

Schradan, sometimes referred to as **OMPA**, is another relatively toxic phosphate systemic in action. Unlike demeton, it has no effective fumigant action but must be converted into an active material within the plant and by the sucking insect. A similar conversion appears to occur in the liver of warm-blooded animals.

Schradan was one of the earliest plant systemics, but has not become widely used. It is best on aphids and is available in bomb form for greenhouse insect control.

Plant derivatives

Pyrethrum is prepared from the flowers of imported chrysanthemum plants. The active ingredients, pyrethrins, are nonpoisonous to humans but fast acting against insects. Pyrethrum is effective only for about a day when used outdoors. Its effectiveness is increased when used with one of the so-called synergists (an added chemical which increases the effectiveness of the main chemical).

A new synthetic chemical, *allethrin*, is very similar chemically. It is used in place of pyrethrum for a few control problems.

Rotenone, one of the oldest insecticides, is prepared from a tropical plant called cubé. A comparatively safe material, it is useful for controlling several vegetable insects. It lasts longer than pyrethrum but not as long as chlorinated hydrocarbon insecticides.

Ryania is produced from the stems of a South American plant. It is not prepared synthetically and only limited amounts are usually available. Ryania gives nearly the same control of the European corn borer as DDT. The advantage over DDT is that it

does not accumulate in body tissues of cattle and other livestock.

The 100-percent product can be used as a wettable powder in water. However, the resulting suspension is much poorer than with synthetic insecticides. A 50-percent wettable powder is now available which approaches the 100-percent product in toxicity. The 37- to 40-percent dust can be used directly on plants. Dusts of lower concentrations are also available.

Carbamate compounds

Carbaryl (Sevin) is chemically different from the organic phosphates and the chlorinated hydrocarbons. It is formulated as a 50-percent wettable powder, an 80-percent wettable powder, a 5-percent dust, and a 5-percent granular material. A liquid concentrate flowable formulation is also available. Sevin has been approved for use on the major fruit insects, European corn borer, corn earworm, and poultry pests. It also looks very promising against a number of vegetable and ornamental insects except aphids.

The insecticide has a comparatively low toxicity to warm-blooded animals, particularly low by skin absorption. It does not present any serious hazard under conditions of pest control use. Rather short day-intervals are permissible.

Dimetilan is a carbamate insecticide with a pyrazolyl structure used exclusively for commercial treatment of thin bands which can be hung in buildings for fly control. An attractant is used with the insecticide and the band is colored red. DDT-resistant (and some phosphate-resistant) houseflies are killed when they land on the bands and remain for a short time. At present the compound is not recommended in other forms.

Zectran is a new methylcarbamate compound shown to have effectiveness on certain ornamental insects and slugs. It has moderate toxicity but no tolerances have been set. The compound will not control mites.

Chlorinated miticides

Certain chemicals are more effective on mites than on insects; some are effective on both. Most of those listed below have their greatest potential use as mite killers and are much less hazardous than phosphates.

Aramite (beta chloroethyl-beta-[p-tertiary butylphenoxy]alpha methylethyl sulfite) is effective on several plant-feeding mites. A 15-percent wettable powder may be used at the rate of 1½ pounds per 100 gallons of water. At the rate used, aramite has little effect on mite eggs. In some cases, however, it will persist and kill active mites for about a week.

Chlorbenside (Mitox) is a chemical relative of ovex, p-chlorobenzyl p-chlorophenyl sulfide. It is a slow-acting material that specifically affects mites but not insects. A 40-percent wettable powder has been used effectively at 1 pound per 100 gallons of water,

especially for European red mites and two-spotted mites.

Chlorobenzilate, a 4, 4-dichlorobenzilic acid ethyl ester, is effective on many species of plant-feeding mites. It is a comparatively safe material, and is compatible with nearly all pesticides except those in which alkaline reactions may take place.

Fenson is a chlorinated hydrocarbon miticide (parachlorophenyl benzenesulfonate) closely related to ovex. The compound has low mammalian toxicity and has proved effective against the plant-feeding mites on apples and pears. It is not permitted on fruits, and therefore must be used prior to blossoming. It is ineffective on insects.

Genite 923 is a miticide made up of a 2, 4-dichlorophenyl ester of benzene sulfonic acid. A 50-percent emulsifiable form has been registered for certain mite control problems, particularly against the European red mite on apples. The rate of use is 1 pint per 100 gallons of water for light to moderate infestations and 1 quart per 100 gallons of water for severe infestations.

Kelthane is a chlorinated miticide that is very effective on a wide range of mites. It is available as an 18½-percent wettable powder or an 18½-percent emulsion concentrate. Kelthane is effective on cyclamen mites and other plant-feeding mites.

Ovex (Ovotran), or p-chlorophenyl p-chlorobenzene sulfonate, is a mite killer which is effective against the egg and active stages. Ovex remains effective for 2 weeks or longer under some outdoor conditions. The 50-percent wettable powder form may be used at rates of 1 to 2 pounds per 100 gallons of water. It has been tested in the greenhouse and on mites infesting fruit.

Pentac is a persistent chlorinated miticide not closely related to other miticides. It is particularly valuable against mites on roses and other greenhouse crops where mite resistance has become general to a number of other materials. It is available as a 50-percent wettable powder. It is ineffective on insects and partially effective on cyclamen mites. Pentac is rather slow acting but fairly long lasting.

Tetradifon (Tedion) is a miticide described as a chlorinated diphenyl sulfone. It is proving effective on orchard and greenhouse mites and is not harmful to beneficial insects. Tedion is sold as a 25-percent wettable powder for spraying or using as a slurry (suspension of the highly concentrated wettable powder in water) on steampipes in greenhouses. It is one of the safest materials as far as mammalian toxicity is concerned.

