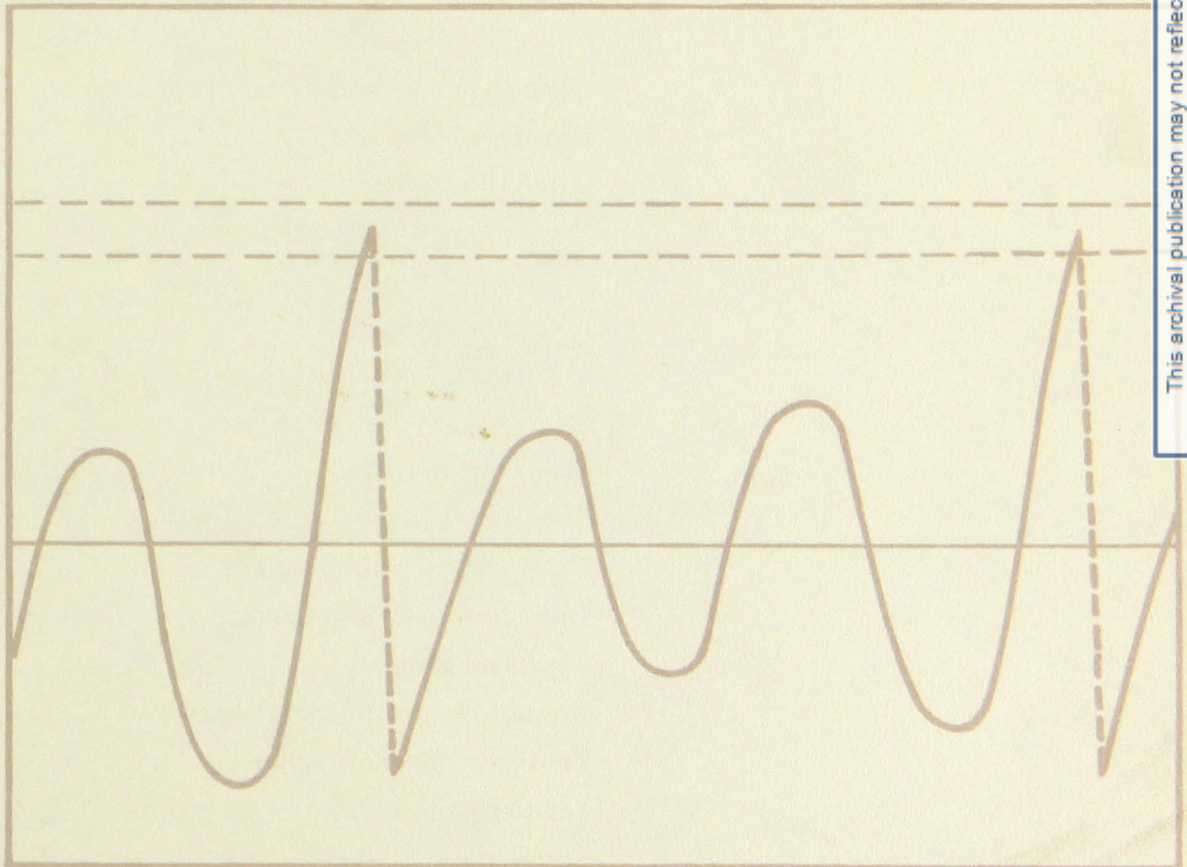
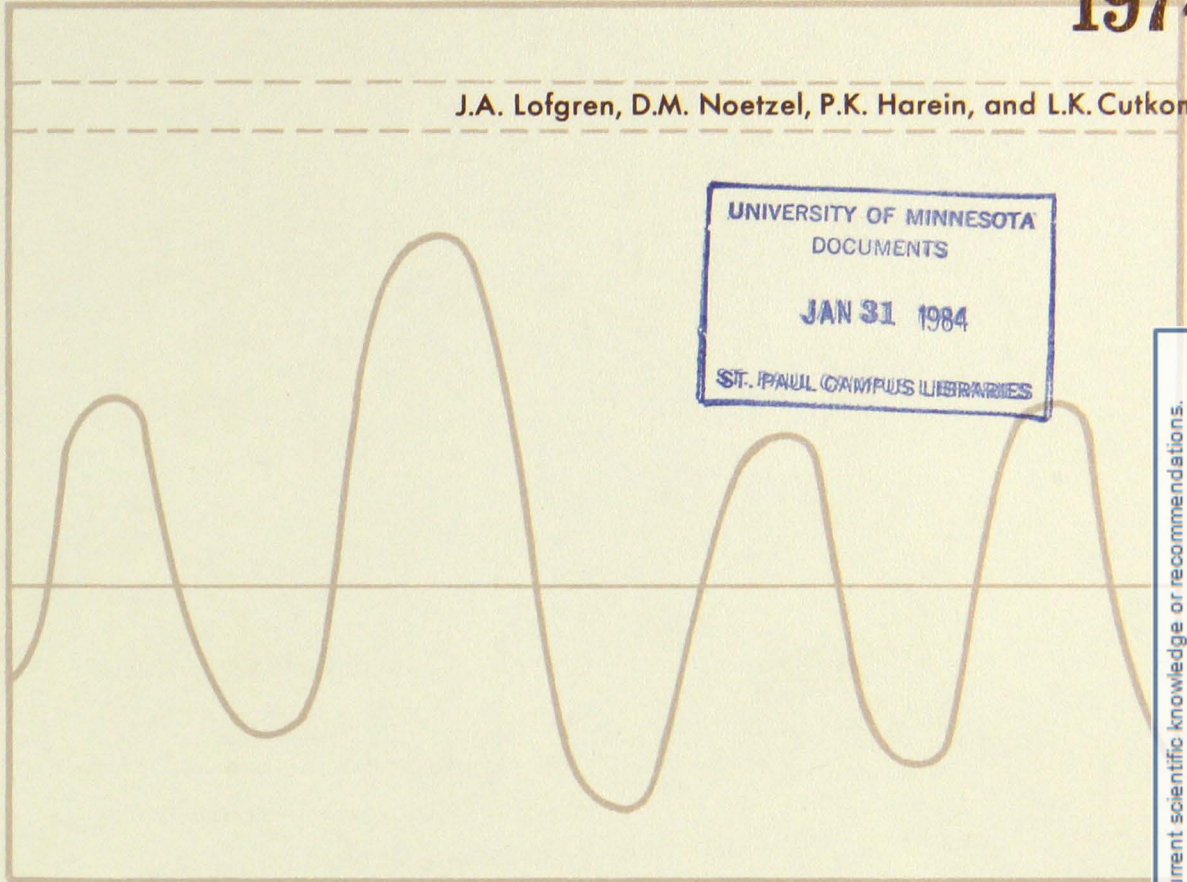


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# Insecticides and Their Uses in Minnesota 1974

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

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

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

### General Precautions for Using Pesticides

1. Always read the label before using sprays or dusts. Note warnings and cautions each time before opening the container.
2. Keep sprays and dusts out of reach of children, pets, and irresponsible people. Sprays and dusts should be stored outside of the home, away from food and feed, and under lock and key.
3. Always store sprays and dusts in original containers and keep them tightly closed. Never keep them in anything but the original container.
4. Never smoke or eat while spraying or dusting.
5. Avoid inhaling sprays or dusts. When directed on the label, wear protective clothing and masks.
6. Do not spill sprays or dusts on the skin or clothing. If they are spilled, remove contaminated clothing immediately and wash thoroughly.
7. Wash hands and face and change to clean clothing after spraying or dusting. Also wash clothing each day before reuse.
8. Cover food and water containers when treating around livestock or pet areas. Do not contaminate fish ponds.
9. Use separate equipment for applying hormone-type herbicides in order to avoid accidental injury to susceptible plants.
10. Always dispose of empty containers so that they create no hazard to humans, animals, or valuable plants.
11. Observe label directions and cautions to keep residues on edible portions of plants within the limits permitted by law.
12. If symptoms of illness occur during or shortly after spraying or dusting, call a physician or get the patient to a hospital immediately.

## Safety Precautions and First Aid

### Precautions when using toxic phosphates

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

Avoid breathing any wettable powder, dust, or contacting an emulsion. If this is unavoidable, use a respirator specifically made for phosphates. A list of respirators can be obtained by writing to the Department of Entomology, Fisheries, and Wildlife; University of Minnesota; Institute of Agriculture; St. Paul, Minnesota 55101.

### Phosphate- and carbamate-poisoning symptoms and antidotes

Many organic phosphate insecticides (TEPP, parathion, methyl parathion, tetraethyl dithiopyrophosphate, EPN, demeton, azinphosmethyl, mevinphos, phorate, disulfoton, 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, coumaphos, and ronnel are much less toxic and diazinon, trichlorfon, and dioxathion are of intermediate toxicity.

All of the organic phosphates discussed, including the least toxic, produce similar symptoms in human beings. All require the same antidote. The symptoms may be produced by absorption through the skin, inhalation, or swallowing. Signs of poisoning include blurred vision (pinpoint pupils), abdominal cramps, tightness of the chest, digestive upset, 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 a chemical has been swallowed and the patient is conscious, generally you should induce vomiting.

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

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4. Keep patient quiet and warm.
5. Physician may administer atropine and/or 2-PAM as an antidote.

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

#### Chlorinated-hydrocarbon first aid

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

1. If chemical has been swallowed, call physician immediately. Generally, if the 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 to provide physicians with information about pesticides and common household poisons, their antidotes, and treatments. Most of these centers operate on a 24-hour basis.

City	Poison Information Center	Telephone
Bemidji	Bemidji Hospital	218-751-5430 Ext. 32
Brainerd	St. Joseph's Hospital	218-829-2861 Ext. 211, 212
Crookston	Riverview Hospital	218-281-4682 Ext. 202, 276, 298
Duluth	St. Luke's Hospital 915 East 1st St. St. Mary's Hospital 407 E. 3rd St.	218-727-6636 Ext. 616, 617 218-727-4551 Ext. 359 Night Ext. 291
Fargo	St. Luke's Hospital	701-237-8115
Fergus Falls	Lake Region Hospital	218-736-5475 Ext. 222 (3 p.m.-7 a.m. and weekends) Ext. 244 (7 a.m.-3 p.m.)

