

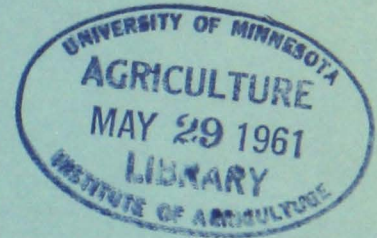
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INSECTICIDES

and Their Uses in Minnesota



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Insecticides and Their Uses in Minnesota

J. A. Lofgren and L. K. Cutkomp*

New insecticides and accompanying recommendations continue to be an important part of effective insect control. Organic phosphate insecticides are being prominently mentioned for control problems which were formerly handled by DDT and other chlorinated hydrocarbons. The development of insect resistance to DDT and its relatives has been influential in this respect. The regulated control of pesticides and label requirements has also played a prominent role in new recommendations. Because of continuing changes, however, you must keep informed through your county and state agencies.

Regulations on Sale and Uses

The sale and use 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, $\frac{3}{5}$, 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.

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2. Wettable powders are dry powders which may be mixed with water to make sprays. Formulations containing 15, 25, 40, 50, and 75 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 $1\frac{1}{2}$ 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.

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 $\frac{1}{2}$ -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 pyrethrum fly sprays on cattle.

6. Granulated material is a ready-to-use preparation of the insecticide in or on particles of an insect 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 plants. 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.

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:

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

Example:

How many gallons of 25-percent DDT emulsifiable concentrate (2 pounds per gallon) are needed to give 3/4 pound actual DDT per acre, using a sprayer with a 50 gallon tank applying 10 gallons per acre (5 acres per tank)?

$$\frac{5 \times 0.75}{2} = 1.87 \text{ gallons}$$

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

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

Example:

How many pounds of 50-percent DDT wettable powder are needed to apply 3/4 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:

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

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:

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

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?

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

REDUCING TO 1 GALLON OF SPRAY

For small jobs, it is often necessary to figure out 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

Dilution table - emulsifiable concentrates

| Pounds of 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 lbs. | 3 lbs. |
| | 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 - wettable powders (for sprays)

| Percent wetable powder used | <u>Desired pounds per acre of actual chemical</u> | | | | | | | |
|--------------------------------------|---|---------------------|---------------------|----------------------|-----------------|-------------------|---------|------------------|
| | 0.125 lb. (2 oz.) | 0.25 lb. (4 oz.) | 0.50 lb. (8 oz.) | 0.75 lb. (12 oz.) | 1 lb. | 2 lbs. | 3 lbs. | 4 lbs. |
| | amount of wettable powder to use per acre | | | | | | | |
| 15 | 13 oz. | 1 lb., 12 oz. | 3 lbs., 5 oz. | 5 lbs. | 6½ lbs. | 13 lbs. | 20 lbs. | 26½ lbs. |
| 25 | 8 oz. | 1 lb. | 2 lbs. | 3 lbs. | 4 lbs. | 8 lbs. | 12 lbs. | 16 lbs. |
| 40 | 5 oz. | 10 oz. | 1 lb., 4 oz. | 1 3/4 lbs. | 2½ lbs. | 5 lbs. | 7½ lbs. | 10 lbs. |
| 50 | 4 oz. | 8 oz. | 1 lb. | 1½ lbs. | 2 lbs. | 4 lbs. | 6 lbs. | 8 lbs. |
| 75 | 3 oz. | 6 oz. | 12 oz. | 1 lb. | 1 lb., 5 oz. | 2 lbs., 11 oz. | 4 lbs. | 5 lbs., 3 oz. |

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

| Formulation to be used in 100 gallons of water | Desired concentration of finished spray in 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 lbs. | 3 lbs. | 5 1/3 lbs. | 13½ lbs. | 27 lbs. | 54 lbs. | | |
| 25 | 1/3 lb. | 1 lb. | 2 lbs. | 3 lbs. | 8 lbs. | 16 lbs. | 32 lbs. | | |
| 40 | 1/5 lb. | 3/4 lb. | 1½ lbs. | 2 lbs. | 5 lbs. | 10 lbs. | 20 lbs. | | |
| 50 | 1/6 lb. (2½ oz.) | ½ lb. | 1 lb. | 1½ lbs. | 4 lbs. | 8 lbs. | 16 lbs. | 40 lbs. | |
| 75 | 1/10 lb. (1½ oz.) | 1/3 lb. | 2/3 lb. | 1 lb. | 2½ lbs. | 5 lbs. | 10 lbs. | 25 lbs. | 52 lbs. |
| Emulsifiable concentrate (in pounds per gallon) | | | | | | | | | |
| 1 | 1 1/3 c. | 1 qt. | ½ gal. | 3 qts. | 2 gals. | 4 gals. | 8 gals. | 20 gals. | 40 gals. |
| 1½ | 3/4 pt. | 1/3 gal. | 1/3 gal. | ½ gal. | 1 1/3 gals. | 2 2/3 gals. | 5 gals. | 13½ gals. | 27 gals. |
| 2 | 2/3 c. | 1 pt. | 1 qt. | 3 pts. | 1 gal. | 2 gals. | 4 gals. | 10 gals. | 20 gals. |
| 4 | 1/3 c. | ½ pt. | 1 pt. | 1½ pts. | ½ gal. | 1 gal. | 2 gals. | 5 gals. | 10 gals. |
| 5 | 2 fluid oz. | 6 fluid oz. | 3/4 pt. | 2 2/3 c. | 3 pts. | 3 qts. | 1 3/4 gals. | 4 gals. | 8 gals. |
| 6 | 1 3/4 fluid oz. | 2/3 c. | 1½ c. | 1 pt. | 2 2/3 pts. | 5 pts. | 1½ gals. | 3 1/3 gals. | 6 2/3 gals. |
| 8 | 1 fluid oz. | ¼ pt. | ½ pt. | 3/4 pt. | 1 qt. | ½ gal. | 1 gal. | 2½ gals. | 5 gals. |

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 ounces
1 ounce = 28.3 grams
1 kilogram = 35.27 ounces or 2.2 pounds
1 milligram per kilogram = 1 part per million

Description of Insecticides

CHLORINATED HYDROCARBONS

Aldrin

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.

Chlordane

Chlordane is available in all common formulations including dust and granules. However, commercial fertilizer-insecticide mixes are not common. The technical material contains small amounts of heptachlor, enneachlor plus the cis, and transisomers of chlordane.

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

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, 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 butter-fat 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.

Dieldrin

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 moderate acute toxicity. Although more toxic than DDT, it persists in lipids somewhat similarly to DDT.

Endrin

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 Thiodan) 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

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 toxic, fairly persistent form known as heptachlor epoxide. Because of persistence on forage, restrictions must be followed where dairy cows might encounter treatment.

Lindane and Benzene Hexachloride

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.

Both 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.

Methoxychlor

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. It is available in all the common formulations.

Perthane

Perthane is a compound of low toxicity, similar to methoxychlor. Emulsions and wettable powders are used in agriculture, although approved uses are rather limited. 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

TDE 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.

Thiodan

Thiodan is a sulfur-containing chlorinated hydrocarbon. Prepared formulations include a miscible formulation, a wettable powder, dusts, and granular dusts. It has received approved use for some potato insects, including aphids. It is also effective on plant bugs present on vegetables and forage crops. Effectiveness on cyclamen mites make it a potential greenhouse pesticide. Close to DDT in acute toxicity, it is of moderate toxicity to warm-blooded animals. Further work is necessary to determine where it will be most useful.

Toxaphene

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

Co-Ral

(See under Animal Systemics, page 17.)

DDVP

DDVP, 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.

Delnav

Delnav is an organic dithiophosphate with good persistent properties. It is a mixture of two chemical isomers. It is available chiefly as 30- and 47-percent emulsion concentrates. Delnav is of moderate toxicity to warm-blooded animals, the toxicity being 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

(See under Plant Systemics, page 18.)

Diazinon

Diazinon is one of the more persistent phosphates showing rather broad application possibilities. This organic thiophosphate, Diazinon, is valuable against a number of fruit pests, including mites; useful against a number of vegetable 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 a 2 pound per gallon emulsion, a 20-percent solution for dilution as recommended in the household, and a 25-percent wettable powder formulation. Also, 1-percent granules have been prepared particularly for fly control in barns.

Dibrom

This insecticide 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.