Insecticide Recommendations—Field Crop Insects

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
Aphids (green- bugs, corn leaf aphids, English grain aphids)	Small grains	malathion	1 lb.	At least 7 days before harvest.
		methyl parathion	4 oz.	Not after heads form.
		parathion	4 oz.	At least 15 days before harvest.
Corn leaf aphid	Corn	phorate (Thimet)	1 lb. (10 lb. of 10% granules)	Apply just before or at the time of tasseling. Direct granules into whorls of plants.
Armyworms	Corn	dieldrin	4 oz.	At least 60 days before harvest or ensiling.
		endrin	3 to 4 oz.	At least 45 days before harvest or ensiling.
		toxaphene	1½ to 2 lb.	Do not feed or ensile treated stalks, leaves, husks. No limitation on use of grain.
	Small grains	dieldrin	4 oz.	At least 7 days before harvest (grain), 30 days for straw.
		endrin	3 to 4 oz.	One application at least 45 days before harvest.
		toxaphene	1½ to 2 lb.	At least 7 days before harvest (14 days for barley). Do not feed straw.
Beet webworm	Sugar beets	trichlorfon (Dylox)	½ to 1 lb.	At least 14 days before harvest. Tops harvested less than 28 days after treatment should not be fed to livestock.
		endrin	6 oz.	At least 20 days before harvest if tops are not fed; 60 days if tops are fed.
		carbaryl (Sevin)	2 to 3 lb.	At least 14 days before harvest of tops.
		endosulfan (Thiodan)	¾ to 1 lb.	Do not feed treated tops.
		toxaphene	2 to 3 lb.	At least 60 days before harvest. Do not feed treated tops.
Corn earworm	Sweet corn	DDT	2 lb.	As emulsion in at least 25 gallons of water to the ear zone. Repeat at 10%, 50%, and 90% silked. With heavy infestations, late corn may need treatment every 2 or 3 days during silking. Do not feed or ensile treated crop residues (stalks, leaves, husks).
		diazinon	1 to 1½ lb.	Direct spray to ear zone at 2- to 3-day intervals until silks dry. At least 2 days before harvest.
		carbaryl (Sevin)	1½ to 2 lb.	In at least 25 gallons of spray per acre. Direct spray to ear zone every 2 or 3 days during silking until silks begin to dry. Do not use in dust form adjacent to bee yards. Sevin is highly toxic to bees.
		(See Special Report 5, "Commercial Vegetable Pest Control Guide")		
Corn rootworm (nonresistant)	Corn	aldrin or heptachlor	½ to 1 lb.	(See Ent. Fact Sheet No. 14) For broadcast application, 1 lb.; for row treatment, ½ lb. Incorporate into soil surface before or at planting time.

Insecticide Recommendations—Field Crop Insects (continued)

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
Corn rootworms (Western and resistant Northern)		diazinon or parathion (stabilized), or phorate (Thimet), or Compound 4072	} 1 lb.	Apply 10 lb. of 10% granules in a 4- to 7-inch band ½ to 1½ inches below the soil surface directly over the row at plant- ing time. An alternate suggestion is a post-emerg- ence application of 10 lb. of 10% granules at the base of the stalks and covered with 2 or 3 inches of soil after the worms begin to feed, usually about mid-June.
	Crickets	Flax	chlordane dieldrin	1 lb. 6 to 10 oz.
	Legumes (for seed)	chlordane dieldrin	1 lb. 6 to 8 oz.	Do not graze treated field or feed treat- ed plants.
Cutworms	Corn	aldrin or heptachlor	1½ to 2 lb.	Apply broadcast before planting time. Disk into soil surface immediately.
		DDT	1½ lb.	Do not feed or ensile treated plants (stalks, leaves, husks) as forage.
		dieldrin	6 to 8 oz.	At least 60 days before harvest (corn).
		endrin	3 to 4 oz.	At least 45 days before harvest.
		toxaphene	2 lb.	Do not feed or ensile treated crops as forage.
	Small grains	dieldrin	6 to 8 oz.	At least 7 days (grain) or 30 days (straw) before harvest.
		endrin	4 to 6 oz.	At least 45 days before harvest.
toxaphene		1½ to 2 lb.	At least 7 days before harvest (14 days for barley). Only one application after grain has headed.	
European corn borer	Corn	DDT	1½ lb. spray 1 lb. granules	Do not graze, feed, or ensile DDT treated stalks, leaves, and husks.
		endrin	3 to 4 oz. (spray or granules)	At least 45 days before harvest.
		EPN	4 to 8 oz.	At least 14 days before harvest.
		carbaryl (Sevin)	1½ to 2 lb.	No waiting period required.
		toxaphene	2 lb. granules	Do not feed treated forage.
			Note: For first brood treat when 75% of the plants show recent larval feeding ("shotholing") in the whorl leaves. For second brood treat when the average egg mass count reaches 100 per 100 plants. On sweet corn treat for second brood when egg hatch starts. One to three treatments may be needed. See Special Report 5, "Commercial Vegetable Pest Control Guide."	
Grasshoppers	Alfalfa, clover hay, forage	diazinon	½ lb.	At least 7 days before cutting. No time limitations before grazing.
		malathion	1 to 1½ lb.	At least 7 days before cutting or en- siling.

Insecticide Recommendations—Field Crop Insects (continued)

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
		carbaryl (Sevin)	1 to 3 lb.	Forage can be fed or harvested immediately. To protect bees do not spray when field is in bloom.
	Corn	aldrin	2 to 4 oz.	At least 21 days (2-ounce rate) or 30 days (4-ounce rate) before harvest or ensiling.
		diazinon	½ lb.	At least 2 days before harvest.
		dieldrin	1 to 2 oz.	At least 40 days before harvest or ensiling.
		malathion	1 to 1½ lb.	At least 5 days before harvest.
	Small grains	carbaryl (Sevin)	1 to 2 lb.	No waiting period required.
		aldrin	2 to 4 oz.	At least 7 days before harvest (grain); 30 days if the straw is used for feed or bedding.
		dieldrin	1 to 2 oz.	At least 7 days (grain) or 30 days (straw) before harvest.
		toxaphene	1 to 1½ lb.	At least 7 days before harvest (14 days for barley). One application only after grain has headed. Do not pasture treated field. Do not feed treated straw.
	Soybeans (including for hay or ensiling)	aldrin	2 oz.	One application at least 30 days before cutting for hay or ensiling.
		dieldrin	1 oz.	One application at least 35 days before cutting for hay or ensiling.
		toxaphene	1 to 1½ lb.	Do not feed or ensile treated plants.
		Note: There are no restrictions on the use of these materials on the crop to be harvested as beans. The restrictions apply to the use of the plants (leaves, vines, pods) as feed.		
	Nonagricultural land (roadsides, fencerows, idle land)	Same as for cropland, or: aldrin chlordane dieldrin heptachlor toxaphene	2 to 4 oz. ½ to 1 lb. 1 to 2 oz. 2 to 4 oz. 1 to 1½ lb.	} Do not graze or cut for feed. Do not allow spray or dust to drift onto adjacent crops or pastures.
	Pasture, grass	diazinon	½ lb.	
		malathion	1 to 1½ lb.	At least 7 days before grazing or cutting.
		naled (Dibrom)	½ to ¾ lb.	Animals can graze immediately.
		carbaryl (Sevin)	1 to 3 lb.	Animals can graze immediately after treatment.
		toxaphene	1 to 1½ lb.	One application per season. Do not graze milk cows. Remove meat animals from treated pasture at least 6 weeks before slaughter. Do not sell or ship treated grass for feed.