City	Poison Information Centers	Telephone
Mankato	St. Joseph's Hospital	507-387-4031
Marshall	Lewis Weiner Memorial Hospital	507-532-2263 Station 31
Minneapolis	Minnesota Poison Information  Minn. Department of Health 717 Delaware St. S.E. Fairview Hospital 2312 South 6th St. Hennepin County General Hospital 619 South 5th St. North Memorial Hospital 3220 Lowry Avenue North Northwestern Hospital 810 E. 27th St.	612-296-5276 Night: 612-784-1869 Night: 612-929-6491 612-332-0282 Ext. 313 612-348-7981 or 612-348-7688 612-588-0616 Ext. 341, 342, 346 612-874-4000
(Fridley)	Unity Hospital 550 Osborne Road	612-786-2200 Ext. 221
Morris	Stevens County Memorial Hospital	612-589-1313 Station 1
Rochester	Methodist Hospital	507-282-4461 Ext. 5250
St. Cloud	St. Cloud Hospital	612-251-2700 Ext. 151 Night Ext. 221
St. Paul	Bethesda Hospital 559 Capitol Blvd.  St. Paul Ramsey Hospital 640 Jackson St. John's Hospital 403 Maria Avenue St. Joseph's Hospital 69 West Exchange  St. Luke's Hospital 300 Pleasant Avenue Children's Hospital 311 Pleasant Avenue	612-227-8611 Ext. 301, 302 or 224-9121 612-222-4694 612-228-3132 612-291-3348, 291-3139, 291-3117, 291-3118 612-298-8201 612-227-6521 Ext. 432, 433
Virginia	Virginia Municipal Hospital	218-741-3340
Willmar	Rice Memorial Hospital	612-235-4543 Ext. 291
Worthington	Worthington Regional Hospital	507-372-2941 Ext. 155, 158

## Protecting Honey Bees from Insecticides

In recent years the increased intensity of agricultural production has led to a decline in wild insect pollinators. Crops requiring or benefiting from cross pollination have thus become dependent on the honey bee. Both yield and quality of many of these crops are enhanced through the use of appropriate insecticides. Thus it is important, even essential, that both grower and beekeeper become familiar with the relative toxicity of insecticides to honey bees.

The following list has been annotated from the exhaustive studies by Anderson and Atkins in California.

### Insecticides highly toxic to honey bees

Aldrin	Gardona (Rabon)
Arsenicals	Heptachlor
Azinphosmethyl (Guthion)	Imidan
Benzene hexachloride	Lindane
Carbaryl (Sevin)	Malathion
Carbofuran (Furadan)	Methyl parathion
Dasanit	Methomyl (Lannate)
Diazinon (Spectracide)	Mevinphos (Phosdrin)
Dichlorvos (DDVP, Vapona)	Naled (Dibrom)
Dieldrin	Parathion
Dimethoate (Cygon)	Phosphamidon (Dimecron)
Dursban	TEPP
EPN	Zectran
Fenthion (Baytex)	

### Insecticides moderately toxic to honey bees

Abate	Endosulfan (Thiodan)
Carbophenothion (Trithion)	Endrin
Chlordane	Oxydemetonmethyl
Crotoxyphos (Ciodrin)	(Meta-Systox R)
Coumaphos (Co-Ral)	Perthane
DDT	Phorate (Thimet)
Demeton (Systox)	Ronnel (Korlan)
Disulfoton (Di-syston)	

### Insecticides with low toxicity to honey bees

Allethrin	Methoxychlor
Aramite	Oxythioquinox (Morestan)
<i>Bacillus thuringiensis</i>	Nicotine
(Thuricide, Biotrol, Dipel)	Omite
Binapacryl (Morocide)	Ovex (Ovotran)
Chlorbenside (Mitox)	Pyrethrins
Chlorobenzilate (Acaraben)	Rotenone
Chloropropylate (Acaralate)	Sabadilla
Dicofol (Kelthane)	TDE (Rhothane, DDD)
Dimite (DMC)	Tetradifon (Tedion)
Dioxathion (Delnav)	Toxaphene
Ethion (Nialate)	Trichlorfon (Dylox)

You can use this table in two ways. First when honey bees have a high potential vulnerability you may, through the use of the table, select an equally effective insecticide that is less toxic to bees. Or if such a choice cannot be made, then you can take greater care in application of the more toxic material.

Remember toxicity is a relative quality and insecticides quite toxic to bees can be used with no damage to bees provided you follow proper precautions.

Precautions which will help to protect honey bees from insecticide damage include:

#### • Communication and cooperation

The applicator and beekeeper should become familiar with each other's problems so that hazards are appreciated by both parties. The applicator should check fields before treating to determine the exact insect pest problem and whether honey bees might be present. The beekeeper should have his colonies registered and keep them as visible as is reasonably possible.

#### • Wise and safe use of chemical

Be sure an insecticide application is necessary; then apply the chemical in the safest manner possible. Use ground application whenever possible. Avoid the use of dusts. Make applications either early in the morning or late in the day to avoid insecticide contact with bees in flight. Do not make applications when excessive drift will occur.

#### • Avoid treating crops in bloom

In Minnesota it is unlawful to apply an insecticide to fruit trees in bloom. In all crops, where pollination increases yield or quality, insecticide application during the bloom period should be critically considered and avoided if possible.

#### • Ultra low volume applications

Large area control programs for insects such as grasshoppers may employ concentrated (ULV) insecticides. These are particularly toxic to honey bees

## Pesticide Toxicity and LD<sub>50</sub>'s

The comparative toxicities of insecticides are based on tests with small animals. White rats are generally used to determine lethal amounts by eating (oral toxicity) and rabbits are used for lethal amounts by skin absorption (dermal toxicity). The amounts are usually expressed as an LD<sub>50</sub>. This means the amount of insecticide that would kill (LD means lethal dose) 50% of the test animals. This LD value is generally expressed in terms of milligrams (mg) of insecticide per kilogram (kg) of body weight of the test animal. The following list of LD<sub>50</sub> values is based on the technical material (usually close to 100% concentrate) and not on the various formulations registered for public use.

## Acute Oral and Dermal LD<sub>50</sub>'s for Insecticides\*

Insecticides	LD <sub>50</sub> in mg./kg.			
	Oral		Dermal	
	Males	Females	Males	Females
Abate	1000-3000	13000	1024-1782	4000
Aldicarb (Temik)**	1	—	5	—
Aldrin	39	60	98	98
Aramite	3900	3900	—	—
Azinphosmethyl (Guthion)	13	11	220	220
Azodrin	21	—	354	—
Benzene hexachloride (BHC)	1250	—	—	—
Binapacryl (Morocide)	63	58	810	720
Bux**	87	—	400	—
Carbaryl (Sevin)	850	500	> 4000	> 4000
Carbofuran (Furadan)**	11†	—	10,200†	—
Carbophenothion (Trithion)	30	10	54	27
Chlorbenside (Mitox)	> 10,000	—	—	—
Chlordane	335	430	840	690
Chlorfenvinphos (Compound 4072)	15	13	31	30
Chlorpyrifos (Dursban)	163	82	2000	2000
Chlorobenzilate	1040	1220	—	5000
Chloropropylate**	> 5000	—	> 10,200	—
Coumaphos (Co-ral)	41 (56-230)‡	16	860-1000‡	—
Crotoxyphos (Ciodrin)**	125	—	385	—
Crufomate (Ruelene)	635	460	—	—
Dasanit**	10	2	30	3
DD Mixture	140	—	2100	—
DDT	113	118	—	2510
Demeton (Systox)	6	3	14	8
Diazinon	108	285	900	455
Dicapthon	400	330	790	1250
Dichlorvos (DDVP, Vapona)	80	56	107	75
Dicofol (Kelthane)	1100	1000	1230	1000
Dicrotophos (Bidrin)**	22	—	225	—
Dieldrin	46	46	90	60
Dimetilan	50	—	600-700	—
Dimethoate (Cygon, De-Fend)	215	245	400	610
Dintrobutylphenol (Elgetol 318)**	40	40	150-200	—
Dinitrocresol	31	31	300	—
Dinitrocyclohexylphenol	60	60	> 1000	—
Dioxathion (Delnav)	43	23	235	63
Disulfoton (Di-Syston)	7	2	15	6
Dyfonate**	8	—	147	—
Endosulfan (Thiodan)	43	18	130	74
Endrin	18	8	18	15
EPN	36	8	230	25
Ethion	65	27	245	62
Ethylene dibromide	146	117	300	—
Ethylene dichloride	770	—	3890	—
Famphur (Warbex)**	35-62	—	1460-5093	—
Fenthion (Baytex)	190	245	330	330
Fenson**	1350-1740	—	—	—
Gardona (Rabon)**	4000-5000	1125	> 5000	74000
Genite 923**	500	—	—	—
Heptachlor	100	162	195	250
Imidan (Prolate)**	147-299	—	> 3160	—
Kepone	125	125	> 2000	> 2000
Lead Arsenate	—	1050	—	> 2400
Lethane 384	90	—	250-500**	—
Lindane	88	91	1000	900

\* Data taken from latest available sources. Oral toxicity data are usually taken on white rats and dermal toxicity on rabbits.

> is greater than. \*\* Sex of test animals not indicated. † These are 1970 figures from Niagara. ‡ These are 1969 figures from Chemagro.

## Acute Oral and Dermal LD<sub>50</sub>'s for Insecticides\* (continued)

Insecticides	LD <sub>50</sub> in mg./kg.			
	Oral		Dermal	
	Males	Females	Males	Females
Malathion	1375	1000	> 4444	> 4444
MesuroI**	130-135	—	> 200	—
Metaldehyde**	1000	—	—	—
Methomyl (Lannate, Nudrin)**	17-24	—	> 1000	—
Methoxychlor	5000	6000	—	> 6000
Methyl parathion	14	24	67	67
Methyl Trithion	98	120	215	190
Mevinphos (Phosdrin)	6	4	5	4
Mirex	740	600	> 2000	> 2000
Mocap**	61	—	26	—
Monitor	21	19	118	—
Naled (Dibrom)	250	—	800	—
Nemacide	270	—	—	—
Nicotine sulfate	—	83	—	285
Omite**	2500	—	—	—
Orthene	945	866	> 2000	—
Ovex (Ovotran)	2050	—	—	—
Oxydemetonmethyl (Meta Systox-R)	65	75	250	—
Oxythioquinox (Morestan)	1800	1100	> 2000	> 2000
Paradichlorobenzene	> 1000	> 1000	—	—
Parathion	13	4	21	7
Paris green	—	100	—	2400
Pentac**	3160	—	> 3160	—
Perthane	> 4000	> 4000	—	—
Phorate (Thimet)	2	1	6	3
Phosolone (Zolone)**	100-180	—	> 1000	—
Phosphamidon (Dimecron)	24	24	143	107
Plictran**	540	—	> 2000	—
Propoxur (Baygon)	95	86	> 1000	72400
Pyrethrum	1870	820	2060	—
Resmethrin	—	4230	—	—
Ronnel (Korlan, Trolene)	1250	2630	—	> 5000
Rotenone**	50-75	—	940	—
Ryania	1200	—	> 4000	—
Strobane	200	—	> 5000	—
Sulphenone**	1400-3650	—	—	—
Supracide**	25-48	—	375	—
TDE (DDD)	> 4000	> 4000	> 4000**	—
TEPP	1	—	2	—
Tetradifon (Tedion)**	> 14,700	—	> 10,000	—
Thanite**	1600	—	> 6000	—
Toxaphene	90	80	1075	780
Trichlorfon (Dipterex, Dylox, Neguvon)	630 (450-500)†	560	5000**†	> 2000
Zectran**	15-63	—	7500	—

\* Data taken from latest available sources. Oral toxicity data are usually taken on white rats and dermal toxicity on rabbits. > is greater than. \*\* Sex of test animals not indicated. † These are 1969 figures from Chemagro.