Dicapthon

Dicapthon 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

This moderately toxic phosphate shows some systemic activity in both plants and animals. It also looks promising for housefly control where resistance to DDT, malathion, and Diazinon exists. It is sold as a 46-percent solubilized liquid concentrate and as a 25-percent wettable powder. The acute oral toxicity to rats is in the moderate range and dermal toxicity is lower.

Dipterex or Dylox

This chlorinated water-soluble phosphate is 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, 5- and 10-percent dusts, and 2½- and 5-percent sprays for some agricultural pests, particularly webworms. 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.

Di-Syston

(See under Plant Systemics, page 18.)

EPN

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 curculio, dieldrin is usually recommended for this pest. It is about one-eighth as toxic as parathion but still classed as highly toxic.

Ethion

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 maggot, 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 pounds per gallon emulsifiabiles (one for usual use and the other for combining with spray oils). A 4-percent dust is 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

Guthion is a dithiophosphate with a rather persistent insecticidal effect. It is sold as a $1\frac{1}{2}$ 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-infesting pests. It is also used on cotton-infesting pests, particularly where the cotton boll weevil is resistant to chlorinated hydrocarbons.

Malathion

This organic thiophosphate is 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 aphids, 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 there are some areas in the United States reporting some resistance of houseflies to malathion. The lasting period of effectiveness varies from about a week or two, 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

(See under Plant Systemics, page 19.)

Phosdrin

This is a very toxic phosphate containing two chemical isomers. Phosdrin 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. Because it deteriorates quickly, comparatively short waiting periods are required between application and harvest. It must be handled with care because of its high toxicity.

Phosphamidon (Dimecron)

Phosphamidon 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 (Korlan, Trolene)

(See under Animal Systemics, page 18.)

Methyl Parathion

This compound 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 botton boll weevils which may be resistant to chlorinated hydrocarbons. It is of high toxicity.

Parathion

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 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

(See under Plant Systemics, page 19.)

TEPP

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 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.

Trithion

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.

Formulations include a 25-percent wettable powder, a 4 pound per gallon emulsifiable (flowable) concentrate, 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 low toxicity by skin absorption.

VC-13

This 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

Co-Ral

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 trials on poultry mites and lice. Late fall applications are most effective for grub control.

Dimethoate

(See under Organic Phosphates, page 14.)

Ronnel (Korlan, Trolene)

This 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 are given to cattle, particularly for cattle grub control. Ronnel has low mammalian toxicity.

Ruelene

This compound has been developed as an important animal systemic of rather broad parasiticial activity. Both external application of it to cattle and as a medicated feed treatment have accomplished largely 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. Approved uses are pending.

Plant Systemics

Demeton (Systox)

Demeton 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

(See under Organic Phosphates, page 14.)

Di-Syston

This insecticide is an organic thiophosphate, 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)

Phorate (registered name Thimet) is a fairly close chemical relative of demeton and 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. 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 attapulgitic clay. The compound is highly toxic to mammals.

Phosdrin

(See under Organic Phosphates, page 16.)

Phosphamidon

(See under Organic Phosphates, page 16.)

Schradan (OMPA)

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.

Schrandan 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

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

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 the chlorinated hydrocarbon insecticides.

Ryania

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 COMPOUND

Sevin

Sevin is chemically different from the organic phosphates and the chlorinated hydrocarbons. It is formulated as a 50-percent wettable powder, an 85-percent sprayable powder, a 5-percent dust, and a 5-percent granular material. A liquid concentrate is also available. Sevin has been approved for use on the major fruit insects. 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.

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

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 $1\frac{1}{2}$ 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)

A chemical relative of ovex, p-chlorobenzyl p-chlorophenyl sulfide, chlorbenside 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

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

Genite 923

This miticide is 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

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

Ovex, or p-chlorophenyl p-chlorobenzene sulfonate, is a mite killer which is effective against the egg and active stages. Under some outdoor conditions, ovex remains effective for 2 weeks or longer. 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.

Tedion

Tedion is a miticide described as a chlorinated diphenyl sulfone. It is proving to be 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.