Insecticide Recommendations—Field Crop Insects (continued)

Insect	Crop	Insecticide	Dosage (actual toxicant per acre)	Remarks
Grasshoppers		Phosdrin	4 oz.	At least 1 day before cutting (aerial application only).
Leafhoppers	Alfalfa hay, forage	diazinon	½ lb.	At least 7 days before cutting. No time limitations before grazing.
		methoxychlor	1½ lb.	At least 7 days before cutting.
Pea aphid	Alfalfa, clover	demeton (Systox)	4 oz.	At least 21 days before cutting (aerial application only).
		malathion	1 lb.	At least 7 days before cutting.
		parathion or methyl parathion	4 oz.	At least 15 days before cutting (aerial application only).
		toxaphene	1 to 1½ lb.	Do not feed or ensile treated corn forage or stover (stalks, leaves, husks).
Plant bugs (tarnished, alfalfa, rapid, Lygus)	Alfalfa, clover, trefoil for seed	DDT	1½ to 2 lb.	Do not graze or harvest for feed. Apply when the crop is in the bud stage or when the bugs average one or more per sweep with a 15-inch net. Do not spray crop in bloom.
		dieldrin	4 to 6 oz.	
		endrin	3 to 4 oz.	
		toxaphene	2 to 3 lb.	
Sweet clover weevil	Sweet clover, alfalfa new seedings	aldrin	8 to 10 oz.	Apply in spring at two-leaf stage. Later in summer second generation may require another treatment. Do not graze or cut for feed.
		dieldrin	8 oz.	
		toxaphene	2 to 3 lb.	
Note: For light infestations dieldrin or heptachlor granules mixed with the seed (½ lb. actual in the amount of seed per acre) will protect the stand if seeding is shallow and pressed in.				
Thrips	Barley	parathion (or methyl parathion)	4 to 6 oz.	Aerial application at least 15 days before harvest. Treat just as heads emerge when infestation averages two or more adult thrips per plant.
White grubs	Corn, soybeans	aldrin	3 lb.	Preplanting broadcast soil treatment.
		dieldrin	3 lb.	
		heptachlor	3 lb.	
Wireworms	Corn, beans, small grains	aldrin, dieldrin, heptachlor, or lindane	1 oz. (per bushel)	As seed treater.
	Corn	aldrin or heptachlor	1 to 2 lb.	Soil treatment before or at planting. Use 1-lb. rate for row treatment, 1½ to 2 lb. for broadcast.
	Potatoes	dieldrin	2 to 3 lb.	Broadcast soil treatment before planting.
			1 lb.	Row treatment at planting time.

Fruit insects

See Special Report 6, "Commercial Fruit Pest Control Guide" or Extension Pamphlet 184, "Home Fruit Spray Guide."

Insecticide Recommendations—Field Crop Insects (continued)

Vegetable insects

See Special Report 5, "Commercial Vegetable Pest Control Guide" or Entomology Fact Sheet 11, "Insect Control in the Home Vegetable Garden."

Mustard for seed and oil

There are very few registrations for insecticides for use on mustard grown for oil. Those which have label registration for mustard are:

Chemical	Maximum rate	Limitation
malathion	up to 3 lb. per acre as dust, 2½ lb. per acre as spray	At least 7 days before harvest.
methyl parathion	up to 1½ lb. per acre	At least 21 days before harvest.
toxaphene	up to 5 lb. per acre	Do not apply after the seedling stage.
lindane	seed treatment	As directed on labels.

Lindane seed treatment will evidently give the young seedling protection against flea beetles. Later flea beetle infestation may be controlled with 1 to 1½ lb. malathion per acre.

Methyl parathion at 6 to 8 ounces per acre is suggested for the control of larvae of the diamondback moth and other caterpillars.

Sunflower insects

At this time no insecticides have label registration for use on sunflowers grown for seed or oil; therefore, no insecticide recommendations can be made.

Household Insects

Insect	Insecticide	Dosage*	Remarks
Ants (indoors). (See also under pests of trees, shrubs, turf.)	chlordane	2% to 5% solution or emulsion, 5% to 6% dust	} Apply to runways. Do not contaminate food or utensils.
	diazinon	0.5% solution or emulsion	
	dieldrin	0.5% solution or emulsion	
	lindane	0.5% solution, 1% dust	
	malathion	3% solution or emulsion	
	ronnel (Korlan)	1% emulsion	
			Note: A treatment with chlordane or dieldrin on the outside walls and foundation, as described under boxelder bugs, may help keep ants from entering the house.
Bedbugs	chlordane	2% to 3% solution or emulsion	} Apply to springs and frames of beds and to cracks and crevices around doors, window casings, baseboards, etc.
	DDT	5% solution	
	lindane	0.5% solution	
	ronnel	1% spray	

* Abbreviations: E. C.—emulsion concentrate; W. P.—wettable powder.

Household Insects (continued)

Insect	Insecticide	Dosage*	Remarks
Boxelder bugs	chlordane	2 pt. 45% E. C. per 50 gal. water	} Spray infested boxelder trees during late summer when bugs are small.
	dieldrin	3 pt. 15% E. C. per 50 gal. water	
	diazinon	1% emulsion	} Apply <i>outside</i> to foundations, walls, and tree trunks where bugs gather.
	dieldrin	2 pt. 15% E. C. per 8 gal. water	
Note: Household insecticides are not effective against hibernating bugs in the home. The best treatment is a broom and dustpan. Thoroughly caulk cracks around windows and doors; see that doors and windows fit tightly.			
Carpenter ants	chlordane	2% to 3% solution or emulsion	} Paint or spray infested wood and runways.
	dieldrin	0.5% solution or emulsion	
Carpet beetles	chlordane	2% to 3% solution	} Apply to backs of carpets, rugs, and pads. Spray or paint along baseboards. Pressurized spray cans may be used for treating clothing. Dust formulations may be applied to the floor before laying carpeting.
	dieldrin	0.5% solution	
	lindane	0.5% to 1% solution	
	diazinon	0.5% solution	
	malathion	3% solution	
Clothes moths	chlordane	2% to 3% solution	} Apply lightly to clothing.
	DDT	5% solution or in EQ-53 for washable woolens	
	dieldrin	0.5% solution	} Apply lightly to clothing (dryclean before using treated clothing).
	lindane	0.5% or 1% solution	
	malathion	3% solution	} Apply lightly to clothing.
	perthane	5% solution	
	naphthalene or PDB flakes, crystals		
Apply uniformly throughout clothing as it is packed for storage in tight chests or boxes.			
Clover mites	(For use <i>outside</i> the home to prevent mites from entering)		
	chlorobenzilate	2 tsp. 25% E. C. per gal. water	} Apply thoroughly to foundations, walls, and to the lawn for at least 20 feet out from and all around the house. Use a drenching spray.
	Kelthane	3 tbsp. 18½% W. P. per gal. water	
	malathion	3 tsp. 50% E.C. per gal. water	
Note: A mixture of malathion with either Kelthane or chlorobenzilate at the above rates is reported to be more effective than either chemical used alone. An 18- to 24-inch sod-free band immediately next to the house will help reduce the clover mite problem. Wipe up mites inside the home with an oily dustcloth or a vacuum cleaner.			