### Forms of Insecticides

1. **Dusts** are dry powders ready for immediate use. They may contain ½, 1, 2, 3, 4, 5, 10, or 20 percent of the actual chemical. The rest of the dust is a carrier, such as talc or pyrophyllite. Combination dusts with two or more insecticides or fungicides are available. Dusts should not be used in sprayers because they do not mix properly with water or oil.

2. **Wettable powders (W.P.)** are dry powders which may be mixed with water to make sprays. Formulations containing 15, 25, 40, 50, 75, and 80 percent

of the actual ingredient are available. These powders contain a carrier plus a wetting agent which permits them to form suspensions when mixed with water. This formulation is useful on vegetation because it does not injure foliage as readily as do emulsions or oil solutions. High-volume hydraulic sprayers with mechanical agitators are best suited for handling wettable powders.

3. **Soluble powders (S.P.)**. Only a few organic insecticides 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 (E.C.)** 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 methoxychlor emulsifiable concentrate contains 2 pounds actual methoxychlor 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 ½ to 10 percent active ingredients. Some solution concentrates are available for further dilution with oil or to form oil sprays such as those used by aerial spray equipment, foggers, and mist blowers. Oil solutions should not be used on plants or animals except for special uses with special formulations, such as certain fly sprays on cattle.

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

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

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

## Calculating Dosage and Rates of Application

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

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

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

Example:

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

$$\frac{5 \times 0.75}{2} = 1.87 \text{ gallons of 25\% methoxychlor in 50-gal. tank}$$

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

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

Example:

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

$$\frac{5 \times 0.75}{0.5} = 7.5 \text{ pounds of 50\% methoxychlor in 50 gals. water}$$

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

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

Example:

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

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

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

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

Example:

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

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



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

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

Example:

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

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

6. For small jobs, it is often necessary to figure how much insecticide to use for 1 gallon of spray. If the recommendation is given in terms of 100 gallons, use the following formulas for 1 gallon.

**With wettable powder:**

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

**With emulsion:**

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

### Table of equivalents

- 1 level tablespoon = 3 level teaspoons
- 1 fluid ounce = 2 tablespoons
- 1 cup = 8 fluid ounces
- 1 pint = 2 cups
- 1 quart = 2 pints, or 32 fluid ounces
- 1 gallon = 4 quarts, or 128 fluid ounces
- 1 gallon (United States) = 0.83 (approximately 4/5) gallon (British or Imperial)
- 1 gallon (British or Imperial) = 1.2 gallons (United States)
- 1 gallon water (United States) weighs 8.345 pounds
- 1 pound = 16 ounces or 453.59 grams
- 1 gram = 0.0353 ounce
- 1 ounce = 28.3 grams
- 1 kilogram = 35.27 ounces or 2.2 pounds
- 1 milligram per kilogram = 1 part per million
- 1 acre = 43,560 square feet; 160 square rods; an area 208.7 feet square; an area 16½ feet wide and one-half mile long.
- 1 mile = 5,280 feet; 1,760 yards; 320 rods.
- 1 rod = 5½ yards; 16½ feet.

### Dilution table—emulsifiable concentrates

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

### Dilution table—wetable powders (for sprays)

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

### Sprayer Calibration

To determine how much liquid a sprayer applies per acre:

1. Check the output of all nozzles for a set time to

make sure that all nozzles discharge at the same rate.

2. Start with a full tank of clean water and have the pressure adjusted as you will use it in the field (usually 20-40 pounds).

## Dilution table—to obtain a finished spray containing a desired concentration of actual chemical (approximate)

Formulation to use in 100 gallons of water	Desired concentration of finished spray, percent								
	0.01	0.03	0.06	0.1	0.25	0.5	1.0	2.5	5.0
<b>Wettable powders (percent)</b>									
15	½ lb.	1½ lb.	3 lb.	5½ lb.	13½ lb.	27 lb.	54 lb.		
25	⅓ lb.	1 lb.	2 lb.	3 lb.	8 lb.	16 lb.	32 lb.		
40	1/5 lb.	¾ lb.	1½ lb.	2 lb.	5 lb.	10 lb.	20 lb.		
50	1/10 lb. (1½ oz.)	½ lb.	1 lb.	1½ lb.	4 lb.	8 lb.	16 lb.	40 lb.	
75	1/6 lb. (2½ oz.)	⅓ lb.	¾ lb.	1 lb.	2½ lb.	5 lb.	10 lb.	25 lb.	50 lb.
<b>Emulsifiable concentrate (pounds per gallon)</b>									
1	1½ cup	1 qt.	2 qt.	3 qt.	2 gal.	4 gal.	8 gal.	20 gal.	40 gal.
1½	¾ pt.	1½ pt.	3 pt.	½ gal.	1½ gal.	2¾ gal.	5 gal.	13½ gal.	27 gal.
2	⅔ cup	1 pt.	2 pt.	3 pt.	1 gal.	2 gal.	4 gal.	10 gal.	20 gal.
4	½ cup	½ pt.	1 pt.	1½ pt.	½ gal.	1 gal.	2 gal.	5 gal.	10 gal.
5	2 fluid oz.	6 fluid oz.	¾ pt.	2¾ cups	3 pt.	3 qt.	1¾ gal.	4 gal.	8 gal.
6	1¾ fluid oz.	¾ cup	1½ cups	1 pt.	2¾ pt.	5 pt.	1½ gal.	3¾ gal.	6¾ gal.
8	1 fluid oz.	¼ pt.	½ pt.	¾ pt.	1 qt.	½ gal.	1 gal.	2½ gal.	5 gal.

3. Drive exactly ⅓ mile (40 rods, 660 feet) in a field at the speed you will use when spraying (usually 4-5 miles per hour). Mark the throttle setting or speed indicator reading and maintain the same speed when spraying.

4. Refill the tank, carefully measuring the amount of liquid required. (If water spillage from a full tank is a problem, you can use a calibrated stick to measure the amount of liquid used.)

To calculate broadcast application rate:

$$\frac{\text{Number of gallons used} \times 66}{\text{Boom width in feet}} = \text{gallons per acre.}$$

Example: If 2½ gallons were used in ⅓ mile and the width covered by the boom is 24 feet, multiply 2½ by 66 and divide by 24. The result is 6.9 gallons per acre.

To determine the amount of formulation to use per acre sprayed:

1. Determine the number of pounds of active ingredient suggested per acre for your situation.

2. For dry materials, divide the number of pounds of active ingredient desired by the percentage of active ingredient in the commercial product to determine the number of pounds of material to apply per acre. Example: If 3 pounds of active ingredient are required and the commercial product is an 80-percent active ingredient powder, divide 3 by 0.8 (3.75 pounds of commercial powder per acre).

For liquids, determine the volume of commercial product to apply per acre to get the proper amount of active ingredient per acre. Example: If ½ pound is required per acre and the commercial product contains 4 pounds per gallon, then 1 quart contains 1 pound, and 1 pint contains ½ pound active ingredient.

To determine the amount to put in the tank:

1. Divide the number of gallons the tank will hold by the number of gallons your sprayer applies per acre. This will give you the number of acres one filling will spray.

2. Multiply the number of acres the tank will spray by the amount of formulation to be used per acre. This will give the amount to be used per tank.

### Calibration of a Granular Applicator

1. Determine the number of pounds of active ingredient suggested per acre.

2. Divide the number of pounds of active ingredient desired by the percentage of active ingredient in the commercial material to determine the number of pounds of the material to apply per acre.

3. Consult the manufacturer's recommendation for an approximate setting. Adjust the setting on each hopper.

4. Select an area for a test run, preferably in the field to be treated, so that speed and traction conditions are constant. Measure off a distance of 660 feet (40 rods).

5. Fill hoppers and attach a suitable container (sack, pail, etc.) to each hopper spout to catch granules from each hopper.

6. Put machine in gear and drive the measured distance at the same speed you will be using when applying the chemical.

7. Weigh the material collected from each hopper. Multiply this weight in pounds by 66 and divide by the band width (in feet). This will give the pounds of granular material applied per acre on the area treated. In equation form:

$$\frac{\text{Weight of granules in pounds} \times 66}{\text{Band width in feet}} = \text{Pounds of granules applied per acre.}$$

8. Readjust machine output and repeat the calibration process until the desired amount is obtained from each hopper.

#### Calibration of Aircraft Spray Equipment

$$\text{Acres covered} = \frac{\text{Length of swath in miles} \times \text{width in feet}}{8.25}$$

$$\text{Acres per minute} = \frac{2 \times \text{swath width} \times \text{mph}}{1,000}$$

$$\text{Gallons per minute} = \frac{2 \times \text{swath width} \times \text{mph} \times \text{gallons per acre}}{1,000}$$

Delivery rating of the nozzle system should be checked in the manufacturer's spray nozzle manual. Keep in mind orifice and core size, pressure, and spraying speed.

## Description of Insecticides

### Chlorinated Hydrocarbons

**Aldrin**<sup>1</sup> is available in emulsions, wettable powders, and granule formulations of from 2 to 20 percent. It is used to control soil-infesting 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. It is approved only for the control of certain soil insects in Minnesota.

**Benzene hexachloride (BHC)** See Lindane

**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.

<sup>1</sup> Restricted use pesticide, see statement on page 2.

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

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

**Chloropropylate (Acaralate)** is closely related to chlorobenzilate and is registered for mite control on fruit trees. It is available as an emulsifiable concentrate containing 2 pounds active ingredient per gallon.

**DDT**<sup>1</sup> use has been discontinued, except where control of disease vectors might be desired as determined by public health officials. Because of residue problems and legal restrictions *there are no DDT uses approved in Minnesota.*

**Dicofol (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. Dicofol is effective on cyclamen mites and other plant-feeding mites.

**Dieldrin**<sup>1</sup> 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. It has been withdrawn for most uses except seed treatment, termite and greenhouse pests.

Dieldrin is of moderately acute toxicity.

**Endosulfan (Thiodan)** is a sulfur-containing chlorinated hydrocarbon. Prepared formulations include a miscible formulation, a wettable powder, dusts, and granules. It has approval for use on potato insects. It is also effective on plant bugs present on vegetables and forage crops, and on the sugar beet webworm. Effectiveness on cyclamen mites and white flies makes it a useful greenhouse pesticide. It is of moderate toxicity to warmblooded animals.

**Endrin**<sup>1</sup> is a chemical isomer of dieldrin. It is primarily available in emulsion and granule forms. Endrin has rather high acute toxicity and must be handled carefully. Chemically it is somewhat less stable than dieldrin. *There are no approved uses for endrin in Minnesota.*

**Fenson** is a chlorinated hydrocarbon miticide which is primarily effective against eggs. It is formulated as a 50-percent wettable powder. Toxicity is very low to mammals.