Insecticides and Their Principle Uses

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|----------------------|---|--|
| Aldrin | Alfalfa | Grasshoppers |
| | Beans | Seed corn maggots, wireworms |
| | Corn | Grasshoppers, rootworms, white grubs, wireworms, billbugs |
| | Crucifers (cabbages, broccoli, cauliflower, etc.) | Cabbage maggots |
| | Cucurbits (squash, melons, cucumbers) | Cucumber beetles |
| | Pasture, turf | White grubs, sod webworms |
| | Potatoes | Wireworms |
| | Radishes, rutabagas | Root maggots |
| | Spinach | Leaf miners |
| | Small grains | Grasshoppers, wireworms |
| Strawberries | White grubs | |
| Sugar beets | Root maggots | |
| Sweet clover | Sweetclover weevils | |
| Allethrin | Cattle, inside buildings | In fly sprays in combination with synergists, with or without repellents |
| Aramite | Ornamentals, nonbearing fruit trees, shrubs | Mites |
| Benzene hexachloride | See lindane | |
| Chlorbenside (Mitox) | Apples, ornamentals | Mites |
| Chlordane | Carrots | Cutworms, carrot beetles |
| | Corn | Cutworms, grasshoppers, rootworms, seed corn maggots, white grubs |
| | Crucifers | Cabbage maggots |
| | Home structures, furnishings, food | Termites, powder-post beetles, ants, clothes moths, cockroaches, carpet beetles, crickets, stored-food pests |
| | Onions | Onion maggots, thrips |
| | Pasture, lawn, turf | White grubs, sod webworms, ants, chiggers |
| | Radishes, rutabagas | Root maggots |
| | Strawberries | White grubs, weevils |
| | Tomatoes | Cutworms |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|------------------|---|--|
| Chlorobenzilate | Fruits, ornamentals | Mites |
| Co-Ral | Livestock, except milk cows | Cattle grubs, hornflies, lice |
| DDD | See TDE | |
| DDT | Alfalfa (for seed) Apples Asparagus Beans Carrots Cattle (beef) Celery Corn Crucifers Dogs Home structures, furnishings, food Lettuce Onions Potatoes Raspberries Strawberries Tomatoes Trees, shrubs Vine crops, cucumbers, squash, pumpkins, etc. | Leafhoppers, plant bugs Codling moths, canker-worms, tussock moth larvae, oyster-shell scales, leafhoppers, plant bugs Asparagus beetles Bean beetles, leafhoppers Leafhoppers Hornflies (as 5 percent in oil on back-rubbers) Leafhoppers, plant bugs European corn borers, earworms Cabbage worms, loopers Fleas Various pests, including clothes moths, stored-food pests, fleas, bedbugs, silverfish Leafhoppers Thrips, maggot flies Colorado potato beetles, flea beetles, leafhoppers "Slugs" or sawfly larvae Weevils, plant bugs Flea beetles, fruit worms Wide variety of leaf-chewing insects, leafhoppers, plant bugs Cucumber beetles, squash-vine borers |
| DDVP | Buildings | Houseflies |
| Delnav | Apples Beans, ornamentals Livestock (meat animals) | Mites Mites Lice, keds ("ticks") |
| Demeton (Systox) | Alfalfa Apples Ornamentals (greenhouse) Potatoes | Aphids, plant bugs Aphids, mites Aphids, mites, mealy bugs Aphids, leafhoppers |
| Diazinon | Apples | Apple maggots, codling moths, curculios |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|----------------------|--|--|
| | Buildings, homes Cabbages, broccoli, etc. Household equipment and furnishings | Houseflies Cabbage worms, loopers Ants, carpet beetles, clothes moths, cock- roaches, fleas, silverfish, ticks |
| | Onions | Onion maggots |
| Dibrom | Barns Beans Crucifers Lettuce, spinach Ornamentals Potatoes | Houseflies Aphids, mites, loopers Aphids, cabbage worms, loopers Loopers, aphids Aphids, mites, leaf miners Flea beetles, Colorado potato beetles |
| Dicapthon | Household equipment and furnishings | Roaches, houseflies |
| Dieldrin | Alfalfa (for seed) Apples, plums Beans Beets Household equipment and furnishings Onions Pastures, lawn, turf Potatoes Radishes, rutabagas Sheep Small grains Strawberries Sugar beets Tomatoes | Grasshoppers, plant bugs, webworms Plum curculios Seed maggots, wireworms, cutworms Soil insects, webworms Ants, roaches, clothes moths, carpet beetles, crickets, spiders Onion maggots, thrips White grubs, webworms Colorado potato beetles, flea beetles, wireworms Root maggots Keds White grubs, grasshoppers, wireworms, armyworms White grubs Maggots, wireworms Cutworms, flea beetles |
| Dimethoate | Uses pending | |
| Dipterex | Barns, buildings | Houseflies |
| Di-Syston | Potatoes | Aphids, flea beetles, leafhoppers |
| Dithiono (Sulfotepp) | Greenhouse pests | |
| D N 289 | Apples (dormant) Shade trees (dormant) | Aphids Mites, scales, leafrollers |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|-----------------|------------------------------------|--|
| Dylox | Alfalfa | Alfalfa caterpillars, plant bugs |
| | Crucifers | Cabbage worms, loopers, webworms |
| | Sugar beets | Webworms |
| Elgetol 318 | Apples (dormant) | Aphids, mites, oyster- shell scales, leafrollers |
| Endrin | Crucifers | Cabbage worms, loopers |
| | Corn | Cutworms, European corn borers |
| | Potatoes | Flea beetles, Colorado potato beetles, aphids, leafhoppers |
| | Small grains | Aphids, cutworms |
| | Sugar beets Tomatoes | Beet webworms Flea beetles, hornworms |
| EPN | Beets, spinach | Leaf miners |
| | Corn | European corn borers |
| Ethion | Onions | Onion maggots |
| | Ornamentals | Mites, aphids |
| Guthion | Apples | Plum curculios, codling moths, leafrollers, apple maggots, aphids, mites |
| | Potatoes | Aphids, leafhoppers, flea beetles |
| Heptachlor | Alfalfa, clover(for seed) | Grasshoppers, cutworms, plant bugs |
| | Corn (soil treatment) | Rootworms, wireworms, white grubs |
| | Lawn, turf, ornamentals | White grubs, grasshoppers, webworms, ants |
| Kelthane | Fruit trees and shade trees | Mites |
| | Houses (outside walls and lawn) | Clover mites |
| | Strawberries | Cyclamen mites |
| Korlan | See Ronnel | |
| Lead arsenate | Apples | Apple maggots, codling moths, plum curculios |
| | Trees, shrubs | Variety of leaf-chewing insects |
| Lethane | Buildings | In space sprays for flies, mosquitoes |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|------------------|--|---|
| Lime-sulfur | Trees, shrubs (dormant) | Scales, aphids |
| Lindane | Beans Cattle (beef) Corn (seed treatment) Cucurbits Household equipment and furnishings Poultry Sheep Small grains Swine | Seed maggots, wireworms Lice, scab mites, hornflies Seed maggots, wireworms Cucumber beetles Ants, carpet beetles, clothes moths, roaches, silverfish, bedbugs, ticks, fleas Lice, mites Keds, lice, "scab" Wireworms Mange, lice |
| Malathion | Alfalfa Apples Barns, buildings Cattle (beef) Grain bins (bin spray) Household equipment and furnishings Most vegetables and garden crops Poultry Small grains Stored grain (as grain protectant or surface spray) Trees, shrubs Also used in "all purpose" mixtures for fruits, vegetables, and ornamentals | Aphids Aphids, codling moths, mites Houseflies, mosquitoes Lice, hornflies Stored-grain insects Ants, roaches, flies, mosquitoes Aphids, mites Lice, mites Aphids Stored-grain insects Aphids, mites, scale insects |
| Methoxychlor | Alfalfa Apples Cattle Grain bins (bin spray) Most vegetables and ornamentals Sheep Strawberries Vine crops Also used in "all purpose" mixtures for fruits, vegetables, and ornamentals | Leafhoppers, plant bugs, alfalfa caterpillars Apple maggots, codling moths, plum curculios Hornflies, lice Stored-grain insects Leaf-chewing insects Keds Weevils Cucumber beetles |
| Nicotine sulfate | Trees, shrubs, fruits, vegetables | Aphids |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|--|--|--|
| Ovex | Fruits, ornamentals | Mites |
| Parathion | Alfalfa Apples Beans Beets Corn Crucifers Onions Peas Potatoes Small grains Strawberries Tomatoes Vine crops | Aphids Aphids, mites, codling moths, leafrollers Aphids, mites, bean beetles Aphids, webworms European corn borers Aphids, cabbage worms Maggots, thrips Aphids Aphids, leafhoppers Aphids Mites, leafrollers Aphids Aphids, squash bugs |
| Perthane | Household furnishings and clothing Lettuce | Clothes moths Leafhoppers |
| Petroleum oils, dormant miscible oils | Trees, shrubs | Scale insects |
| Phorate (Thimet) | Potatoes Sugar beets | Aphids, leafhoppers, flea beetles, Colorado potato beetles Root maggots, aphids |
| Phosdrin | Crucifers Peas Small grain, corn Sorghum | Aphids, cabbage worms, loopers Aphids Aphids Earworms, aphids |
| Phosphamidon | Potatoes | Aphids, Colorado potato beetles, flea beetles, leafhoppers |
| Pyrethrins ("Pyrethrum") usually combined with syn- ergists | Buildings Cattle Grain bins (bin spray) Home interiors Stored grain (in grain protectants or surface spray) | Flies, mosquitoes Flies, mosquitoes Stored-grain insects Fleas, flies, mosquitoes Stored-grain insects |
| Ronnel (Korlan, Trolene) | Barns, buildings Cattle (except milk cows) Household equipment Poultry Sheep Swine | Flies Grubs, hornflies, lice Roaches Mites, lice Keds Lice |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|----------------------------------|--|---|
| Rotenone | Asparagus Cats, dogs Cattle Crucifers Cucurbits Raspberries Sheep Tomatoes | Asparagus beetles Fleas Grubs, lice Cabbage worms, flea beetles Cucumber beetles Cane borers, fruit worms, sawfly larvae Keds Flea beetles |
| Ryania | Corn | European corn borers |
| Sabadilla | Cucurbits | Squash bugs |
| Sevin | Apples | Codling moths, plum curculios, apple maggots |
| Sulfotepp | See Dithiono | |
| Systox | See Demeton | |
| TDE (DDD) | Apples Strawberries Tomatoes Vine crops | Leafrollers Leafrollers Fruit worms, hornworms Squash vine borers |
| Tedion | Ornamentals and non-bearing fruit trees, or postharvest on fruit trees | Mites |
| TEPP | Alfalfa Beans, beets, crucifers, potatoes | Aphids Aphids |
| Thanite--component of fly sprays | | |
| Thimet | See Phorate | |
| Thiodan | Potatoes | Aphids, leafhoppers, plant bugs |
| Toxaphene | Alfalfa, clover Apples Cattle (beef) Corn Crucifers Onions Potatoes Sheep Tomatoes | Grasshoppers, plant bugs Aphids, mites Hornflies, lice Armyworms, cutworms, grasshoppers, European corn borers Cabbage worms Thrips Flea beetles, Colorado potato beetles Keds ("ticks") Flea beetles |

| <u>Chemical</u> | <u>For Use On</u> | <u>To Control</u> |
|-----------------|-----------------------|--------------------------------|
| Trithion | Onions Ornamentals | Onion maggots Mites, aphids |
| VC-13 | Onions | Onion maggots |

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, University of Minnesota, Institute of Agriculture, St. Paul 1, Minnesota.

PHOSPHATE-POISONING SYMPTOMS AND ANTIDOTE

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, Dicapthon, Co-Ral, and ronnel being much less toxic and Diazinon, Dylox, and Delnav being intermediate.