Household Insects (continued)

Insect	Insecticide	Dosage*	Remarks	
Cockroaches (roaches, "water bugs")	chlordane	2% or 3% solution or spray, 5% or 6% dust	} Apply with paintbrush or as "spot treatment" with sprayer or duster. Treat cracks, crevices, and other hiding places or runways. Do not contaminate food or utensils.	
	diazinon	0.5% solution or spray		
	dieldrin	0.5% solution or spray		
	ronnel (Korlan)	1% to 2% spray		
	malathion	2% or 3% solution or spray		
Crickets	chlordane	2% to 3% spray or 5% to 6% dust	} Apply as "spot treatment" to corners, baseboards, under cabinets, in closets, etc.	
	diazinon	0.5% spray		
	dieldrin	0.5% spray		
	malathion	2% to 3% spray		
Note: A treatment with chlordane or dieldrin on the outside walls and foundation, as described under boxelder bugs, will help prevent crickets from entering the house.				
Fleas	Dogs	DDT or as for cats	5% to 10% dust or in washes or shampoos	
	Cats	rotenone	1% dust	
		methoxychlor	1% dust	
		malathion	4% dust	
	Infested kennels, beds, or other areas	DDT	5% spray	<i>Do not use DDT on cats.</i>
		malathion	2% or 3% spray	
		ronnel (Korlan)	1% spray	
Houseflies (indoors)	pyrethrins plus synergist or DDVP	Space sprays or aerosol "bombs"		
Residual treatment of outbuildings or outside of the home	diazinon	1% spray or bait	} Apply to resting places of flies—around windows, doors, frames, under eaves, etc., or as a window screen paint.	
	naled (Dibrom)	0.4% bait		
	dimethoate (Cygon)	1% spray		
	Trichlorfon (Dipterex)	1% bait		
	dichlorvos (DDVP)	½% to 1% bait		
	malathion	1% spray or bait		
	ronnel (Korlan)	½% to 1% spray or 1% bait		
Note: Fly control depends on good sanitation. Keep garbage in tightly closed cans; dispose of garbage twice a week. Clean up decaying organic matter, haul out manure twice weekly, treat compost piles if flies are breeding in them. Use well-fitting screens on doors and windows.				
Mosquitoes (indoors)	Pyrethrins plus synergist, or dichlorvos (DDVP)	} Space sprays or in aerosol "bombs." Some aerosols may also contain DDT or methoxychlor.		

Household Insects (continued)

Insect	Insecticide	Dosage	Remarks
Mosquitoes (outdoors)	DDT	1 lb. 50% W. P. per 5 gal. water, or 5% emulsion spray plus 1% malathion spray	} Apply to mosquito resting places such as shrubbery, hedges, and under eaves. May also be painted on screens. Do not apply to feed or food crops.
	chlordan	0.5% spray	
	dichlorvos (DDVP) naled (Dibrom)	} 1% to 3% solution	} Fogging for temporary adult control.
	dieldrin		
	dimethoate (Cygon)	1% emulsion spray	} Apply to mosquito resting places such as shrubbery, hedges, and under eaves. May also be painted on screens. Do not apply dieldrin or Cygon to feed or food crops. Sensitive plants may be harmed from overspraying or by large droplets.
	malathion	1% emulsion or suspension spray	
Note: Mosquito control in towns and cities should be an organized community program based on treatment of breeding areas and must be approved by the Minnesota Department of Agriculture.			
Powder-post beetles	chlordan	2% oil solution	} Paint, spray, or dip to saturate wood.
	DDT	5% oil solution	
	pentachlorophenol	4% to 5% solution	
Silverfish, firebrats	DDT	5% solution 5% to 10% dust	} Apply to infested areas, corners in closets, behind radiators, around pipes.
	chlordan	2% to 3% solution, 5% to 6% dust	
	diazinon	1% spray	
	dieldrin	0.5% spray	
	lindane	0.5% spray, 1% dust	
	ronnel (Korlan)	1% spray	
Stored-food pests (flour beetles, meal moths, larder beetles, etc.)	chlordan	2% to 3% solution	} Find and destroy or heat-treat infested foods. Paint or spray insecticides on shelves, cracks, corners. Do not contaminate food or utensils. Keep susceptible food stored in tight glass, metal, or plastic containers. Clean storage area thoroughly. See Entomology Fact Sheet 13, "Pantry Pests."
	DDT	5% solution	
	lindane	0.5% solution	
Termites	chlordan	} Termite infestations usually require the services of an experienced pest-control operator. Consult Entomology Fact Sheet 6, "Are They Really Termites?"	
	dieldrin		
	heptachlor		

Livestock and Poultry Insects

Pest	Host	Insecticide	Dosage or concentration	Remarks	
Cattle grubs	Milk cows or beef cattle	rotenone	1% dust	Treat when grubs first appear in backs; repeat every 30 to 40 days until grubs no longer appear.	
			7½ lb. 5% powder per 100 gal. water as spray		
	Beef cattle or nonmilking dairy cattle	coumaphos (Co-Ral)	16 lb. 25% W. P. per 100 gal. water (0.5% spray)		
			4 lb. 25% W. P. per 3 gal. water as "pour on," 1 pt. per head		
Cattle lice	Milk cows or beef cattle	ronnel (Trolene)	0.275% in feed or mineral supplement for 14 days	Do not treat within 60 days of slaughter. Follow precautions on label.	
		Ruelene	0.5% spray at 1 gal. per head (300 lb. or more); 8.3% "pour on," 1 fluid oz. per 100 lb. body weight	Do not apply to lactating milk cows, or within 28 days of freshening. Do not apply to meat animals within 28 days of slaughter. Apply once in fall.	
		Synergized pyrethrins	As labelled	Dust or spray; repeat in 15 to 20 days.	
		rotenone	1% dust or 2 lb. 5% powder per 100 gal. water	Rub dust into hair; repeat in 15 to 20 days.	
	Beef cattle or nonmilking dairy cattle	Ciodrin	chlordane	0.25% spray	Spray with 1 to 4 qt. per head. Do not use within 7 days of slaughter.
				0.5% spray or dip	
		coumaphos (Co-Ral)	Ciodrin	8 lb. 25% W. P. per 100 gal. water (0.25%)	
				0.25% emulsion spray	
		dioxathion (Delnav)	0.15% dip or spray, one part 30% E. C. in 200 parts of total spray or dip (½ gal. per 100 gal.)	Do not use oftener than once every 2 weeks.	
		lindane	2 lb. 25% W. P. per 100 gal. water or 1 qt. 20% E. C. per 100 gal. water	Do not treat within 30 days of slaughter.	
		malathion	16 lb. 25% W. P. per 100 gal. water (0.5%), 1 gal. 50% to 57% E. C. per 100 gal. water		
		methoxychlor	8 lb. 50% W. P. per 100 gal. water (0.5%)		

Livestock and Poultry Insects (continued)