**Heptachlor**<sup>1</sup> is a close chemical relative of chlordane. It is available in emulsion, wettable powder, and granule formulations. Heptachlor controls most soil-infesting insects. Dusts used are of lower concen-

tration than chlordane dusts and are comparable with aldrin. Heptachlor converts to a persistent form known as heptachlor epoxide. Because of persistent residues, uses are restricted to the control of certain soil insects in Minnesota.

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

**Lindane**<sup>1</sup> and **benzene hexachloride** are in the moderately toxic class and do not accumulate appreciably or persist in body tissues.

Lindane contains at least 99 percent of the *gamma* isomer of benzene hexachloride (BHC). 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.

**Methoxychlor** is a possible replacement for controlling some insects previously controlled with DDT. 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 cows' hair for fly control.

Methoxychlor is safer to use on cucurbits and tomatoes than many other insecticides. Except for the plum curculio, it is ineffective against Minnesota insects that were difficult to control with DDT. Methoxychlor is available in most of the common formulations.

**Mirex** is closely related to Kepone and is used in a bait for ant control. It is moderately toxic in technical form but quite safe in the bait formulation.

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

**Perthane** is a compound of low toxicity, similar to methoxychlor. Emulsions and wettable powders are used in agriculture, although approved uses are rather limited. It is sometimes used in combination with parathion for cabbageworm control. Oil solutions and preparations in aerosol bombs are useful to control

the clothes moth, carpet beetle, and other household insects.

**Strobane** is very similar to toxaphene and is formulated as emulsifiables, wettable powder, dusts and in aerosols. It is used mainly for household insects usually in combination with other products.

**TDE (DDD)**<sup>1</sup> is very similar to DDT but has not been as widely used. It is effective against leaf rollers. There are *no permitted uses for TDE in Minnesota*.

**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 certain livestock pests. It has a moderately long residual effect.

## Carbamates

**Aldicarb (Temik)** is an aliphatic carbamoyloxime with systemic activity in plants. Used as a soil treatment, it gives control for about 10 weeks. It is presently registered on cotton and sugarbeets and for use on ornamentals. It is highly toxic. Present formulation is a 10-percent granule.

**Bux** is a carbamate developed for the control of hydrocarbon-resistant corn rootworms; it is presently available as a 10-percent granular formulation and as a 2-pound per gallon emulsifiable concentrate.

**Carbaryl (Sevin)** is formulated as 50-percent and 80-percent wettable powders, a 5-percent dust, a 5-percent bait, and 5- and 10-percent granular material. A liquid concentrate flowable formulation and a molasses suspension are also available. It has been approved for use on the major fruit insects, European corn borer, corn earworm, and poultry pests. It is also effective against a number of vegetable and ornamental pests except certain aphids.

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

**Carbofuran (Furadan)** is an N-methyl carbamate that is effective in controlling corn rootworms and alfalfa weevils. It is formulated as a sandcore granule containing 10-percent active ingredient and as a flowable liquid concentrate. It has a low dermal toxicity,

<sup>1</sup> Restricted use pesticide, see statement on page 2.

even though it is quite toxic orally. Furadan appears promising for the control of a number of other insects on a variety of crops. It has systemic qualities at higher rates.

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

**Mesuroil** is a methyl carbamate formulated as a 2% bait used for the control of slugs and snails. It is registered for use in home flower gardens and commercial greenhouses. It is also being evaluated as a wettable powder for control of mites and other pests of apples and pears.

**Methomyl (Lannate, Nudrin)** is a new carbamate insecticide which is highly effective against lepidopterous larvae and aphids. It is registered for the control of cabbage loopers, corn earworms, and some potato pests. It is formulated as a 90-percent soluble powder and a 1.8-pound per gallon water soluble liquid concentrate. The dermal toxicity is moderate but the oral toxicity is high.

**Mexacarbamate (Zectran)** is effective against a wide range of pests of trees, shrubs, and ornamentals. It is not registered for any use on food crops. It is also available as a slug bait.

**Propoxur (Baygon)** is a methyl carbamate that has been used by professional pest control operators for the control of cockroaches, ants, and certain other household pests. It is quite fast-acting but also has a fairly long residual action, except on concrete.

## Organic phosphates

**Abate** is an organophosphate that is highly effective against mosquito larvae. It has a very low mammalian toxicity and presents little hazard to fish and birds. Abate is available in several granular formulations and as an emulsifiable concentrate containing 4 pounds actual toxicant per gallon.

**Azinphosmethyl (Guthion)** is a dithiophosphate with a persistent insecticidal effect. It is sold as a 2-pound per gallon emulsion, and a 50-percent wettable powder. It must be handled with considerable care during mixing and spraying as it is of high acute oral toxicity to warm-blooded animals. It has been approved for use on several fruit and vegetable pests. It is also

used on cotton and potato pests. A closely related compound, azinphosethyl, is available.

**Azodrin** is a systemic dimethyl phosphate that has been used effectively on cotton insects. It is highly toxic and is available as an emulsifiable concentrate containing 5 pounds actual toxicant per gallon. It is registered for use on potatoes.

**Bomyl** is an organic phosphate formulated in a sugar bait for the control of houseflies. It is fast acting and gives a rapid knockdown of flies.

**Carbophenothion (Trithion)** is a monochlorinated thiophosphate compound that has shown great effectiveness against aphids and most plant-feeding mites. Current recommendations are on fruit pests, onion maggot, and aphids on vegetables.

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

**Chlorfenvinphos (Compound 4072, Birlane)** is a chlorinated organophosphate (diethyl-1-(2, 4-dichlorophenyl)-2-chlorovinyl phosphate) having a broad spectrum of activity. It is recommended as a residual fly spray in barns.

**Counter** is a relative of phorate which is effective against corn rootworms and some other soil insects. An experimental label for limited use is in effect for 1973-74. It is available as 15 percent granule formulation.

**Chlorpyrifos (Dursban or Lorsban)** is a new pyridyl thiophosphate that appears to be effective against a wide range of insects including mosquitoes, turf insects, and certain household pests. Dursban is moderately toxic orally, but has low dermal toxicity.

**Crotoxyphos (Ciodrin)** is a thiophosphate with low mammalian toxicity. The compound is approved for control of biting flies on dairy cows. It is not considered to be a systemic insecticide. It persists as an effective material longer than other insecticides used for this purpose. It is slower in action than some phosphates, such as dichlorvos. For certain purposes, such as face fly control, crotoxyphos may be combined with dichlorvos.

**Crufomate (Ruelene)** has been developed as an important animal systemic of rather broad parasitocidal activity. Either external application of it to cattle

or treatment as a medicated feed can be used to control cattle grubs. A "pour on" method has been as effective as spraying with high pressure equipment. However, such an external treatment appears inadequate 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.

**Coumaphos (Co-Ral)** is an animal systemic which controls cattle grubs and lice. It is a thiophosphate with a coumarin ring structure. Wettable-powder or emulsion formulations are sprayed directly on the animals or used as "pour-on" treatments. A 1-percent dust has been approved on dairy cows for horn fly control. Coumaphos dusts are also available for use on poultry mites and lice. Fall applications are most effective for grub control.

**Cythioate (Proban)** is an organophosphate formulated in tablet form. It is an animal systemic for use by veterinarians to treat dogs for fleas, ticks and demodectic mange.

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

**Diazinon** is a phosphate showing rather broad application possibilities. This organic thiophosphate is valuable against many fruit, vegetable, and forage crop pests and widely used for housefly control. It is of moderate toxicity to warm-blooded animals. It is available in 4-pound-per-gallon emulsions, a 50-percent wettable powder, and 14-percent granules.

**Dicaphthon** is an organophosphate used primarily by pest control operators for cockroach and fly control. It is quite residual for a phosphate and is moderately toxic. It stains many types of surfaces.

**Dichlorvos (DDVP or Vapona)** is a highly active compound that gives rapid knockdown and kill of flies. It is principally available as a liquid bait formulation for housefly and specialized cockroach control. A lower concentration has been approved for face fly

control on cattle. The compound is not very stable and is shortlived except when used in a plastic strip. Dichlorvos is moderately toxic to warm-blooded animals. It is available as a combination with crotoxyphos (Ciodrin) for fly control. It is also available in a plastic strip "generator."

**Dichlofenthion (VC-13)** is a chlorinated thiophosphate with insecticidal and nematocidal properties. VC-13 has been 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.

**Dicrotophos (Bidrin)** is a vinyl phosphate with contact and systemic properties. It is approved as a foliage spray on certain cotton insects and as an injection for the control of elm bark beetles. The material is quite toxic and must be handled with care.

**Dimethoate (Cygon, De-Fend, Rebelate, Dimex 267)** is a moderately toxic organic phosphate with systemic activity in plants. It is registered for residual housefly control in dairy barns, other livestock buildings, and poultry houses. It is used for control of aphids, leafhoppers, and other sucking insects on peas, beans, potatoes, melons, and most vegetable crops. It is available as concentrates containing 2.0 and 2.67 pounds active ingredient per gallon and as a 25 percent wettable powder.

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

**Disulfoton (Di-Syston)** is a systemic organic thiophosphate insecticide. Principal recommendations include soil treatment, especially on potatoes and ornamentals. Plants are protected from sucking insects and mites for several weeks. Disulfoton is supplied in a 15-percent granular formulation and a liquid concentrate. It is highly toxic.

**Dyfonate** is an ethylphosphorodithioate that has performed well against soil insects and is presently registered for corn rootworm control. It has a relatively high oral toxicity. It is available as 10- and 20-percent granules and as a 4-pound-per-gallon emulsifiable concentrate.

**EPN** is very effective in controlling most plant-feeding mites, except the clover mite. A wettable powder containing 25 percent EPN is available. It is approved for use on European corn borer and corn rootworm adults. It is about one-eighth as toxic as parathion but still classed as highly toxic.

**Ethion** is an organic thiophosphate which controls several fruit pests. It has been used on rosy apple aphids, bud moths, several mites, onion maggots, and scale insects. Some effective uses have included combinations with dormant oils on fruit trees and woody ornamentals. Ethion is prepared as a 25 percent wettable powder, a 5-percent granular, a 4-pound-per-gallon emulsifiable concentrate. It is also prepared in combination with oil. The summer oil formulation is known as Ethion 0.67 oil. It is used during delayed dormant and early summer for mite and scale control on fruit.

Ethion has a rather long residual effect for a phosphate with no marked systemic activity. It is moderately toxic to warm-blooded animals.

**Famphur (Warbex)** is a phosphorothioate livestock systemic presently registered for cattle grub and louse control on beef cattle. It may be used in oil as a "pour-on" treatment.

**Fensulfothion (Dasanit)** is a phosphate soil insecticide and nematocide. It performs well against corn rootworms and onion maggots. It is formulated as 15 percent granules and as a spray concentrate.