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 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, thiodan):

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.

| <u>City</u> | <u>Address</u> | <u>Telephone</u> |
|--------------|--|------------------|
| Bemidji | Bemidji Hospital | Pl. 1-5430 |
| Brainerd | St. Joseph's Hospital | 2861 |
| Crookston | Bethesda Hospital | At. 1-4682 |
| | St. Francis Hospital | At. 1-2490 |
| Duluth | St. Lukes Hospital 915 E. 1st Street | RAndolph 7-6636 |
| Fergus Falls | Lake Region Hospital | 523 |
| Mankato | Immanuel Hospital | MAnkato 8-1605 |
| Marshall | Lewis Weiner Memorial Hospital | 2263 |
| Minneapolis | Division of Special Health Services State Health Department | FEderal 9-7751 |
| | Abbott Hospital 110 E. 18th Street | FEderal 9-8414 |
| | Fairview Hospital 2312 S. 6th Street | FEderal 6-6691 |
| | Minneapolis General Hospital 619 S. 5th Street | FEderal 3-1178 |

| | | |
|-------------|--|-----------------------|
| | North Memorial Hospital 3220 Lowry Avenue North | JUniper 8-9451 |
| | Northwestern Hospital 810 E. 27th Street | FEderal 2-7266 |
| Morris | Stevens County Memorial Hospital | 1191 |
| Rochester | St. Mary's Hospital | AT 9-4581 |
| St. Cloud | St. Cloud Hospital | BL. 1-2700 |
| St. Paul | Ancher Hospital 495 Jefferson Avenue | CApital 2-7341 |
| | Bethesda Hospital 559 Capitol Boulevard | CApital 4-7561 |
| | St. John's Hospital 403 Maria Avenue | PRospect 1-5521 |
| | St. Joseph's Hospital 69 W. Exchange | CApital 2-6321 |
| | St. Luke's Hospital 287 N. Smith Avenue | CApital 2-6644 |
| | Children's Hospital 311 Pleasant Avenue | CApital 7-6521 |
| Virginia | Virginia Municipal Hospital | Harwood 1-3340 |
| Willmar | Rice Memorial Hospital | Belmont 5-4543 |
| Worthington | Worthington Memorial Municipal Hospital | Worthington 2-5601 |

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. |
| 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 lbs. | Do not feed or ensile treated stalks, leaves, husks. |
| | 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 lbs. | At least 7 days before harvest (14 days for barley). Do not feed straw. |
| Beet webworm | Sugar beets | Dylox | ½ to 1 lb. | At least 14 days before harvest. Do not feed tops within 28 days of treatment. |

*Abbreviations: E. C. --emulsion concentrate; W. P. --wetable powder

| Insect | Crop | Insecticide | Dosage (actual toxicant per acre) | Remarks |
|---|-----------------------|----------------------|---|--|
| | | endrin | 6 oz. | At least 20 days before harvest if tops are not fed; 60 days if tops are fed. |
| | | toxaphene | 2 to 3 lbs. | At least 60 days before harvest. Do not feed tops. |
| (See Commercial Vegetable Pest Control Guide) | | | | |
| Corn earworm | Sweet corn | DDT | 2 lbs. | As emulsion in at least 25 gallons of water to the ear zone. Repeat at 10 percent, 50 percent, and 90 percent 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). |
| | | Sevin | 1½ to 2 lbs. | 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. At least 7 days before feeding or ensiling treated plant parts. |
| Corn rootworms | Corn | aldrin or heptachlor | ½ to 1 lb. | For broadcast application, 1 pound rate; ½ pound rate for band or row treatment. Incorporate into soil surface before or at planting time. |
| Crickets | Flax | dieldrin | 6 to 10 oz. | Apply before swathing to prevent boll clipping. |
| | Legumes (for seed) | dieldrin | 6 to 8 oz. | Do not graze treated field or feed treated plants. |

| Insect | Crop | Insecticide | Dosage (actual toxicant per acre) | Remarks | |
|-----------|------------------------|-------------------------|---|--|--|
| Cutworms | Corn | aldrin or heptachlor | 1 to 1½ lbs. | Apply before or at planting time as for corn rootworm. Lower rate for row treatment, higher rate for broadcast application. | |
| | | Corn, soybeans, flax | DDT | 1½ lbs. | 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 lbs. | Do not feed or ensile treated crops as forage. |
| | Small grains | dieldrin | 6 to 8 oz. | At least 7 days before harvest (grain), 30 days for straw. | |
| | | endrin | 4 to 6 oz. | At least 45 days before harvest. | |
| | | toxaphene | 1½ to 2 lbs. | At least 7 days before harvest (14 days for barley). Only one applica- tion after grain has headed. | |
| | European corn borer | Corn | DDT | 1½ lbs. 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. | |
| toxaphene | | | 2 lbs. granules | Do not feed treated forage to milk cows or meat animals within 28 days of slaughter. | |

| Insect | Crop | Insecticide | Dosage (actual toxicant per acre) | Remarks |
|---|--------------------------------|-------------|---|--|
| <p>Note: For first brood treat when 75 percent of the plants show recent larval feeding ("shot holing") 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 "Commercial Vegetable Pest Control Guide."</p> | | | | |
| Grasshoppers | Alfalfa, clover hay, forage | dieldrin | 1 oz. | Only one application. Treat alfalfa before 6 to 8 inches high and clover before 2 inches high. No treatment within 35 days of cutting or harvesting. |
| | | malathion | 1 to 1½ lbs. | At least 7 days before cutting or ensiling. Do not sell or ship treated hay or forage. |
| Corn | | aldrin | 2 to 4 oz. | At least 21 days (2 ounce rate) or 30 days (4 ounce rate) before harvest or ensiling. |
| | | dieldrin | 1 to 2 oz. | At least 40 days before harvest or ensiling. |
| | | malathion | 1 to 1½ lbs. | At least 5 days before harvest. |
| | | toxaphene | 1 to 1½ lbs. | Do not feed or ensile treated corn forage or stover (stalks, leaves, husks). |
| | | aldrin | 2 to 4 oz. | } Do not graze or cut for feed. Do not allow spray or dust to drift onto adjacent crops or pastures. |
| dieldrin | 1 to 2 oz. | | | |
| heptachlor | 2 to 4 oz. | | | |
| malathion | 1 to 1½ lbs. | | | |
| Nonagricultural land (roadsides, fencerows, idle land) | | toxaphene | 1 to 1½ lbs. | |

| Insect | Crop | Insecticide | Dosage (actual toxicant per acre) | Remarks |
|--------|---|-------------|---|---|
| | Pasture, grass | aldrin | 2 to 4 oz. | Do not graze milk cow or meat animals being finished for slaughter. |
| | | heptachlor | 2 to 3 oz. | Do not graze milk cows. Do not graze meat animals to be finished for slaughter for 90 days after treatment. |
| | | malathion | 1 to 1½ lbs. | At least 7 days before grazing or cutting. |
| | | toxaphene | 1 to 1½ lbs. | One application per season. Do not graze milk cows. If meat animals are also treated for control of ectoparasites (flies, lice), remove them from treated pastures at least 6 weeks before slaughter. Do not sell or ship treated grass for feed. |
| | Small grains | 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 lbs. | 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(in- cluding for hay or ensiling) | aldrin | 2 oz. | One application at least 30 days before cutting for hay or ensiling. |

| Insect | Crop | Insecticide | Dosage (actual toxicant per acre) | Remarks |
|--|--|-----------------|---|--|
| | | dieldrin | 1 oz. | One application at least 35 days before cutting for hay or ensiling. |
| | | toxaphene | 1 to 1½ lbs. | 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. | | | | |
| Leafhoppers | Alfalfa hay, forage | 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 | 4 oz. | At least 15 days before cutting (aerial application only). |
| | | Phosdrin | 4 oz. | At least 1 day before cutting (aerial application only). |
| Plant bugs (tarnished, alfalfa, rapid, Lygus) | Alfalfa, clover, trefoil <u>for seed</u> | DDT | 1½ to 2 lbs. | 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 lbs. | |
| 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 lbs. | |

| Insect | Crop | Insecticide | Dosage (actual toxicant per acre) | Remarks |
|---|------------------------------|--|---|--|
| <p>Note: For light infestations dieldrin granules mixed with the seed ($\frac{1}{2}$ pound actual in the amount of seed per acre) will protect the stand if seeding is shallow and pressed in.</p> | | | | |
| Thrips | Barley | parathion (or methyl parathion) | 4 to 6 oz. | Aerial application at least 15 days before harvest. Treat just as heads emerge. |
| White grubs | Corn, soybeans | aldrin | 3 lbs. | Preplanting soil treatment. |
| | | dieldrin | 3 lbs. | |
| | | heptachlor | 3 lbs. | |
| Wireworms | Corn, beans, small grains | aldrin, dieldrin, heptachlor, or lindane | 1 oz. (per bushel) | As seed treater |
| | Corn | aldrin or heptachlor | 1 to $1\frac{1}{2}$ lbs. | Soil treatment before or at planting. Use 1 pound rate for row treatment, $1\frac{1}{2}$ pounds for broadcast. |

FRUIT INSECTS

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

VEGETABLE INSECTS

See "Commercial Vegetable Pest Control Guide" or Entomology Fact Sheet No. 11, "Insect Control in the Home Vegetable Garden."