Pest	Host	Insecticide	Dosage or concentration	Remarks		
Cattle lice		ronnel (Korlan)	0.25% spray	At least 8 weeks before slaughter.		
			1% in oil	On back rubber.		
		toxaphene	8 lb. 50% W. P. per 100 gal. water (0.5%)	Do not treat within 28 days of slaughter.		
<p>Note: A 5% solution of DDT, malathion, methoxychlor, or toxaphene in fuel oil applied to cable type back rubbers will also help reduce lice on beef cattle. All cattle should be treated for lice in the fall so that they go into winter free of lice.</p>						
Cattle scab	Notify veterinarian or the Minnesota Livestock Sanitary Board.					
Flies, biting (horn, stable, deer, horse, mosquito)	(See Extension Folder 192, "Fly Control for Livestock")					
	Milk cows or beef cattle	dichlorvos (DDVP)	1% oil spray	2 oz. per head per day maximum.		
		Ciodrin	1 to 2% in oil or 0.25% emulsion spray or combination of DDVP plus Ciodrin as labelled	2 oz. per head per day maximum or on back rubbers.		
		malathion	4% dust	2 to 4 tbsp. per animal; apply dry to backs. Do not apply during or within 5 hours of milking.		
		methoxychlor	50% W. P.	One tbsp. per animal; apply dry to backs.		
		pyrethrins plus synergists and repellents (such as R-11, R-326, Crag, or Tabatrex)	0.05 to 0.1%	Spray daily or as needed with hand sprayer, fogger, aerosol, treadle sprayer, or automatic sprayer.		
		thiocyanates (Lethane or Thanite)	3.5%	1 to 2 fluid oz. per animal; not over 2 oz. daily.		
Hornflies	Beef cattle only	coumaphos (Co-Ral)	0.25% spray (8 lb. 25% W. P. per 100 gal. spray)	Not within 7 days of slaughter.		
		dioxathion (Delnav)	0.15% spray or dip (½ gal. 30% E. C. per 100 gal. spray)	Do not use oftener than once every 2 weeks.		
			1.5% in oil	On back rubber.		
				chlordan	0.5% spray	
				DDT	5% in fuel oil on back rubbers only	At least 30 days before slaughter.
				lindane	0.03% spray or 0.2% in oil on back rubbers	
				malathion	0.5% spray (16 lb. 25% W. P. or 1 gal. 50% E. C. per 100 gal. spray)	
		2% in oil on back rubbers				

Livestock and Poultry Insects (continued)

Pest	Host	Insecticide	Dosage or concentration	Remarks		
Face flies	Dairy cattle or beef cattle	methoxychlor	0.5% spray	Not within 28 days of slaughter.		
			5% in oil on back rubbers			
		toxaphene	0.5% spray			
			5% in oil on back rubbers			
			50% W. P.			
			ronnel (Korlan)	0.5% spray, 1% in oil on back rubbers	1 tsp. per animal; apply dry to backs. Not within 8 weeks of slaughter.	
			dichlorvos (DDVP)	0.5% bait or baited spray	See Entomology Fact Sheet 25. Apply ½ to ⅔ tsp. in a single 6-inch stroke with a small paintbrush to foreheads, or spray faces daily after milking.	
			DDVP-Ciodrin combination	As labelled		
		Beef cattle only	DDT	5% in oil	On back rubbers (inverted "V" type is most effective).	
			ronnel	1% in oil		
	toxaphene		5% in oil			
	methoxychlor		5% in oil			
		coumaphos (Co-Ral)	0.5% spray	Apply to heads.		
		ronnel (Korlan)	0.5% spray			
Houseflies in barns and other buildings	Milkhouse or milkroom	pyrethrins	0.1% plus synergist	Space spray.		
			dichlorvos (DDVP)	0.5% spray or "slow release" strips or strands	Spot treat. Do not contaminate utensils and equipment.	
			naled (Dibrom)	0.5% bait		
			ronnel (Korlan)	½% to 1% spray	Residual treatment. Do not contaminate utensils and equipment.	
			diazinon	1% spray		
			malathion	1% spray		
		pyrethrins	0.1%			
		Barns and animal housing areas	dichlorvos (DDVP)	1.0%	Space spray with foggers, aerosol, or finely atomized spray.	
			naled (Dibrom)	0.3%		
			diazinon	1% residual spray		
					2% bait or in impregnated cords	Not in poultry houses.
			naled (Dibrom)	0.5% bait		
			DDVP	0.5% bait		
			trichlorfon (Dipterex)	1% bait		
	dimethoate (Cygon)		1% residual spray			
		Dimetilan (Snip)	Fly bands			

Livestock and Poultry Insects (continued)

Pest	Host	Insecticide	Dosage or concentration	Remarks
Houseflies	Barns other than dairy, as above or	malathion	1% residual spray 1% to 2% bait	Do not use in dairy barns, in dairy cattle housing areas, or in poultry houses. Note: When using baits and sprays do not contaminate feed or water or troughs and containers. Follow label directions regarding the removal of animals from buildings during spraying.
		ronnel (Korlan)	0.5% to 1% residual spray	
		fenthion (Baytex)	1% spray	
		Antiresistant DDT	0.5% spray	
Poultry mites, lice	Chickens, turkeys	coumaphos (Co-Ral)	0.5% dust	Dust birds thoroughly or use in dust boxes.
			0.25% spray	One gal. per 100 birds.
		malathion	0.5% spray	Treat roosts and birds. Use 1 gal. of spray per 100 birds.
		malathion	4% dust	1 lb. per 40 sq. ft. of litter.
		malathion	3% solution	Roost paint.
		carbaryl (Sevin)	5% dust on birds or 0.05 lb. actual per 100 birds as spray	At least 7 days before slaughter. Do not repeat treatment within 4 weeks.
	carbaryl (Sevin)	0.5% spray	Treat walls, roosts, floors. Do not treat eggs, nest litter, feed, or water. Do not apply within 7 days of slaughter.	
		Turkeys on range	malathion	2 qt. 50% to 57% E. C. in 24 gal. of water
Screwworms	Cattle, swine, sheep, horses	Smear 62 Smear 1038 Smear EQ 335 Smear 5% ronnel		Treat wounds, wire cuts. Treat wounds, wire cuts. Treat wounds, wire cuts. Not milk cows. At least 21 days before slaughter.
		coumaphos (Co-Ral)	0.5% spray	Not for milk cows, At least 7 days before slaughter. Apply to wounds and adjacent area.
			5% dust	
		ronnel	2.5% in "Livestock Bomb"	Not milk cows. At least 21 days before slaughter of meat animals.
		ronnel (Korlan)	0.5% spray	At least 56 days before slaughter. Not for milk cows.
Sheep keds ("ticks")	Sheep	chlordan	0.25% dip, 0.5% spray	
		coumaphos (Co-Ral)	0.25% spray	At least 15 days before slaughter.
		dioxathion (Delnav)	0.15% dip or spray	Do not use oftener than once in 2 weeks. Do not dip animals less than 3 months old.
		diazinon	0.03% to 0.06% suspension spray or 2% dust	At least 14 days before slaughter.