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

**Imidan (Prolate)** is a new organophosphate broad spectrum insecticide. It is effective against most of the important fruit pests including mites but does not seriously affect predacious mites. It is also registered for alfalfa weevil control. It has a moderate oral toxicity but low dermal toxicity. Prolate is the name used for formulations for use on livestock.

**Malathion (Cythion)** is an organic thiophosphate chiefly available as a 5-pound per gallon emulsion concentrate, a 25-percent wettable powder, and a

4-percent dust. It is very useful on most aphid, mite, and scale problems on plants. Previously parathion would have been used routinely for these pests except for the hazard involved. Malathion is useful for small gardeners and is valuable for use in ground sprayers and dusters where more hazardous materials could not be used. It is approved as a grain protectant. The advantages include fairly rapid deterioration on crops with short waiting periods before harvest.

Some houseflies are resistant to malathion. The lasting period of effectiveness varies from about 1 to 2 weeks, depending on the mixture used and the environmental influences on the insecticide after it has been sprayed. It is of very low mammalian toxicity. It may also be applied undiluted to crops by aircraft as an ultra low volume concentrate. In this form the material lasts somewhat longer.

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

**Mevinphos (Phosdrin)** contains two vinyl phosphates that are chemical isomers. It is highly toxic. It is a strong contact toxin, but is also 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 most effective when applied as a foliage spray. Comparatively short waiting periods are required between application and harvest because mevinphos deteriorates quickly. It must be handled with care because of its high toxicity.

**Mocap** is a phosphate active as a nematocide and soil insecticide. It is currently registered for corn rootworm control in Minnesota. It is available commercially as a 10-percent granule. The toxicity is quite high both orally and dermally.

**Monitor** is a newly registered phosphate effective for the control of aphids, leafhoppers, flea beetles, and Colorado potato beetle on potatoes. It is also effective against cutworms and loopers on cabbage and other cole crops.

**Naled (Dibrom)** is a bromine, chlorine-containing organic phosphate with a rapid effect as a contact insecticide. It has moderate 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 are used for fly control in dairy barns and poultry houses.

**Orthene** is a new phosphate with systemic properties. It appears to be very promising for controlling aphids, plant bugs, and leafhoppers as well as chewing insects such as cutworms, armyworms, and loopers. It is not highly toxic to mammals.

**Oxydemetonmethyl (Meta-Systox-R)** is an organophosphate closely related to demeton but having lower mammalian toxicity. It is systemically active in plants and can be used as a foliar or soil application. It is especially effective against mites and aphids.

**Parathion** is an organic thiophosphate which is highly effective against insects and mites. It is available as a 2-pound (25-percent) or 8-pound per gallon emulsion concentrate, or as a 15- or 25-percent wettable powder. Dusts of 1 or 2 percent and 10-percent granules may also be obtained. The lasting effect against insects is generally a matter of a few days, usually shorter than with most of the chlorinated hydrocarbon insecticides. It is very hazardous to human beings, particularly during mixing and spraying operations or when the chemical has recently been applied to a crop. To minimize the hazard, most applications should be made by qualified aerial spray operators.

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

**Phorate (Thimet)** is an organic phosphate used as a soil insecticide for corn rootworm control. As a soil systemic applied on potatoes, snap beans, and lima beans it provides 6- to 8-week-long control of foliar feeding insects. It also protects potato tubers from wireworm injury. Other registrations include soil systemic use on grain sorghum, wheat, alfalfa, cotton, and topical treatments on corn for corn borer, aphid, and mite control. Thimet is available as 15 percent and 10 percent granular formulations. It is highly toxic to mammals.

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

beets; several potato insects; and certain pests of ornamentals.

**Rabon (Gardona)** is a vinyl phosphate that is very effective for control of houseflies. It is also approved for corn earworm and armyworm on corn. It has relatively low toxicity to mammals. It may be used on farms for control of houseflies resistant to other organophosphates.

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

**Supracide** is a newly registered phosphate for use on alfalfa. It is effective against alfalfa weevil and has a fairly long residual action for a foliar applied phosphate.

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

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

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

**Trichlorfon (Dipterex, Dylox, Neguvon, Proxol)** is a chlorinated water-soluble phosphate available under the name Dipterex for applications in barns for housefly control. The granular form is commonly available. This product is also effective on chlordane-resistant German cockroaches. The name Dylox is used for formulations, such as 80-percent soluble powder for some agricultural pests, particularly webworms and cutworms. This chemical is about one-half as toxic as DDT to warm-blooded animals, with no indication of accumulation or storage in tissues. Neguvon is a formulation for use as a systemic on livestock.



**Zinophos** is a highly toxic organophosphate available as a 4-pound emulsifiable concentrate. Its use is limited as a nematocide and soil insecticide. It has promise for cabbage maggot control.

**Zytron (DMPA)** is a systemic phosphate which also has herbicidal activity. It is moderately toxic to mammals. There are no recommended uses in Minnesota.

### **Botanicals, Sulfonates, Carbonates, and Miscellaneous Products**

**Aramite** is a sulfite miticide which has been used on ornamentals and non-bearing fruit trees. Formulations include emulsifiable concentrate, wettable powders, and dusts. It has low toxicity. It is being replaced, generally, by Omite, a chemically related compound.

**Bacillus thuringiensis (Thuricide, Dipel, Biotrol)** is the name of a bacterium which causes a fatal disease to the larvae of many species of moths and butterflies. The commercial formulations are bacterial insecticides which give biological control. It is useful in controlling European corn borer, cankerworms, and loopers.

**Binapacryl (Morocide)** is a new nitrophenyl miticide that shows promise against fruit and ornamental mites.

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

**Chlordimeform (Galecron, Fundal)** a formamidine, is not chemically related to any other acaricide. It is an effective miticide, especially on tree fruits, but it is also effective against lepidopterous larvae, such as cabbage looper and codling moth. It is presently approved for use on apples and cole crops in Minnesota. It is commercially available as a 95-percent soluble powder and as a 4-pound emulsifiable.

**Dinitro (DNOSBP)** is an older dinitro compound used effectively as a dormant spray, as ovicide, killing eggs of mites and scale insects on fruit trees and ornamentals.

**Omite** is a sulfite miticide which is effective against phosphate resistant mites. It is used mainly in commercial fruit production.

**Ovex (Ovotran)**, or p-chlorophenyl p-chlorobenzene sulfonate, is a mite killer which is effective

against the egg and active stages. Ovex remains effective for 2 weeks or longer under some outdoor conditions. The 50-percent wettable powder form may be used at rates of 1 to 2 pounds per 100 gallons of water. It has been tested in the greenhouse and on mites infesting fruit.

**Oxythioquinox (Morestan)** is a dithiol cyclic carbonate that is effective on resistant mites and mite eggs. It is relatively ineffective against insects. It is registered on certain fruits and ornamentals. Morestan is low in toxicity to warmblooded animals.

**Plictran** is a hydroxy tin compound which is very promising as a miticide. Not yet in general use it will probably have value in fruit production and on ornamentals. There is evidence that some predatory mites are not harmed by this material.

**Pyrethrum** is prepared from the flowers of imported chrysanthemum plants. The active ingredients, pyrethrins, are among the safest insecticides for man to use. An important attribute of pyrethrum is the rapid breakdown it permits. 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).

Some synthetic chemicals, such as *allethrin*, are very similar chemically. It is used in place of pyrethrum for a few control problems.

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

**Ryania** is the name applied to a preparation of the ground-up stems of a shrub, *Ryania speciosa*. It has some insecticidal qualities and has been used for the control of European corn borer, codling moth larvae, and some other lepidopterous larvae.

**Sabadilla** is an extract from the seeds of a plant, *Schoenocaulon spp.* It is a contact insecticide and was formerly used against the squash bug and certain other sap sucking insects.

**Tetradifon (Tedion)** is a miticide described as a chlorinated diphenyl sulfone. It is proving effective on orchard and greenhouse mites and is not harmful to beneficial insects. Tedion is sold as a 25-percent

wettable powder for spraying or using as a slurry (suspension of the highly concentrated wettable powder in water) on steampipes in greenhouses. It is one of the safest materials as far as mammalian toxicity is concerned.

**Thiocyanates (Lethane, Thanite)** are rapid knock-down materials usually combined with pyrethrins and other ingredients in sprays for the control of household and livestock pests. Some thiocyanates have also been used in mixtures for vegetable pest control.

## Insecticide Suggestions to Control Insect Pests of Field Crops in 1974

Do not use after 1974

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Aldrin, DDT, dieldrin, endrin, heptachlor, lindane, and TDE (DDD) are classified as restricted use pesticides in Minnesota. Dealers must be licensed to sell these products. Licenses are available from the Minnesota Department of Agriculture. Formulations containing these pesticides can be used only for purposes specified by the Department of Agriculture.

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To help prevent illegal residues in livestock products it is suggested that the restricted use pesticides not to be used for any purpose, except seed treatment, on dairy farms. If these pesticides are used as soil treatments on corn the crop should be harvested for **grain** only and dairy cattle or meat animals being finished for slaughter should not be allowed to graze in treated fields. Dairy men, poultry producers and feeders should also be sure that purchased hay or other feed does not contain illegal residues.

If fields have received a soil treatment with a restricted use pesticide annually for 5 or more years, at least two years without treatment should elapse before planting soybeans or alfalfa.

Illegal residues may also occur in root crops (potatoes, sugar beets, carrots, etc.) grown in fields pre-

viously treated with these chemicals.

Carbaryl (Sevin), ULV malathion and parathion are very toxic to bees. Crops in bloom should not be treated and applications should not be made near bee yards or when bees are present in the field to be treated.

Demeton (Systox), disulfoton (Di-Syston), mevinphos (Phosdrin), methyl parathion, parathion, phorate (Thimet), and phosphamidon (Dimecron) are **highly toxic** chemicals and should be used only by persons acquainted with the necessary precautions for their safe use. The granular formulations are less hazardous to the operator than are the liquids. Avoid inhalation of dusts or vapors and contact with the skin. Follow directions on the labels for the use of protective clothing and other safety measures.