HOUSEHOLD INSECTS

| Insect | Insecticide | Dosage | Remarks |
|---|-----------------|--|---|
| Ants (indoors). (See also under pests of trees, shrubs, turf.) | chlordan | 2 to 5 percent solution or emulsion, 5 to 6 percent dust | } Apply to runways. Do not contaminate food or utensils. |
| | Diazinon | 0.5 percent solution or emulsion | |
| | dieldrin | 0.5 percent solution or emulsion | |
| | lindane | 0.5 percent solution, 1 percent dust | |
| | malathion | 3 percent solution or emulsion | |
| | ronnel (Korlan) | 1 percent emulsion | |
| Note: A treatment with chlordan or dieldrin on the outside walls and foundation, as described under box-elder bugs, may help keep ants from entering the house. | | | |
| Bedbugs | chlordan | 2 to 3 percent solution or emulsion | } Apply to springs and frames of beds and to cracks and crevices around doors, window casings, baseboards, etc. |
| | DDT | 5 percent solution | |
| | lindane | 0.5 percent solution | |
| Box-elder bugs | chlordan | 2 pts. 45 percent E. C. per 50 gals. water | } Spray infested box-elder trees during late summer when bugs are small. |
| | dieldrin | 3 pts. 15 percent E. C. per 50 gals. water | |

| Insect | Insecticide | Dosage | Remarks |
|--|-------------|---|--|
| | Diazinon | 1 percent emulsion | Apply <u>outside</u> to foundations, walls, and tree trunks where bugs gather. |
| | dieldrin | 2 pts. 15 percent E. C. per 8 gals. water | |
| <p>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.</p> | | | |
| Carpenter ants | chlordane | 2 to 3 percent solution or emulsion | Paint or spray infested wood and runways. |
| | dieldrin | 0.5 percent solution or emulsion | |
| Carpet beetles | chlordane | 2 to 3 percent 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 percent solution | |
| | lindane | 0.5 to 1 percent solution | |
| | Diazinon | 0.5 percent solution | |
| | malathion | 3 percent solution | |
| Clothes moths | chlordane | 2 to 3 percent solution | Apply lightly to clothing. |
| | DDT | 5 percent solution or in EQ-53 for washable woolens | |
| | | dieldrin | 0.5 percent solution |

| Insect | Insecticide | Dosage | Remarks |
|--------|-------------------------------------|---------------------------|---|
| | lindane | 0.5 or 1 percent solution | } Apply lightly to clothing. |
| | malathion | 3 percent solution | |
| | perthane | 5 percent 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 outside the home to prevent mites from entering)

| | | |
|-----------------|---|--|
| chlorobenzilate | 2 tsps. 25 percent 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 tbsps. 18½ percent W. P. per gal. water | |
| malathion | 3 tsps. 50 percent 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. A sod-free band 18 to 24 inches immediately next to the house will help reduce the clover mite problem. Wipe up mites inside the home with an oily dust-cloth or a vacuum cleaner.

Cockroaches (roaches, "water bugs")

| | | |
|-----------------|---|---|
| chlordan | 2 or 3 percent solution or spray, 5 or 6 percent 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 percent solution or spray | |
| dieldrin | 0.5 percent solution or spray | |
| ronnel (Korlan) | 2 percent spray | |
| lindane | 0.5 to 1 percent solution or spray | |
| malathion | 2 or 3 percent solution or spray | |

| Insect | | Insecticide | Dosage | Remarks |
|----------------------|---|--|--|---|
| Crickets | | chlordane | 2 to 3 percent spray or 5 to 6 percent dust | } Apply as "spot treatment" to corners, baseboards, under cabinets, in closets, etc. |
| | | Diazinon | 0.5 percent spray | |
| | | dieldrin | 0.5 percent spray | |
| | | malathion | 2 to 3 percent spray | |
| | | Note: A treatment with chlordane or dieldrin on the outside walls and foundation, as described under box-elder bugs, will help prevent crickets from entering the house. | | |
| Fleas | Dogs | DDT or as for cats | 5 to 10 percent dust or in washes, shampoos | |
| | Cats | rotenone | 1 percent dust | <u>Do not use DDT on cats.</u> |
| | | methoxychlor | 1 percent dust | |
| | | malathion | 4 percent dust | |
| | Infested kennels, beds, or other areas | DDT | 5 percent spray | |
| | | malathion | 2 or 3 percent spray | |
| | | ronnel (Korlan) | 1 percent spray | |
| Houseflies (indoors) | | pyrethrins plus synergist | Space sprays or aerosol "bombs" | } Apply to resting places of flies-- around windows, doors, frames, under eaves, etc., or as a window-screen paint. |
| | Residual treatment of outbuildings or outside of the home | Diazinon | 1 percent spray or bait | |
| | | Dibrom | 0.4 percent bait | |
| | | Dipterex | 1 percent bait | |

| Insect | Insecticide | Dosage | Remarks | |
|---------------------|---|---------------------------------|---|--|
| | DDVP | $\frac{1}{2}$ to 1 percent bait | } Apply to resting places of flies-- around windows, doors, frames, under eaves, etc., or as a window- screen paint. | |
| | malathion | 1 percent spray or bait | | |
| | ronnel (Korlan) | 1 percent spray or 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) | DDT | In combination with synergized pyrethrum space sprays or in aerosol "bombs." | |
| | (outdoors) | DDT | 1 lb. 50 percent W. P. per 5 gals. water, or 0.5 percent emulsion spray plus 1 percent malathion spray | Apply to mosquito resting places such as shrubbery, hedges, and under eaves. May also be painted on screens. |
| | | DDVP | 1 to 3 percent solution | Fogging for temporary adult control. |
| | | dieldrin | 1 pt. 15 percent E. C. per 5 gals. water | Apply to mosquito resting places such as shrubbery, hedges, and under eaves. May also be painted on eaves. |
| | Note: Mosquito control in towns and cities should be an organized community program based on treatment of breeding areas. | | | |
| Powder-post beetles | DDT | 5 percent oil solution | } Paint, spray, or dip to saturate wood. | |
| | pentachlorophenol | 4 to 5 percent solution | | |

| Insect | Insecticide | Dosage | Remarks |
|--|-----------------|---|---|
| Silverfish, firebrats | DDT | 5 percent solution, 5 to 10 percent dust | Apply to infested areas, corners in closets, behind radiators, around pipes. |
| | chlordan | 2 to 3 percent solution, 5 to 6 percent dust | |
| | Diazinon | 1 percent spray | |
| | dieldrin | 0.5 percent spray | |
| | lindane | 0.5 percent spray, 1 percent dust | |
| | ronnel (Korlan) | 1 percent spray | |
| Stored-food pests (flour beetles, meal moths, larder beetles, etc.) | chlordan | 2 to 3 percent 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 No. 13, "Pantry Pests." |
| | DDT | 5 percent solution | |
| | lindane | 0.5 percent solution | |
| Termites | chlordan | Termite infestations usually require the services of an experienced pest-control operator. Consult Entomology Fact Sheet No. 6, "Are They Really Termites?" | |
| | dieldrin | | |