Livestock and Poultry Insects (continued)

Pest	Host	Insecticide	Dosage or concentration	Remarks
		DDT	0.5% spray 0.25% dip	At least 30 days before slaughter; one treatment only.
		lindane	2 lb. 25% W. P. per 100 gal. water (spray)	At least 30 days before slaughter.
			1 lb. 25% W. P. per 100 gal. water (dip)	At least 30 days before slaughter.
		malathion	16 lb. 25% W. P. per 100 gal. water (spray only)	
		methoxychlor	8 lb. 50% W. P. per 100 gal. water (spray or dip)	
		ronnel (Korlan)	0.25% spray	At least 84 days before slaughter.
		toxaphene	8 lb. 50% W. P. per 100 gal. water (spray) (0.5%)	At least 28 days before slaughter.
		dieldrin	1½% dust	1 to 2 oz. per head with duster. Treat once at least 90 days before slaughter.
Sheep scabies ("scab")	Sheep	Notify veterinarian or the Minnesota Livestock Sanitary Board.		
Swine mange and lice	Swine	lindane	2 lb. 25% W. P. per 100 gal. water	Spray or dip. Treat sows at least 40 days before farrowing. Do not treat suckling pigs less than 8 weeks old.
Wool maggots (fleece worms)	Sheep	Screwworm smears Smear 62 Smear 1038 Smear EQ 335 Smear 5% ronnel		Shear wool from infested area and treat wound and surrounding skin.
		lindane	2 lb. 25% W. P. per 100 gal. water	Spray to prevent strike.
		coumaphos (Co-Ral)	0.25% spray	At least 15 days before slaughter.
		dioxathion (Delnav)	0.15% dip or spray	
		ronnel (Korlan)	0.5% spray	At least 84 days before slaughter.

Tree, Shrub, and Lawn Insects

Pest	Where found	Insecticide	Dosage	Remarks
				Note: The all-purpose garden and fruit mixture of methoxychlor plus malathion will control most leaf-feeding and sap-sucking insects on trees and shrubs. DDT may be substituted for the methoxychlor. For special problems, follow recommendations given below.
Ants	Lawn	chlordan	5% to 10% dust or granular 50% W. P., 3 tbsp. per gal. water	¼ lb. per 100 sq. ft. Apply as spray to 100 sq. ft.

Tree, Shrub, and Lawn Insects (continued)

Pest	Where found	Insecticide	Dosage	Remarks
			45% E. C., 5 tsp. per gal. water	Apply as spray to 100 sq. ft.
		dieldrin	5% dust or granular	½ lb. per 100 sq. ft.
		heptachlor	2½% dust or granular	¼ lb. per 100 sq. ft.
			25% E. C.	3 tsp. per gal. on 100 sq. ft.
			Note: Liquid sprays may be used as a drench on individual ant nests. Water broadcast treatments thoroughly. Keep children and pets off until dry.	
Aphids	Trees, shrubs	malathion	2 pt. 50% E. C. per 100 gal., or 2 tsp. per gal. water	Apply thoroughly to all foliage
		dimethoate (Cygon)	1½ pt. 2.67 lb. E. C. per 100 gal.	
			Note: Some aphids, such as elm cockscomb gall, elm leaf, woolly apple, woolly elm, and woolly elm bark, may be controlled with dormant sprays described under scale insects.	
Borers	<p>Borers usually attack trees which are low in vigor, damaged, or suffering from drought, lack of nutrients, or winter injury. To prevent borer attack, trees should be well watered and fertilized, if needed; prune out dead or dying branches and properly dress all wounds.</p> <p>Active borer tunnels or burrows may be treated by injecting carbon disulfide into them with an oil can. After treating, plug the burrows with clay or putty. <i>Carbon disulfide</i> is extremely explosive so avoid smoking or any flame when using it.</p> <p>A strong DDT-emulsion spray or wash containing 2½% DDT applied to the trunks and lower branches will control some borers. Avoid treating the foliage with the concentrated spray.</p> <p>The proper time to apply DDT is about the time the adult borers are laying eggs. This usually occurs at the following times of the year:</p>			
Bronze-birch borers			Late June, early July	
Poplar borers			August	
Apple-tree borers			Late May, early June	
Lilac borers			Late May, early June	
Locust borers			August	
Cankerworms, spring and fall	Elm, apple, oak, maples, boxelder, and other trees	DDT methoxychlor carbaryl (Sevin)	50% W. P. 2 lb. per 100 gal. or 2 tbsp. per gal. As labelled	Apply at first sign of injury, usually early in May.
Caterpillars and sawflies	Various trees and shrubs	Most leaf-chewing caterpillars and sawfly larvae may be controlled by spraying the foliage with 2 lb. 50% DDT or methoxychlor per 100 gal. of water (2 tbsp. per gal., or with Sevin as directed on the label. The time when these different worms appear varies. Some of the common defoliators are listed along with the time they are usually present on the trees.		
		Time to control		
Eastern tent caterpillars	Wild cherry, apple, mountain ash, other	Early to mid-May, when tents are noticed		

Tree, Shrub, and Lawn Insects (continued)

Pest	Where found	Insecticide	Dosage	Remarks
White-marked tussock moths	Elm, basswood, poplars, apple			Middle to late May; occasionally again in August
Fall webworms	Most deciduous trees			July and early August
Spiny elm caterpillars	Elm			Late May, early June
Brown-headed ash sawflies	Ash			Late May, early June
Red-headed pine sawflies	Jack pine			Late June, early July
Jack-pine sawflies	Jack pine			Late May, early June
Introduced pine sawflies	White pine			Early feeding in June, again in August
Spruce budworms	Fir, spruce			As buds break and again 10 days later
Galls	Most deciduous trees, especially oak, hackberry, maple, linden, elm	Control of the insects or mites which cause galls with chemicals is not very satisfactory. Most galls do not seem to cause much injury. Pruning out and burning infested twigs or leaves sometimes reduce the problem.		
Elm bark beetles	Elm	DDT or methoxychlor	25% E. C.; 8 gal. per 100 gal. total spray (hydraulic sprayers); 50 gal. per 100 gal. total spray (mist blowers)	See Ext. Folder 211, "The Dutch Elm Disease." Cover all bark surfaces thoroughly as spring dormant spray. DDT may be used in fall dormant period.
Leaf beetles	Many deciduous trees, especially willow, elm, cottonwood, aspen	DDT, methoxychlor, or carbaryl (Sevin)	2 lb. 50% W. P. per 100 gal. or 2 tbsp. per gal. water	Apply when adult beetles appear; repeat when larvae appear.
Leafhoppers	Many trees and shrubs, especially caragana	DDT	2 to 4 lb. 50% W. P. per 100 gal. or 2 to 4 tbsp. per gal. water	
Mites ("red spider," spider mites)	Many trees and shrubs, especially evergreens and ornamentals	aramite	2 lb. 15% W. P. per 100 gal. or 2 tbsp. per gal. water	
		chlorobenzilate	1 qt. 25% E. C. per 100 gal. or 2 tsp. per gal. water	
		Kelthane	2 lb. 18½% W. P. per 100 gal. or 2 tbsp. per gal. water	
		ovex	1½ lb. 50% W. P. per 100 gal. or 2 tbsp. per gal. water	
		tetradifon (Tedion)	1½ lb. 25% W. P. per 100 gal.	
		malathion	2 pt. 50% E. C. per 100 gal. or 2 tsp. per gal. water	