## Field Crop Insects

Crop	Insect	Insecticide	Dosage	Limitations, remarks (Days before harvest)		
Alfalfa	Alfalfa weevil	azinphosmethyl (Guthion)	½ — ¾ lb.	21 days, one application per cutting		
		carbofuran (Furadan)	¼ — ½ lb.	7 days ¼ lb., 14 days ½ lb.		
		methyl parathion	¼ lb.	15 days		
		Imidan	1 lb.	7 days, one application per cutting		
		diazinon plus methoxychlor	½ lb. + 1 lb.	10 days — available as a ready-to-use mixture		
		malathion plus methoxychlor	¾ lb. + ¾ lb.	10 days — available as a ready-to-use mixture		
		Supracide	½ lb.	10 days		
		Cut first crop early to avoid most losses. Treat when over 30% of plant tips show feeding. Treat stubble if there are more than 8 larvae per sq. ft. or when regrowth has 50% of the terminals with feeding or if larvae are delaying regrowth.				
	Aphids, leafhoppers	demeton (Systox)	¼ lb.		21 days, one application per cutting	
		diazinon	½ lb.		7 days	
		dimethoate (Cygon, De-Fend, Rebelate, Dimex 267)	¼ — ½ lb.		10 days	
		malathion	1 lb.		No time limitations	
		parathion	¼ lb.		15 days	
		Control aphids when thick enough to cause wilting, usually during drought. Spotted alfalfa aphids may severely damage new seedlings.				
		Alfalfa, clover	Armyworm, cutworms	carbaryl (Sevin)	1½ lb.	No time limitations, spray or bait
malathion	1 lb. (or ULV)			No time limitations:		
trichlorfon (Dylox)	1 lb. spray or bait			7 days — 1 lb. 14 days — bait		
Leafhoppers	Treat when over 5 per sq. ft.					
	carbaryl		1 lb.		No time limitations	
	diazinon		½ lb.		7 days	
	methoxychlor		1 lb.		7 days	
	malathion		1 lb.		No time limitations	
Apply when regrowth after first cutting is 8 to 12 inches and leafhoppers are over 2 per net sweep.						
Grasshoppers	carbaryl			1 to 1½ lb.	No limitations	
	diazinon			½ lb.	7 days	
	malathion			1½ lb. or ½ lb. technical as ULV	5 days, ULV No time limitations	
	Control when there are over 8 grasshoppers per sq. yd. in the field or treat margins after cutting at more than 20 per sq. yd.					
Spittlebug	methoxychlor			1 lb.	7 days	
	Apply on first crop when spittle masses average more than one per stem.					
Plant bugs	malathion + methoxychlor		¾ lb. + ¾ lb.	7 days		
	trichlorfon		1 lb.	7 days		
	diazinon + methoxychlor		½ lb. + 1 lb.	7 days		
	Control seldom needed except on seed crop. Cut early to avoid injury.					
Alfalfa, clover (for seed only)	Plant bugs	endosulfan (Thiodan)	1 lb.	Do not harvest for forage or graze.		
		toxaphene	2 lb.	Do not treat crop in bloom.		

## Field Crop Insects (continued)

Crop	Insect	Insecticide	Dosage	<i>Limitations, remarks</i> (Days before harvest)	
Corn, field	Aphids	malathion	1 lb.	5 days	
		methyl parathion	4 oz.	12 days	
		parathion	4 oz.	12 days	
		phorate (Thimet)	1 lb.	Granules applied in the whorl just before tasselling.	
		disulfoton (Di Syston)		Granules — 40 days	
	Chemical control of cornleaf aphids is seldom economically justified. If 10% of the plants have over 500 aphids per plant prior to tasselling treatment may pay.				
	Armyworm	carbaryl (Sevin)	1½ to 2 lb.	No limitations	
		malathion	1 to 1½ lb.	5 days	
		toxaphene	2 lb.	Do not feed stalks, leaves, or husks. No limitation for grain.	
		trichlorfon	1 lb.	No limitations	
Treat when over 10% of the plants are infested. Higher rates for large worms.					
Corn	Corn rootworm larvae	Bux	1 lb.	Planting time application of granules in 7-inch band over the row. Do not place in direct contact with the seed. Band of granules should be covered lightly. Some liquid formulations are registered but are suggested for trial use only.  Cultivation time applications of materials registered for such use may be made after rootworm eggs hatch in June. Apply at base of stalks and cover with soil.  Rates given are for 40-inch row spacing or for 13,200 ft. of row.	
		carbofuran (Furadan)	¾ to 1 lb.		
		Dasanit	1 lb.		
		Dyfonate	1 lb.		
		Mocap	1 lb.		
	phorate (Thimet)	1 lb.			
	Bux will probably be more effective as a basal treatment at cultivation time than as a planting time treatment on early planted corn.				
	Treat corn following corn or following sorghum-sudan crosses.				
	Corn rootworm adults	carbaryl	1 lb.	No time limitations. ULV or dilute	
		diazinon	1 lb.	No time limitations	
malathion		1 lb.	5 days		
malathion ULV		4 to 8 oz. as technical by air	5 days		
EPN		¼ — ½ lb.	14 days		
Treat when beetles reach 10 per plant when pollen and fresh silks are present.					
Cutworms	aldrin*	2 lb.	} Apply broadcast and disk in before planting.		
	chlordane	4 lb.			
	heptachlor*	2 lb.			
	diazinon	1 to 2 lb.		Apply in 7-inch band as for rootworms at planting time.	

\* Restricted use pesticide, see statement on page 2.

## Field Crop Insects (continued)

Crop	Insect	Insecticide	Dosage	Limitations, remarks (Days before harvest)	
Corn	Cutworms, webworms	carbaryl spray or bait	1 to 2 lb.	Post emergence spray to cover approximately 12-inch band at base of plants in at least 15 gal. total spray per acre. Limitations same as for armyworm. Carbaryl bait is more effective than sprays for cutworms.	
		trichlorfon (Dylox)	1 lb.		
		toxaphene	2 lb.		
	Apply when over 10% of the plants are infested.				
	European corn borer	carbaryl	1½ lb.	Spray or granules, no time limitations.	
		carbofuran	1 lb.	Granules. No more than 2 applications.	
		diazinon	1 lb.	Granules. No time limitations.	
		Dyfonate	1 lb.	Granules. 45 days.	
		EPN	½ lb.	As spray or granules, 14 days.	
		phorate	1 lb.	As granules.	
		toxaphene	2 lb.	As granules. Use on corn for grain only.	
	Treat when 50% of whorl leaves show shot-holing for first brood.				
	Grasshoppers	carbaryl	1½ lb.	No time limitations.	
		diazinon	½ lb.	No time limitations.	
		malathion	1 lb. or ½ lb. technical as ULV	5 days	
		toxaphene	1½ lb.	For grain only, no time limitations.	
	Treat field margins early when grasshoppers are small.				
	Seed-corn maggot, seed-corn beetle, wireworms	aldrin*, dieldrin*, heptachlor*, lindane*, or diazinon	1 oz. per bu.	Seed treatment only. Will not control heavy wireworm infestations.	
		Wireworms, white grubs, webworms, Seed-corn maggots, seed-corn beetles	aldrin* chlordane heptachlor*	2 lb. 4 lb. 2 lb.	Broadcast application disked in before planting. A row treatment at half the indicated rate applied at planting time may be used.
	Seed-corn maggots, beetles, wireworm	Dasanit	1 lb.	Band in row at planting time as for rootworm.	
Dyfonate		1 lb.			
Wireworm	phorate	1 lb.	As for rootworm.		
Small grains	Aphids	malathion	1 lb.	No limitations. 15 days Treatment most economical before heading with over 100 aphids per ft. of row.	
		methyl parathion	4 oz.		
		parathion	4 oz.		
	Armyworm, cutworms	malathion	1½ lb.	7 days	
		toxaphene	2 lb.	Use for grain only.	
	Treat when number of worms exceeds 5 per sq. ft.				
	Grasshoppers	malathion	1 lb. or ½ lb. as technical by air	7 days	

\* Restricted use pesticide, see statement on page 2.

## Field Crop Insects (continued)

Crop	Insect	Insecticide	Dosage	<i>Limitations, remarks</i> (Days before harvest)
Small grains	Grasshopper	toxaphene	1½ lb.	Use for grain only. Treat when over 8 per sq. yd. in field or over 30 in margins.
	Wireworms	aldrin*, dieldrin*, heptachlor* or lindane*	1 oz. per bu.	Seed treatment only.
Barley	Thrips	parathion or methyl parathion by air	6 oz.	15 days. Apply just at heading when there are 4 or more adult thrips per plant.
Flax	Cutworms, crickets	chlordane	1 to 1½ lb.	Do not apply after blossoms appear.
		trichlorfon	1 lb.	21 days
Soybeans	Bean leaf beetle, flea beetles, blister beetles	carbaryl (Sevin)	1 lb.	No limitations.
		Treat when defoliation exceeds 25% during pod fill or seedling stage or when pod feeding is extensive.		
	Cutworms, Armyworms	carbaryl	1½ lb.	No limitations.
		toxaphene	1½ lb.	21 days. Do not feed treated plants.
	Grasshoppers	carbaryl	1½ lb.	No limitations.
		malathion	½ lb. technical as ULV by air	7 days
		toxaphene	1½ lb.	21 days. Do not feed treated plants.
		carbaryl	1 lb.	No limitations.
	Green cloverworm	malathion	1 lb.	7 days
		Treat when defoliation exceeds 25% or when worms number more than 15 per foot of row during pod fill.		
Sugar beets	Leafhoppers	malathion	1 lb.	7 days
	Webworm	carbaryl (Sevin)	1½ lb.	14 days, tops.
endosulfan (Thiodan)		1 lb.	Do not feed tops.	
parathion		4 to 8 oz.	15 days	
trichlorfon (Dylox)		1 lb.	14 days, beets 28 days, tops	
Treat when worms exceed 5 per sq. ft.				
Cutworms	carbaryl	2 lb. spray 1 to 2 lb. bait	14 days, tops. Bait formulation preferred.	
	trichlorfon	1 lb.	14 days, beets 28 days, tops	
Root maggots	aldicarb (Temik)	1½ lb.	Row treatment at seeding time. Place granules above seed in 5 to 7 inch band or as furrow treatment above seed. Some products may also be sidedressed at time of fly emergence. Check labels.	
	Dasanit	1 to 2 lb.		
	diazinon	2 lb.		
	disulfoton (Di-Syston)	1 lb.		
	Dyfonate	1 lb.		
	phorate (Thimet)	1 lb.		
Wireworms	lindane*	1 oz. per bu.	Seed treatment only.	
Potatoes	Aphids, flea beetles, leafhoppers	disulfoton (Di-Syston)	2 to 3 lbs.	Row treatment in fertilizer bands at planting time. 75 days. Higher rate for heavy soils.
		phorate (Thimet)	2 to 3 lbs.	Row treatment in fertilizer bands at planting time only. Higher rate for heavy soils.

\* Restricted use pesticide, see statement on page 2.