LIVESTOCK AND POULTRY INSECTS

| Pest | Host | Insecticide | Dosage | Remarks |
|--------------|--|-----------------------|---|---|
| Cattle grubs | Milk cows or beef cattle | rotenone | 1 percent dust | Treat when grubs first appear in backs; repeat every 30 to 40 days until grubs no longer appear. |
| | | | 7½ lbs. 5 percent powder per 100 gals. water as spray | |
| | | | 12 oz. 5 percent powder per 1 gal. water plus soap as a wash | |
| | Beef cattle or nonmilking dairy cattle | Co-Ral | 16 lbs. 25 percent W.P. per 100 gals water (dip or spray) | One treatment in early fall after fly season. Use adequate pressure and suitable nozzles to wet the skin thoroughly. Do not use within 45 days of slaughter. Follow precautions on label. |
| | | ronnel (Trolene) | 1 bolus per 300 lbs. of body weight (also available in some feed concentrates.) | One treatment in early fall. Administer with standard balling gun; preferably done by a veterinarian. Do not treat within 60 days of slaughter. Follow safety precautions on label. |
| Cattle lice | Milk cows or beef cattle | Synergized pyrethrins | As labelled | Dust or spray; repeat in 15 to 20 days. |
| | | rotenone | 1 percent dust or 2 lbs. 5 percent powder per 100 gals. water | Rub dust into hair; repeat in 15 to 20 days. |

| Pest | Host | Insecticide | Dosage | Remarks |
|------|--|--|---|--|
| | Beef cattle or nonmilking dairy cattle | Co-Ral | 16 lbs. 25 percent W.P. per 100 gals. water | Spray with 1 to 4 quarts per head. Do not use within 45 days of slaughter. |
| | | Delnav | 0.15 percent dip or spray, one part 30 percent E.C. in 200 parts of total spray or dip ($\frac{1}{2}$ gal. per 100 gals.) | Do not use offener than once every 2 weeks. |
| | | lindane | 2 lbs. 25 percent W.P. per 100 gals. water | } Do not treat within 30 days of slaughter. |
| | | | 1 qt. 20 percent E.C. per 100 gals. water | |
| | | malathion | 16 lbs. 25 percent W.P. per 100 gals. water | |
| | | | 1 gal. 50 to 57 per- cent E.C. per 100 gals. water | |
| | | methoxychlor | 8 lbs. 50 percent W.P. per 100 gals. water | |
| | | ronnel (Korlan) | 16 lbs. 25 percent W.P. per 100 gals. water | At least 8 weeks before slaughter. |
| | toxaphene | 8 lbs. 50 percent W.P. per 100 gals. water | Do not treat within 28 days of slaughter. | |

| Pest | Host | Insecticide | Dosage | Remarks |
|---|--|--|--|---|
| Note: A 5-percent solution of DDT, malathion, methoxychlor, or toxaphene in fuel oil applied to cable type back-rubbers will also help reduce lice on beef cattle. <u>All</u> cattle should be treated for lice in the fall so that they go into winter free of lice. | | | | |
| Cattle Scab | Notify veterinarian or Minnesota Livestock Sanitary Board. | | | |
| Flies, biting (horn, stable deer, horse, mosquitoes) | (See Extension Folder 192, "Fly Control for Livestock") | | | |
| | Milk cows or beef cattle | malathion | 4 percent dust | 2 to 4 tbsps. per animal; apply dry to backs. Do not apply during or within 5 hours of milking. |
| | | methoxychlor | 50 percent W. P. | One tbsp. per animal; apply dry to backs. |
| | | pyrethrins plus synergists and repellents (such as R-11, R-326, or Tabatrex) | 0.1 percent | Spray daily or as needed with hand sprayer, fogger, aerosol, treadle sprayer, or automatic sprayer. |
| | | thiocyanates (Lethane or Thanite) | 3.5 percent | 1 to 2 fluid ounces per animal; not over 2 ounces daily. |
| Hornflies | Beef cattle only | Co-Ral | 0.5 percent spray (16 lbs. 25 percent W. P. per 100 gals. spray.) | Not within 45 days of slaughter. |
| | | Delnav | 0.15 percent spray or dip ($\frac{1}{2}$ gal. 30 percent E. C. per 100 gals. spray) | Do not use oftener than once every 2 weeks. |

| Pest | Host | Insecticide | Dosage | Remarks |
|------------|--------------------------------|-----------------|--|--|
| | | DDT | 5 percent in fuel oil on back-rubbers only | |
| | | malathion | 0.5 percent spray (16 lbs. 25 percent W.P. per 100 gals. spray) | |
| | | | 2 percent in oil on back-rubbers | |
| | | methoxychlor | 0.5 percent spray | |
| | | | 5 percent in oil on back-rubbers | |
| | | toxaphene | 0.5 percent spray | Not within 28 days of slaughter. |
| | | | 5 percent in oil on back-rubbers | |
| | | | 50 percent W.P. | 1 tbsp. per animal; apply dry to backs. |
| | | ronnel (Korlan) | 0.5 percent spray, 1 percent in oil on back-rubbers | Not within 8 weeks of slaughter. |
| Face flies | Dairy cattle or beef cattle | DDVP (Vapona) | 0.2 percent bait | Apply $\frac{1}{2}$ to $\frac{2}{3}$ tsp. in a single 6-inch stroke with a small paintbrush to foreheads daily after milking. |
| | | pyrethrins | 0.1 percent plus synergists and re- pellent (R-11, R-326, Tabatrex, Crag) | Spray to head daily. |

| Pest | Host | Insecticide | Dosage | Remarks |
|---|--------------------------------|-----------------|--|--|
| | Beef cattle only | DDT | 5 percent in oil | } On back-rubbers (inverted "V" type is most effective). |
| | | toxaphene | 5 percent in oil | |
| | | methoxychlor | 5 percent in oil | |
| | | Co-Ral | 0.5 percent spray | } Apply to heads |
| | | ronnel (Korlan) | 0.5 percent spray | |
| Houseflies in barns and other buildings | Milk house or milk room | pyrethrins | 0.1 percent plus synergist | |
| | | DDVP | 0.5 percent bait only | Spot treat. Do not contaminate utensils and equipment. |
| | | ronnel (Korlan) | 1 percent spray | Residual treatment. Do not contaminate utensils and equipment. |
| | Barns and animal housing areas | pyrethrins | 0.1 percent | } Space spray with foggers, aerosol, or finely atomized spray. |
| | | Dibrom | 0.3 percent | |
| | | Diazinon | 1 percent residual spray 1 percent bait | |
| | | Dibrom | 0.4 percent bait | |
| | | DDVP | 0.5 percent bait | |
| | | Dipterex | 1 percent bait | |

| Pest | Host | Insecticide | Dosage | Remarks |
|--|------------------------------|--|---|--|
| | | lindane | 0.3 percent residual spray | Houseflies are generally resistant to lindane; may be ineffective when used alone. |
| | | malathion | 1 percent residual spray 1 to 2 percent bait | |
| | | ronnel (Korlan) | 1 percent residual spray | |
| Note: When using baits and sprays do not contaminate feed or water or feed and water troughs and containers. | | | | |
| Poultry mites, lice | Chickens | Co-Ral | 0.5 percent dust | Dust birds at least 45 days before slaughter. |
| | | malathion | 0.5 percent spray | Treat roosts and birds. Use 1 gallon of spray per 100 birds. |
| | | malathion | 4 percent dust | 1 pound per 40 square feet of litter. |
| | | malathion | 3 percent solution | Roost paint |
| | Turkeys on range | malathion | 2 qts. 50 to 57 percent E. C. in 24 gals. of water. | Will treat 3 to 4,000 birds. Use at least 7 days before slaughter. |
| Screwworms | Cattle, swine, sheep, horses | Smears 62 Smears 1038 Smears EQ 335 Smears 5 percent ronnel | | Treat wounds, wire cuts. Not milk cows |
| | | Co-Ral | 0.5 percent spray 5 percent dust | } Not for milk cows. At least 45 days before slaughter. Apply to wounds and adjacent area. |
| | | | | |

| Pest | Host | Insecticide | Dosage | Remarks |
|-------------------------|--|---------------------------------------|---|---|
| | | ronnel(Korlan) | 0.5 percent spray | At least 56 days before slaughter. Not for milk cows. |
| Sheep keds ("ticks") | Sheep | Co-Ral | 0.25 percent spray | At least 45 days before slaughter. |
| | | Delnav | 0.15 percent dip or spray | Do not use oftener than once in 2 weeks. |
| | | DDT | 0.5 percent spray 0.25 percent dip | At least 30 days before slaughter; one treatment only. |
| | | lindane | 2 lbs. 25 percent W.P. per 100 gals. water (spray) | At least 30 days before slaughter. |
| | | | 1 lb. 25 percent W.P. per 100 gals. water (dip) | At least 30 days before slaughter. |
| | | malathion | 16 lbs. 25 percent W.P. per 100 gals. water (spray only) | |
| | | methoxychlor | 8 lbs. 50 percent W.P. per 100 gals. water (spray or dip) | |
| | | ronnel (Korlan) | 16 lbs. 25 percent W.P. per 100 gals. water (spray only) | At least 84 days before slaughter. |
| toxaphene | 8 lbs. 50 percent W.P. per 100 gals. water (spray) | At least 28 days before slaughter. | | |
| dieldrin | | 1½ percent dust | 1 to 2 ounces per head with duster. Treat once at least 90 days before slaughter. | |