Tree, Shrub, and Lawn Insects (continued)

Pest	Where found	Insecticide	Dosage	Remarks
Night crawlers, earthworms	Lawn, turf	chlordan or dieldrin	Will help reduce numbers of night crawlers when used as recommended for white grubs.	
		lead arsenate	10 lb. per 1,000 sq. ft. Soak thoroughly.	
Scale insects		Dormant sprays		
Oyster-shell	European elm Scurfy Cottony maple European fruit lecanium	DN-289	1 gal. per 100 gal. water	Apply in fall after all growth has stopped or in spring before buds open but when temperature is above freezing.
European elm		Elgetol 318	1 gal. per 100 gal. water	
Scurfy		dormant oils or dormant oil plus ethion or diazinon	2 to 3 gal. per 100 gal. water as labelled	
Cottony maple				
European fruit lecanium				
Pine-needle		liquid lime sulfur	1 part to 9 parts water	Apply in spring before buds open but when temperature is above freezing.
		Crawler sprays:		
		2 pt. 50% emulsion concentrate of malathion per 100 gal. water, or carbaryl as labelled.		
		When to apply:		
European fruit lecanium	Elm, fruit trees	Late June, early July (about when catalpas bloom)	Thorough coverage of foliage, twigs, and branches.	
Oystershell	Many shade, fruit, ornamental trees, shrubs	When apple petals have fallen (early June)		
Cottony maple		Late June, July		
Scurfy	Elm, maple, hackberry	June and July		
Pine-needle	Pines, spruce	Late May (when lilacs bloom)	Repeat in 10 to 15 days.	
White grubs, sod webworms, billbugs	Lawn, turf	aldrin	4 lb. actual per acre 1½ lb. 5% dust or granular per 1,000 sq. ft. 5 fl. oz. of 2 lb. E. C. concentrate per 1,000 sq. ft.	Note: Apply to seedbed before seeding or sodding or apply to the surface of established turf and soak thoroughly. May be combined with lawn fertilizer.
		chlordan	2½ lb. 10% dust or granular per 1,000 sq. ft. 8 fl. oz. of 45% E. C. per 1,000 sq. ft.	
		dieldrin	4 lb. 2½% dust or granular per 1,000 sq. ft. 6 fl. oz. of 15% E. C. per 1,000 sq. ft.	
		heptachlor	¼ lb. 20% granular per 1,000 sq. ft. 4 fl. oz. 2 lb. E. C. per 1,000 sq. ft.	

Stored Grain Insects

Note: Market or food grains should not be stored in barns, in buildings where livestock feed is stored, or in other situations where they are near to sources of infestation. Excessive moisture content, dirty or damaged grain, and dirty bins all encourage insect infestation.

Bin sprays Thoroughly clean bins as soon as they are emptied; spray walls, ceilings, and floors of the empty bin with:

malathion	1 gal. 57% premium-grade E. C. in 25 gal. water (1 pt. in 2 to 5 gal. water).
methoxychlor	2 gal. 25% E. C. for 25 gal. of spray or ready-to-use methoxychlor bin spray.
synergized pyrethrins	Ready-to-use bin spray.

Grain protectants applied directly to grain as it comes from combine or as it is binned:

malathion	1 pt. premium-grade E. C. per 2 to 5 gal. water per 1,000 bu.
malathion	1% premium-grade wheat flour dust, 60 lb. per 1,000 bu.
synergized pyrethrins	Ready-to-use protectant sprays or dusts, as labeled.

Surface treatments applied to surface of grain after it is in the bin:

malathion	½ to 1 pint premium-grade E. C. in 2 gal. water per 1,000 sq. ft. of grain surface area.
malathion	1% premium-grade wheat flour dust, 30 lb. per 1,000 sq. ft.
synergized pyrethrins	Ready-to-use, 1 gal. per 1,000 sq. ft.

Fumigation (Applied to binned grain to stop insect infestation. Does not give a residual preventive treatment.)

Many commercial fumigants are available; some of the common ones are listed below. Grain to be fumigated should be in a tight bin and leveled to a height no more than within 6 to 8 inches from the top of the side walls of the bin. Fumigate on a calm day when the grain temperature is at least 60° F. Persons applying or handling the fumigant should protect themselves from vapors by using suitable gas masks and protective clothes. More than one person should be present at the job in case of accident. Read and follow all precautions listed on the labels for each different fumigant. Information about other fumigants is available from the Department of Entomology, Fisheries, and Wildlife, University of Minnesota, St. Paul, Minnesota 55101.

Fumigant	Dosage (gal. per 1,000 bu.)			
	Small grain		Shelled corn	
	Wooden bins	Metal bins	Wooden bins	Metal bins
Carbon tetrachloride-carbon disulfide, 80-20	4	2	6	5
Carbon tetrachloride-ethylene dibromide, 95-5	4	2	6	5
Carbon tetrachloride-ethylene dichloride, 3-1	6	3	8	6
Carbon tetrachloride-ethylene dichloride-ethylene dibromide, 60-35-5	4	2	6	5

Use other liquid fumigant mixtures as labeled.

Aluminum phosphide (Phostoxin). Tablets may be added to grain as it is binned, or probed into binned grain.

Type of storage	Grain temperature	Dosage (tablets per 1,000 bu.)
Concrete or steel elevator tanks	54-59° F.	150
	60-68° F.	90
	over 68° F.	60
Round steel bins ("Butler" type)	54-59° F.	180
	60-68° F.	120
	over 68° F.	90

For average wooden farm bins use 180 tablets per 1,000 bu.