### Field Crop Insects (continued)

Crop	Insect	Insecticide	Dosage	Limitations, remarks (Days before harvest)
Potatoes	Aphids	methomyl (Lannate, Nudrin)	0.9 lb.	14 days
		Monitor	¾-1 lb.	14 days
	Cutworms	carbaryl (Sevin)	2 lb.	No limitations
		Colorado potato beetle	azinphosmethyl (Guthion)	½ lb.
	Fleabeetles	Azodrin	¼ to ½ lb.	7 days
		carbaryl	1 lb.	No limitations
		diazinon	¼ to ½ lb.	35 days
		endosulfan	½ to 1 lb.	No limitations
		Monitor	¾ lb.	14 days
		azinphosmethyl	½ lb.	7 days
		Azodrin	½ lb.	7 days
		carbaryl	1 lb.	No limitations
		diazinon	¼ to ½ lb.	35 days
		endosulfan	½ to 1 lb.	No limitations
	Leafhoppers	Monitor	¾ lb.	14 days
		phosphamidon	¼ lb.	7 days
		Azodrin	¼ to ½ lb.	7 days
		carbaryl	1 lb.	No limitations.
		demeton	½ lb.	21 days
		diazinon	½ lb.	35 days
		dimethoate	½ lb.	No limitations
		endosulfan	½ to 1 lb.	No limitations
		malathion	¾ lb.	No limitations
		methomyl	0.9 lb.	14 days
	Wireworms	Monitor	¾ lb.	14 days
		oxydemetonmethyl	½ lb.	7 days
	White grubs, cutworms	chlordane	4 lb.	Broadcast before planting. Disk in.
Dyfonate		4 lb.	Broadcast before planting. Disk in.	
Sorghum	Greenbugs	phorate	2 to 3 lb.	Band treatment at planting.
		chlordane	4 lb.	Broadcast before planting.
Sorghum	Greenbugs	ethyl parathion	½ lb.	12 days, aerial application. Methyl para- thion may cause plant injury.
		dimethoate	¼ to ½ lb.	28 days
		disulfoton	½ to 1 lb.	7 days (grain)
		malathion	1 lb.	7 days
		phorate	½ to 1 lb.	28 days
Sunflowers	Sunflower moth larvae	endosulfan (Thiodan)	1 lb.	Not more than 3 applications. Do not feed treated plants. No limitations on use of seeds.
		methyl parathion	1 lb.	No more than 3 applications. 5 day inter- vals 30 days before harvest.

° Restricted use pesticide, see statement on page 2.

## Field Crop Insects (continued)

Crop	Insect	Insecticide	Dosage	Limitations, remarks (Days before harvest)	
Sweetclover	Sweetclover weevil	carbaryl	1½ lb.	} For plowdown. Treat seedlings when defoliation reaches 50%.	
		diazinon	1 lb.		
		malathion	1 lb.		
Mustard, rape seed	Flea beetles	carbaryl (Sevin)	1 to 1½ lb.	14 days	
	Diamond back moth larvae	carbaryl	1 to 1½ lb.	14 days	
		malathion	1½ lb.	7 days	
Wild rice (in paddies)	Wild rice worm	malathion	1 to 1½ lb.	14 days after eggs appear in florets. Additional applications as needed. 7 days.	
		carbaryl	1½ lb.		
Bluegrass (for seed)	Plant bugs (Capsus)	diazinon	½ lb.	No limitations	
		malathion	¾ lb.	No limitations	
		Treat as heads emerge when Capsus bugs are detected or at first sign of silver top.			
Bluegrass, Timothy (for seed)	Meadow plant bug	malathion	¾ lb.	No limitations	
		Treat at early heading stage when there is an average of two bugs per net sweep.			
	Armyworm	carbaryl	1½ lb.	No limitations	
		malathion	1 lb.	No limitations	
		Treat when there are 5 worms per sq. ft.			
Corn, sweet	Earworm	carbaryl	1½ lb.	No limitations before harvest. Highly toxic to bees. Do not apply as dust to pollinating corn. Avoid treating while bees are in the field.	
		diazinon	1½ lb.	2 days	
		endosulfan (Thiodan)	1½ lb.	Not on corn for processing. Not more than 5 applications. Do not feed treated forage.	
		Gardona	1 lb.	5 days, forage	
		methomyl (Lannate, Nudrin)	¼ to ½ lb.	3 days, forage. May cause injury to some varieties.	
	Corn rootworm larvae	Bux	}		See under field corn
		Dasanit			
Dyfonate					
Mocap phorate					
Corn rootworm adults	carbaryl	1 lb.	No time limitations, see bee precautions under earworm.		
	diazinon	½ - 1 lb.	2 days		
	malathion	1 lb. or 4 oz. technical as ULV	5 days		
	EPN	¼ lb.	14 days		
	Gardona	1 lb.	5 days for forage		
Cutworms, armyworms	carbaryl	1½ to 2 lb.	No limitations. Bait is generally more effective than spray for cutworms.		
	toxaphene	2 lb.	Do not feed or ensile treated plants.		
	trichlorfon	1 lb.	28 days		
European corn borer		carbaryl	1 to 2 lb.	No time limitations; see bee precautions under earworm.	

\* Restricted use pesticide, see statement on page 2.



## Field Crop Insects (continued)

Crop	Insect	Insecticide	Dosage	Limitations, remarks (Days before harvest)	
Corn, sweet	European corn borer	diazinon	1 to 2 lb.	10 days for forage	
		Dyfonate	1 lb.	45 days	
		EPN	¼ lb. granular ¼ lb. spray	14 days	
	Wireworms	Gardona	1 lb.	5 days, forage	
		aldrin*, dieldrin*, heptachlor*, lin- dane*, diazinon	1 oz. per bu.	Seed treatment only.	
		diazinon Dyfonate phorate	1 to 2 lb. 1 lb. 1 lb.	} Band on the row at planting.	
Peas	Aphids	demeton (Systox)	¼ lb.		21 days
		diazinon	½ lb.		1 day feeding of vines, 4 days hay.
		dimethoate (Cygon, De-Fend, Rebe- late, Dimex 267)	3 oz.	Do not feed or graze vines if mobile viner is used. 21 days if stationary viner is used.	
		disulfoton	1 lb.	As granules broadcast at planting. 50 days	
	Loopers	malathion	1 lb.	3 days. 7 days for forage.	
		mevinphos (Phosdrin)	0.2 lb.	1 day	
		naled (Dibrom)	1 to 2 lb.	4 days	
		parathion	¼ lb.	10 days	
		carbaryl	1½ to 2 lbs.	No time limitations.	
		methomyl	½ to 1 lb.	1 day	
Beans, dry, edible	Aphids	parathion	½ lb.	15 days	
		mevinphos	4 oz.	1 day	
		diazinon	½ lb.	7 days. No more than one application.	
	Bean Leaf Beetle	disulfoton	1 to 2 lb.	Soil treatment banded on the row. Do not place with seed.	
		dimethoate	½ lb.	NTL. Do not feed forage.	
		endosulfan	¾ lb.	No more than 3 applications. Do not treat Lima beans. Do not feed forage.	
		malathion	1 lb.	1 day	
		phorate	2 lb.	Soil treatment banded on row at plant- ing. Do not place with seed. 60 days, forage.	
		Green Clover- worm	carbaryl	1 lb.	NTL
	Leafhoppers	methoxychlor	1 lb.	1 day	
		carbaryl	1 lb.	NTL	
		malathion	1 lb.	1 day	
carbaryl		1 lb.	NTL		
dimethoate		¼ lb.	Do not feed forage.		
disulfoton		See Aphids			
Seed corn maggot, wireworm	endosulfan	See Aphids			
	malathion	1 lb.	1 day		
	methoxychlor	1 lb.	1 day		
	phorate	See Aphids			
	diazinon	1 to 2 oz. per bu. as seed treatment.			

\* Restricted use pesticide, see page 2.

## Household Insects

Insect	Insecticide	Dosage	Remarks
Ants (indoors). (See also under pests of trees, shrubs, turf.)	propoxur (Baygon)	1.1% solution	} Apply to runways. Do not contaminate food or utensils. Diazinon at 1% to be applied by PCO** only
	chlordane	2% to 5% solution or emulsion	
	diazinon	0.5% solution or emulsion	
	malathion (premium grade)	3% solution or emulsion	
	ronnel (Korlan)	1% emulsion	
Note: A treatment with chlordane on the outside walls and foundation, as described under boxelder bugs, may help keep ants from entering the house.			
Bedbugs	chlordane	2% to 3% solution or emulsion	} Apply to springs and frames of beds and to cracks and crevices around doors, window casings, baseboards, etc.
	malathion (premium grade)	1% to 3% spray	
	pyrethrins	0.2% spray	
	ronnel	1% spray	
Boxelder bugs	carbaryl (Sevin)	¾ lb. 80% W.P. per 50 gal. water	} Spray infested boxelder trees during late summer when bugs are small.
	chlordane	2 pt. 45% E. C. per 50 gal. water	
	endosulfan (Thiodan)	¾ lb. 50% W.P. per 50 gal. water	
		diazinon	1% emulsion
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. See Entomology Fact Sheet No. 10 for further details.			
Carpenter ants	chlordane	2% to 3% solution or emulsion	Paint or spray infested wood and runways.
	dichlorvos (Vapona)	0.5% emulsion	Apply near nests in enclosed places such as in walls.
Carpet beetles	chlordane	2% to 3% solution or emulsion	} 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. Diazinon at 1% to be applied by PCO** only.
	diazinon	0.5% solution or emulsion	
	malathion (premium grade)	3% solution or emulsion	
Clothes moths	chlordane	2% to 3% solution or emulsion	} Apply lightly to clothing.
	malathion (premium grade)	3% solution or emulsion	
		naphthalene or PDB (paradichlorobenzene) flakes, crystals	} Apply uniformly throughout clothing as it is packed for storage in tight chests or boxes.

\*\* PCO = pest control operator.

## Household Insects (continued)

Insect	Insecticide	Dosage	Remarks
<b>Clover mites</b>  propoxur (Baygon) dicofol (Kelthane) malathion	(For use <i>outside</i> the home to prevent mites from entering)	1.1% spray 0.06% spray 0.25% spray	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.
Note: An 18- to 24-inch sod-free band immediately next to the house will help reduce the clover mite problem. Wipe up mites inside the home with an oily dustcloth or a vacuum cleaner. Also see Entomology Fact Sheet No. 15.			
<b>Cockroaches</b> (roaches, "water bugs")	chlordane diazinon Dursban  Kepone bait malathion (premium grade) propoxur (Baygon)  ronnel (Korlan)	2% or 3% solution or spray, 5% or 6% dust 0.5% solution or spray 0.25 to 0.5% solution or spray as labeled 2% or 3% solution or spray 1% coarse aerosol or 2% bait 1% to 2% spray	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 at 1%, Dursban, and Baygon to be applied by PCO** only.
<b>Crickets</b>	carbaryl chlordane  diazinon malathion (premium grade)	2% to 5% bait 2% to 3% spray or 5% to 6% dust 0.5% spray 2% to 3% spray	Along outside foundation walls.  Apply as "spot treatment" to corners, baseboards, under cabinets, in closets, etc. Diazinon at 1% to be applied by PCO** only.
Note: A treatment with chlordane on the outside walls and foundation, as described under boxelder bugs, will help prevent crickets from entering the house.			
<b>Fleas Dogs</b>	Cythioate	30 mg./20 lb.	Treatment to be made under veterinarian's care only. Also will give tick control.
<b>Fleas Cats dogs</b>	carbaryl (Sevin) dichlorvos (Vapona)  malathion (premium grade) methoxychlor rotenone	5% dust 9.3% collar on dogs 4.6% collar on cats 4% dust 1% dust 1% dust	Some cats may show a skin sensitivity to the collar. Do not make the collar too tight on the animal.
<b>Fleas Infested kennels, beds, or other areas</b>	propoxur (Baygon) carbaryl diazinon malathion (premium grade)  methoxychlor plus pyrethrins ronnel (Korlan)	1.1% spray 5% dust 0.5% spray 2% or 3% spray  ready-to-use household sprays 1% spray	1.1% propoxur (Baygon) to be applied by PCO** only. 1% Diazinon to be applied by PCO** only.