| Pest | Host | Insecticide | Dosage | Remarks |
|-----------------------------|-------|--|--|---|
| Sheep scabies ("scab") | Sheep | Notify veterinarian or the Minnesota Livestock Sanitary Board. | | |
| Swine mange | Swine | lindane | 5 lbs. 25 percent W.P. per 100 gals. water | Spray or dip. Treat sows at least 40 days before farrowing. Do not treat suckling pigs. |
| Wool maggots (fleece worms) | Sheep | Screwworm smears Smears 62 Smears 1038 Smears EQ 335 Smears 5 percent ronnel | | Shear wool from infested area and treat wound and surrounding skin. |
| | | lindane | 2 lbs. 25 percent W.P. per 100 gals. water | Spray to prevent strike. |
| | | Co-Ral | 0.25 percent spray | At least 45 days before slaughter. |
| | | Delnav | 0.15 percent dip or spray | |
| | | ronnel (Korlan) | 0.5 percent dip or 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 the recommendations given below.

| | | | | |
|------|------|------------|---|---|
| Ants | Lawn | chlordan | 5 to 10 percent dust or granular | $\frac{1}{4}$ pound per 100 square feet |
| | | | 50 percent W. P., 3 tbsps. per gal. water | Apply as spray to 100 square feet |
| | | | 45 percent E. C., 5 tsps. per gal. water | Apply as spray to 100 square feet |
| | | dieldrin | 5 percent dust or granular | $\frac{1}{2}$ pound per 100 square feet |
| | | heptachlor | 2 $\frac{1}{2}$ percent dust or granular | $\frac{1}{4}$ pound per 100 square feet |
| | | | 25 percent E. C. | 3 teaspoons per gallon on 100 square feet |

Note: Liquid sprays may be used as a drench on individual ant nests. Water broadcast treatments thoroughly.

| | | | | |
|--------|---------------|-----------|--|----------------------------------|
| Aphids | Trees, shrubs | malathion | 50 percent E. C. 2 pts. per 100 gals, or 2 tsps. per gal. water | Apply thoroughly to all foliage. |
|--------|---------------|-----------|--|----------------------------------|

Note: Some aphids, such as elm cockscomb gall, elm leaf, woolly apple, woolly elm, and woolly elm bark, may be controlled with dormant sprays, as described under scale insects.

Borers 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; the dead or dying branches should be pruned out and all wounds properly dressed.

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. Carbon disulfide is extremely explosive so avoid smoking or any flame when using it.

A strong DDT-emulsion spray or wash containing 2½ percent DDT applied to the trunks and lower branches will control some borers. Avoid treating the foliage with the concentrated spray.

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:

| | |
|---------------------|-------------------------|
| Bronze-birch borers | Late June, early July |
| Poplar borers | August |
| Apple-tree borers | Late May, early June |
| Lilac borers | Late May and early June |
| Locust borers | August |

| | | | | |
|-------------------------------|--|-----|--|--|
| Canker worms, spring and fall | Elm, apple, box-elder, and other trees | DDT | 50 percent W. P. 2 lbs. per 100 gals. or 2 tbsps. per gal. | Apply at first sign of injury, usually early in May. |
|-------------------------------|--|-----|--|--|

| | | | | |
|---------------------------|--------------------------|--|--|--|
| Caterpillars and sawflies | Various trees and shrubs | Most leaf-chewing caterpillars and sawflies may be controlled by spraying the foliage with 2 pounds 50 percent DDT per 100 gallons of water (2 table-spoons per gallon). 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. | | |
|---------------------------|--------------------------|--|--|--|

| Pest | Where found | <u>Time to Control</u> |
|----------------------------|--|--|
| Eastern tent caterpillars | Wild cherry, apple, mountain ash, other | Early to mid-May, when tents are noticed |
| 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, male, 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. |

| Pest | Where found | Insecticide | Dosage | Remarks |
|---------------------------------------|---|-----------------|---|---|
| Leaf beetles | Many deciduous trees, especially willow, elm, cottonwood, aspen | DDT | 50 percent W.P., 2 lbs. per 100 gals. water or 2 tbsps. per gal. | Apply when adult beetles appear; repeat when larvae appear. |
| Leafhoppers | Many trees and shrubs, especially caragana | DDT | 2 to 4 lbs. 50 percent W.P. 100 gals. or 2 to 4 tbsps. per gal. water | |
| Mites ("red spider," spider mites) | Many trees and shrubs, especially evergreens and ornamentals | aramite | 2 lbs. 15 percent W.P. per 100 gals. or 2 tbsps. per gal. water | |
| | | chlorobenzilate | 1 qt. 25 percent E.C. per 100 gals. or 2 tsps. per gal. water | |
| | | Kelthane | 2 lbs. 18½ percent W.P. per 100 gals. or 2 tbsps. per gal. water | |
| | | ovex | 1½ lbs. 50 percent W.P. per 100 gals. or 2 tbsps. per gal. water | |
| | | malathion | 2 pts. 50 percent E.C. per 100 gals. or 2 tsps. per gal. water | |
| Night crawlers, earthworms | Lawn, turf | dieldrin | | When used as recommended for white grubs, will help reduce numbers of night crawlers. |
| | | lead arsenate | 10 lbs. per 1,000 sq. ft. Soak thoroughly. | |

| Pest | Where found | Insecticide | Dosage | Remarks |
|---|---|--|-------------------------------------|--|
| Scale insects | | | | |
| <u>Dormant Sprays</u> | | | | |
| Oyster-shell European elm Scurfy Cottony maple European fruit lecanium | } | DN-289 | 1 gal. per 100 gals. water | Apply in spring before buds open but when temperature is above freezing. |
| | | Elgetol | 1 gal. per 100 gals water | |
| | | dormant oils | 2 to 3 gals. per 100 gals. water | |
| Pine-needle | | liquid lime sulfur | 1 part to 9 parts water | Apply in spring before buds open but when temperature is above freezing. |
| <u>Crawler Sprays</u> (2 pts. 50 percent emulsion concentrate of malathion per 100 gals. water) | | | | |
| <u>When to Apply</u> | | | | |
| European fruit lecanium | Elm, fruit trees | Late June, early July (about when catalpas bloom) | | Thorough coverage of foliage, twigs, and branches. |
| Oyster- shell | 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. |

| Pest | Where found | Insecticide | Dosage | Remarks |
|---|-------------|-------------|---|---------|
| White grubs, sod webworms, billbugs | Lawn, turf | aldrin | 4 lbs. actual per acre 1½ lbs. 5 percent dust or granular per 1,000 sq. ft. 5 fl. oz. 2 lbs. E. C. concentrate per 1,000 sq. ft. | |
| | | chlordane | 2½ lbs. 10 percent dust or granular per 1,000 sq. ft. 8 fl. oz. 45 per- cent E. C. per 1,000 sq. ft. | |
| | | dieldrin | 4 lbs. 2½ percent dust or granular per 1,000 sq. ft. 6 fl. oz. 15 percent E. C. per 1,000 sq. ft. | |
| | | heptachlor | ¼ lb. 25 percent granular per 1,000 sq. ft. 4 fl. oz. 2 lbs. per gal. E. C. | |

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.

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 percent premium-grade E. C. in 25 gals. water (1 pt. in 2 to 5 gals. water).

methoxychlor 2 gals. 25 percent E. C. for 25 gals. 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 gals. water per 1,000 bu.

malathion 1 percent premium-grade wheat flour dust, 60 lbs. 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 $\frac{1}{2}$ to 1 pint premium-grade E. C. in 2 gals. water per 1,000 sq. ft. of grain surface area.

malathion 1 percent premium-grade wheat flour dust, 30 lbs. 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.)

There are many commercial fumigants 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 or 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 and Economic Zoology, University of Minnesota, St. Paul 1, Minnesota.

| 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 |
| Chloroform - carbon bisulfide, chloroform - ethylene dibromide mixtures as labeled. | | | | |
| Use other liquid fumigant mixtures as labeled. | | | | |

Aluminum phosphide
(Phostoxin)

Add 180 tablets per 1,000 bu. as grain is binned or probe tablets into binned grain.