Greenhouse and Floricultural Pest Control

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
Ants	chlordane	5% to 6% dust or 1 lb. of 50% W. P. per 3 gal. water	} Apply to soil and along walks. Do not apply to foliage.
	diazinon	½ lb. 50% W. P.	
	dieldrin	2% dust, 1½ lb. of 25% W. P. or 2½ gal. of 19½% E. C.	
Aphids	malathion	1 to 1½ pt. of 57% E. C. 2½ lb. of 25% W. P.	
	parathion	1 lb. of 25% W. P., aerosol, or smoke	
	sulfotepp (Dithio)	Smoke or aerosol	
	demeton (Systox)	½ to 2 pt. of 25% E. C.	Soil treatment. May be applied in combination with a liquid fertilizer.
	endosulfan (Thiodan)	1 lb. of 50% W. P.	Approved use on chrysanthemums. Dusts may also be used.
	naled (Dibrom)	1 fl. oz. of 8 lb. E. C. per 10,000 cu. ft. space	Apply to steam pipes as described.
	dichlorvos (DDVP)	1 fl. oz. of 4 lb. E. C. per 10,000 cu. ft. space	Apply to steam pipes as described. A 10% aerosol also can be used.
	Dimethoate (Cygon)	1 pt. of 43.5% E. C.	As foliage spray to carnations, daisies, and nursery stock; as soil drench to carnations using 4 fluid oz. per 1,000 sq. ft. bench. Further varietal tests necessary.
Caterpillars	diazinon	½ lb. 50% W. P.	
	carbaryl (Sevin)	2 lb. of 50% W. P.	Except for older stages of cabbage looper.
	methoxychlor	2 lb. of 50% W. P.	Preferred for sensitive foliage.
Centipedes, symphylids	lindane	6 oz. of 25% W. P. per 1,000 sq. ft.	Work into soil. Steam sterilization is also advised.
Cutworms	dieldrin	2% dust, 1 lb. of 50% W. P. or 1 qt. of 19.5% E. C.	} Soil treatment.
	chlordane	5% to 10% dust, 1 lb. 50% W. P.	
	DDT	10% dust or 2 lb. of 50% W. P.	
	toxaphene	10% to 20% dust or 2½ lb. of 50% W. P.	
Cyclamen mites	Kelthane	1½ lb. of 18.5% W. P. 1½ pt. of 18.5% E. C.	} Make two or three applications at 2-week intervals. Use sanitation and isolation during clean-up period.
	endrin	1 qt. of 18.5% E. C.	
	endosulfan (Thiodan)	1 lb. of 35% W. P. or 1 pt. of 24% E. C.	
Fungus gnats	chlordane	1 qt. of 75% E. C.	

Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
Grasshoppers	dieldrin	½ lb. of 50% W. P. or 1 pt. of 19.5% E. C.	} Treat soil weekly until infestation is controlled.
	malathion	4% dust or 1½ to 2 pt. of 57% E. C.	
	nicotine sulfate	1 pt. of 40% E. C.	
	chlordane	1 lb. of 50% W. P.	
	heptachlor	1 lb. of 25% W. P.	
	dieldrin	½ lb. of 50% W. P.	
Leafhoppers	aldrin	1 lb. of 25% W. P.	
	DDT	2 lb. of 50% W. P.	
	diazinon	½ lb. of 50% W. P.	
Leaf miners	carbaryl (Sevin)	2 lb. of 50% W. P.	
	parathion	½ lb. of 25% W. P.	Avoid excessive treatment of asters especially.
Leaf rollers	DDD (TDE)	2 lb. of 50% W. P.	Dusts and sprays more effective than aerosols.
	parathion	¾ lb. of 25% W. P.	
Mealybugs	parathion	1 lb. of 25% W. P.	Repeat in 3 to 4 weeks.
	sulfotepp (Dithio)	Smoke or aerosol	Aerosol and smoke kill adults only.
	malathion	3 lb. of 25% W. P. or 1½ pt. of 57% E. C.	
	dichlorvos (DDVP)	Apply 10% aerosol using 0.1 lb. per 50,000 cu. ft.	Apply in air above plants; ventilators should be closed for at least 2 hours.
Roaches	chlordane	} Same as for ants	
	dieldrin		
	diazinon		
Scale insects	malathion	} Same as for mealybugs	Three or four applications.
	parathion		
	sulfotepp		
	diazinon		
	dichlorvos (DDVP)	10% aerosol bomb as given for mealybugs	Repeat as often as necessary.
Slugs, snails	metaldehyde, or proprietary baits containing metaldehyde	2 oz. of 15% dust per 100 sq. ft.	Apply once every 2 weeks to soil.
Sowbugs (pillbugs)	chlordane	5% to 10% dust	
	lindane	1 lb. of 25% W. P.	
Spider mites	parathion	1 lb. of 25% W. P.	} Avoid using parathion on ferns. Use aerosols at 3- to 4-day intervals. Use sprays very thoroughly, two applications at 7- to 10-day intervals.
	sulfotepp (Dithio)	Smoke or aerosol	
	demeton (Systox)	1½ pt. of 25% E. C.	
	malathion	1½ pt. of 57% E. C.	
	naled (Dibrom)	Dose as given for aphids	

Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
	dichlorvos (DDVP)	1 fluid oz. per 10,000 cu. ft. space or 0.1 lb. of 10% aerosol per 50,000 cu. ft.	Fluid application is for steam-pipe application as given under aphids. Aerosols released as described under mealybugs.
Spider mites (aramite resistant)	ethion	2 lb. of 25% W. P.	} Make very thorough applications and follow a sequence of chemically unrelated materials to avoid or postpone resistance.
	Kelthane or chlorobenzilate plus azobenzene	1½ lb. of 18½% W. P. ¾ lb. of 25% W. P. 1½ lb. of 70% W. P.	
	tetradifon (Tedion)	1 lb. of 25% W. P.	
	aramite	1½ lb. of 15% W. P.	
Spider mites (phosphate-resistant)	chlorobenzilate	1½ lb. of 25% W. P.	} Avoid emulsions, especially aramite, ovex, and chlorobenzilate. Avoid ovex on roses and other tender foliage.
	Kelthane	1½ lb. of 18½% W. P.	
	ovex	1½ lb. of 50% W. P.	
	Azobenzene (combined with aramite or chlorobenzilate)	1½ lb. of 70% W. P.	
	tetradifon (Tedion)	1 lb. of 25% W. P.	
	Chlorobenzilate plus OMPA	Aerosol	} Tedion is slow acting against adult mites but has fairly long residual activity. It is most effective when used on steam pipes.
	OMPA plus aramite	Aerosol	
	Pentac	4 to 8 oz. of W. P.	
Spittle bugs	dieldrin	1 lb. of 50% W. P.	Somewhat slow acting but effective where resistance is serious.
Springtails	lindane	1 lb. of 25% W. P.	
Tarnished plant bugs and other plant bugs	malathion	1½ pt. of 57% E. C.	
	dieldrin	½ lb. of 50% W. P.	
	DDT	2 lb. of 50% W. P.	
	heptachlor	1 lb. of 25% W. P.	
Thrips	chlordane	2 lb. of 50% W. P.	
	DDT	2 lb. of 50% W. P.	
	dieldrin	½ lb. of 50% W. P. or 1 pt. of 19.5% E. C.	} For evaporative cooling pads add 2 pt. of 19.5% E. C. dieldrin per 100 gal. circulating water.
	lindane	½% to 1% through evaporative pads	
	heptachlor	1 lb. of 25% W. P. or 1 pt. of 25% E. C.	
White flies	endosulfan (Thiodan)	Same as for aphids	
	parathion	1 lb. of 25% W. P.	
	sulfotepp (Dithio)	Smoke or aerosol	
	malathion plus DDT	3 lb. of 25% W. P. plus 2 lb. of 50% W. P.	
	dichlorvos (DDVP)	10% aerosol bomb as given for mealybugs	