GREENHOUSE AND FLORICULTURAL PESTS

| Pest | Insecticide, miticide | Dosage | Remarks |
|---------------------------|-----------------------|--|--|
| Ants | chlordan | 5-6 percent dust, 2 percent spray | } Apply to soil and along walks. Do not apply to foliage. |
| | Diazinon | 1 percent spray | |
| | dieldrin | 2 percent dust, $\frac{1}{2}$ percent spray | |
| Aphids | malathion | 1-1 $\frac{1}{2}$ pts. of 5 lbs. E. C. per 100 gals. water | |
| | | 2 $\frac{1}{2}$ lbs. of 25 percent W. P. per 100 gals. water | |
| | parathion | 1 lb. of 25 percent W. P. per 100 gals. water | |
| | | Aerosol | |
| | sulfotepp (Dithio) | Smoke or aerosol | |
| | demeton (Systox) | | Soil treatment. |
| | Thiodan | 1 lb. of 50 percent W. P. per 100 gals. water | Approved use on chrysanthemums. Dusts may also be used. |
| Chrysanthemum gall midges | lindane | 1 lb. of 25 percent W. P. per 100 gals. water | } For adult control. |
| | DDT | 2 lbs. of 50 percent W. P. per 100 gals. water | |
| | parathion | 1 lb. of 25 percent W. P. per 100 gals. water | |

| Pest | Insecticide, miticide | Dosage | Remarks |
|----------------|---|---|---|
| Cutworms | dieldrin | 2 percent dust, 1 lb. of 50 percent W. P. or 1 qt. of 1½ lbs. E. C. per 100 gals. water | Soil treatment. |
| | DDT | 10 percent dust, 2 lbs. of 50 percent W. P. per 100 gals. water. | |
| | toxaphene | 10 to 20 percent dust, 2½ lbs. of 50 percent W. P. per 100 gals. water | |
| Cyclamen mites | endrin | 1 qt. of 1.6 percent lbs. E. C. per 100 gals. water | Make two or three applications at 2-week intervals. |
| | kelthane | 1½ lbs. of 18½ percent W. P. per 100 gals. water | |
| | | 1½ pts. of 18½ percent E. C. per 100 gals. water | |
| | Note: Sanitation and isolation are important. | | |
| Fungus gnats | chlordan | 1 qt. of 4 lbs. E. C. per 100 gals. spray | Treat soil weekly until infestation is controlled. |
| | dieldrin | ½ lb. of 50 percent W. P. per 100 gals. spray | |
| | | 1 pt. 1½ lbs. E. C. per 100 gals. spray | |
| | malathion | 4 percent dust, 1½ to 2 pts. E. C. of 5 lbs. E. C. per 100 gals. spray | |
| | nicotine sulfate | 1 pt. of 40 percent (5 lbs.) E. C. per 100 gals. spray | |

| Pest | Insecticide, miticide | Dosage | Remarks |
|------------------------|---|---|--|
| Centipedes, symphylids | lindane | 6 oz. of 25 percent W. P. per 1,000 sq. ft. | Work into soil. Steam sterilization is also advised. |
| Leaf miners | parathion | $\frac{1}{2}$ lb. of 25 percent W. P. per 100 gals. spray | Avoid excessive treatment of asters especially. |
| Leaf rollers | DDD (TDE) | 2 lbs. of 50 percent W. P. per 100 gals. spray | Dusts and sprays more effective than aerosols. |
| | parathion | $\frac{3}{4}$ lb. of 25 percent W. P. per 100 gals. spray | |
| Mealy bugs | parathion | 1 lb. of 25 percent W. P. per 100 gals. spray | Repeat in 3 to 4 weeks. |
| | sulfotepp (Dithio) | Smoke or aerosol | Aerosol and smoke will kill adults only. |
| | malathion | 3 lbs. of 25 percent W. P. per 100 gals. spray | |
| Spider mites | | $1\frac{1}{2}$ pts. of 5 lbs. E. C. per 100 gals. spray | |
| | parathion | 1 lb. of 25 percent W. P. per 100 gals. spray | 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) | $1\frac{1}{2}$ pts. of 25 percent E. C. per 100 gals. spray | |
| malathion | $1\frac{1}{2}$ pts. of 5 lbs. E. C. per 100 gals. spray | | |

| Pest | Insecticide, miticide | Dosage | Remarks |
|-------------------------------------|-----------------------|--|-------------------|
| Spider mites (aramite resistant) | Kelthane | 1½ lbs. of 18½ W.P. per 100 gals. spray | } See Note below. |
| | or chlorobenzilate | ¾ lb. of 25 percent W.P. per 100 gals. spray | |
| | plus azobenzene | 1½ lbs. of 70 percent W.P. per 100 gals. spray | |
| | Tedion | 1 lb. of 25 percent W.P. per 100 gals. spray | |

Note: Make very thorough applications and follow a sequence of chemically unrelated materials to avoid or postpone resistance.

| | | | |
|---------------------------------------|---|---|---|
| Spider mites (phosphate resistant) | aramite | 1½ lbs. of 15 percent W.P. per 100 gals. spray | } Avoid emulsions, especially aramite, ovex, and chlorobenzilate. Avoid ovex on roses and other tender foliage. |
| | chlorobenzilate | 1½ lbs. of 25 percent W.P. per 100 gals. spray | |
| | Kelthane | 1½ lbs. of 18½ percent W.P. per 100 gals. spray | |
| | ovex | 1½ lbs. of 50 percent W.P. per 100 gals. spray | |
| | Azobenzene (combined with aramite or chlorobenzilate) | 1½ lbs. of 70 percent W.P. per 100 gals. spray | |
| | Tedion | 1 lb. of 25 percent W.P. per 100 gals. spray | |

| Pest | Insecticide, miticide | Dosage | Remarks |
|---|--|--|--------------------------------------|
| Roaches | chlordan | | |
| | dieldrin | Same as for ants | |
| | Diazinon | | |
| Scale insects | malathion | Same rate as for mealy bugs | 3 or 4 applications. |
| | parathion | | |
| | sulfotepp | | |
| Slugs, snails | metaldehyde, or proprietary baits containing metaldehyde | 2 oz. of 15 percent dust per 100 sq. ft. | Apply once every 2 weeks to soil. |
| Sowbugs(pillbugs) | lindane | 1 lb. of 25 percent W.P. per 100 gals. spray | |
| Spittle bugs | dieldrin | 1 lb. of 50 percent W.P. per 100 gals. spray | |
| | lindane | 1 lb. of 25 percent W.P. per 100 gals. spray | |
| Springtails | malathion | 1½ pts. of 5 lbs. E.C. per 100 gals. spray | |
| Tarnished plant bugs and other plant bugs | dieldrin | ½ lb. of 50 percent W.P. per 100 gals. spray | |
| | DDT | 2 lbs. of 50 percent W.P. per 100 gals. spray | |
| | heptachlor | 1 lb. of 25 percent W.P. per 100 gals. spray | |

| Pest | Insecticide, miticide | Dosage | Remarks |
|-------------|-----------------------|--|---------|
| Thrips | DDT | 2 lbs. of 50 percent W. P. per 100 gals. spray | |
| | dieldrin | $\frac{1}{2}$ lb. of 50 percent W. P. per 100 gals. spray | |
| | | 1 pt. of $1\frac{1}{2}$ lbs. E. C. per 100 gals. spray | |
| | heptachlor | 1 lb. 25 percent W. P. per 100 gals. spray | |
| White flies | | 1 pt. of 2 lbs. E. C. per 100 gals. spray | |
| | parathion | 1 lb. of 25 percent W. P. per 100 gals. spray | |
| | sulfotepp (Dithio) | Smoke or aerosol | |
| | malathion plus DDT | 3 lbs. of 25 percent W. P. per 100 gals. spray | |
| | | 2 lbs. of 50 percent W. P. per 100 gals. spray | |
| | Thiodan | Same as for aphids | |

USE INSECTICIDES CAREFULLY!

Wear protective clothing and respirators or gas masks for highly toxic materials such as parathion, TEPP, sulfotepp, and demeton. Wash thoroughly after spraying and change to clean clothes. Do not smoke or eat while spraying. Read and follow the precautions given on labels.

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