\*\* PCO = pest control operator.

## Household Insects (continued)

Insect	Insecticide	Dosage	Remarks	
Houseflies (indoors)	pyrethrins plus synergist or dichlorvos	Space sprays or aerosol "bombs"	<p>Apply to resting places of flies—around windows, doors, frames, under eaves, etc., or as a window screen paint.</p> <p>Do not use in or on homes.</p>	
	dichlorvos	slow-release resin strips		
	Residual treatment of outbuildings or outside of the home	diazinon		1% spray or bait
		naled (Dibrom)		0.4% bait
		dimethoate (Cygon, De-Fend)		1% spray
		trichlorfon (Dipterex)		1% bait
		dichlorvos		½% to 1% bait
		malathion		1% spray or bait
		ronnel (Korlan)		½% to 1% spray or 1% bait
		chlorfenvinphos (Compound 4072)		0.5% spray
	Rabon (Gardona)	1.0% spray		
Mosquitoes (indoors)	pyrethrins plus synergist, or dichlorvos	Space sprays or in aerosol "bombs." Some aerosols may also contain methoxychlor. Resin strips containing dichlorvos may also be hung indoors. They provide a slow release of insecticide.		
Mosquitoes (outdoors)	<i>For use in a hydraulic sprayer</i>			
	fenthion (Baytex)	46% E.C. — 4 oz./gal water or 3 gal. per 100 gal. water	Apply to mosquito resting places such as shrubbery, hedges, and under eaves. May also be painted on screens.	
	methoxychlor	50% W.P. — 8 tbsp. per gal. water or 8 lbs. per 100 gal. water		
		25% E.C. — 4 tbsp. per gal water or 2 gal. per 100 gal. water	Apply about 50 gallons of these mixtures per acre or 5 gallons per 4,000 square feet. Fenthion (Baytex) is very toxic to birds.	
	malathion	57% E.C. — 2 tsp. per gal. water or 2 pints per 100 gal. water		
	carbaryl (Sevin)	50% W.P. — 4 tbsp. per gal. water or 2 lbs. per 100 gal. water	Do not allow spray to contaminate food or feed crops or pastures.	
		80% W.P. — 1½ tbsp. per gal. water or 1½ lbs. per 100 gal. water	Do not use carbaryl when honeybees are known to be active in the area.	
	naled (Dibrom)	60% E.C. — ½ tsp. per gal. water or 1 pint per 100 gal. water	Some plants may be harmed by overspraying or by large droplets.	
<p>Note: A combination of methoxychlor and malathion (both used at their regular rates) makes a good mosquito spray: Malathion gives a quick kill while methoxychlor provides longer lasting residual control.</p>				

\*\* PCO = pest control operator.

## Household Insects (continued)

Insect	Insecticide	Dosage	Remarks
<i>For use in a mist blower</i>			
	dichlorvos (Vapona)	23% E.C. — 4 gal. per 100 gal. water	Apply to mosquito resting places such as shrubbery, hedges, and under eaves.  Apply 5-10 gal. of these mixtures per acre or ½-1 gal. per 4,000 sq. ft.  Do not allow spray to contaminate food or feed crops or pastures.  Do not use carbaryl when honeybees are known to be active in the area.  Fenthion (Baytex) is very toxic to birds.
	fenthion (Baytex)	46% E.C. — 4.5 gal. per 100 gal. water	
	methoxychlor	25% E.C. — 10 gal. per 100 gal. water	
	malathion	57% E.C. — 2 gal per 100 gal. water	
	carbaryl	80% W.P. — 10 lbs. per 100 gal. water	
	naled (Dibrom)	60% E.C. — ½ gal. per 100 gal. water	
<i>For use in a fogger</i>			
	malathion	57% E.C. — 1 gal. per 25 gal. fuel oil	Apply to mosquito resting places such as shrubbery, hedges, and under eaves.  Apply 5-10 pints of these mixtures per acre if E.C. is used and 2-5 pints per acre if technical material is used.  Do not allow insecticide to contaminate food or feed crops or pastures.  If the fog is directed too close to plants for too long a time or if the fogger is not operating properly, some plants may be burned.  Dibrom is corrosive to fogging equipment.  If a <i>thermal</i> fogger is used, the insecticide must be mixed with No. 1 fuel oil or diesel oil. Water may be used in a <i>nonthermal</i> fogger, but an E.C. must then be used as the insecticide. Fuel oil is the preferred carrier for both types of foggers.
		technical (95%) — ½ gal. per 25 gal. fuel oil	
	dichlorvos (Vapona)	23% E.C. — 1 gal. per 25 gal. fuel oil	
	naled (Dibrom)	14 lb. concentrate — 1½ pints per 25 gal. fuel oil	
	Pyrethrins	0.15% to 0.25% plus synergists	
<p>Note: Mosquito control in towns and cities should be an organized program based on treatment of breeding areas and must be approved by the Minnesota Department of Agriculture. For more detailed information on mosquito control, especially for community wide control, aerial application, larval control, and other insecticides, consult the Minnesota Department of Agriculture or the University of Minnesota bulletin entitled "Mosquito Control."</p>			
Powder-post beetles	chlordane	2% oil solution	} Paint, spray, or dip to saturate wood.
	pentachlorophenol	4% to 5% solution	
Silverfish, firebrats	propoxur (Baygon)	1% solution	} Apply to infested areas, corners in closets, behind radiators, around pipes. Diazinon at 1% and Baygon to be applied by PCO** only.
	chlordane	2% to 3% solution, 5% to 6% dust	
	diazinon	1% spray	
	malathion (premium grade)	3% spray	
	ronnel (Korlan)	1% spray	
Stored-food pests (flour beetles, meal moths, larder beetles, etc.)	chlordane	2% solution	} Find and destroy or refrigerate 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. Store at low temperatures. Clean storage area thoroughly. See Entomology Fact Sheet 13, "Pantry Pests."
	diazinon	0.5% solution	
	malathion (premium grade)	2% solution	

## Household Insects (continued)

Insect	Insecticide	Dosage	Remarks
<p><b>Termites</b></p> <p style="text-align: center;">Termite infestations usually require the services of an experienced pest-control operator. Consult Entomology Fact Sheet 6, "Are They Really Termites?"</p>			
Ticks (brown dog tick, indoors)	propoxur (Baygon)	1.1% spray	For PCO** use only.
	carbaryl	1% spray	
	chlordane	1% spray, 5% dust	Treat cracks and crevices so ticks contact insecticide.
(American dog tick, outdoors)	chlordane	1% spray	} Apply thoroughly to roadsides, footpaths, and vegetation surrounding campsites and picnic areas.
	Gardona	½% spray	
	toxaphene	1% spray, 5% dust	
(both species, on dogs)	carbaryl	5% dust	} Rub dusts thoroughly into fur; apply sprays so coverage of animal is complete.
	coumaphos (Co-Ral)	½% dust, 1% pressurized spray	
	Pyrethrins plus synergist	1.0 % spray	
	rotenone	4-5 % dust	
	trichlorfon	1% dust	
Millipedes	carbaryl (Sevin)	1 lb. 80% or 1½ lb. 50% W. P. per 10 gal. water as a barrier spray on outside foundation walls.	
Nuisance bees and wasps	chlordane	3% spray	} Treat nests in walls.
	dichlorvos (Vapona)	spray or aerosol	
	carbaryl	2.25% spray	For ground-nesting species.

\*\* PCO = pest control operator.

## Livestock and Poultry Pests Do Not Use This Table After 1974

Pest	Host	Insecticide	Dosage	Limitations		
Cattle Grubs	Beef cattle	coumaphos (Co-Ral)	0.5% spray	None		
			4% pour-on			
			6.2% pour-on in water			
		crufomate (Ruelene)	13.4% pour-on in oil		} 1 oz. 6.2% pour-on per 100 lb. not to exceed 8 oz. per animal or ½ oz. 13.4% per 100 lb. not to exceed 5 oz. per animal.	
			0.375% spray			} Do not repeat application within 28 days nor apply within 7 days before market.
			famphur (Warbex)			
	0.199% feed pre-mix	Not after Nov. 1st.				
		1 oz. per 200 lb. body weight (do not exceed 4 oz.) Do not repeat treatment. 35 days before slaughter. Not after Nov. 1.				
		4 oz. per 100 lb. daily for 10 days. 4 days before slaughter.				

### Livestock and Poultry Pests (continued)

Pest	Host	Insecticide	Dosage	Limitations	
		fenthion (Tiguvon)	0.255% spray 3.0% pour-on	1 application per season. Do not use within 45 days of slaughter. ½ fluid oz. per 100 lb. of body weight. 35 days between treatments. 35 days before slaughter.	
		Imidan (Prolate)	4.0% pour-on 0.25% spray	1 fluid oz. per 100 lb. of body weight, but not over 8 fluid oz. per animal. 21 days before slaughter. Apply with high pressure until run-off. 21 days before slaughter.	
		ronnel	0.002 lb./100 lb. body weight/day 0.26% in feed 5.5% in mineral block	Feed for 7 consecutive days. Do not treat after Oct. 31. Use as only source of ronnel medication. Not within 10 days of slaughter. 0.3 lb. per 100 lb. for 14 days. Not within 10 days of slaughter. For 75 days.	
Cattle Lice	Dairy cattle	crotoxyphos-dichlorvos (Ciodrin-Vapona, Ciovap)	0.25% spray	Do not apply oftener than once every 7 days.	
		crotoxyphos (Ciodrin)	0.25% spray 3.0% dust	Every 14 days.	
		synergized pyrethrins	0.05% - 0.1%	No time limitations.	
	Beef cattle	coumaphos (Co-Ral)	0.25% spray or dip		
		crotoxyphos (Ciodrin)	0.25% spray or 3% dust		
		crotoxyphos-dichlorvos (Ciovap)	0.25% spray		
		crufomate (Ruelene)	5.0% pour-on in water 0.375% spray 13.4% pour-on in oil	} 7 days before slaughter.	
		dioxathion (Delnav)	0.15% pour-on		Not oftener than 2 weeks.
		fenthion (Tiguvon)	1% in oil		On backrubber.
		malathion	0.5% dip or spray	7 days.	
		methoxychlor	0.5% dip or spray 10% dust	No time limitations.	
		ronnel (Korlan)	0.25% spray or dip 1.0% in oil 5.0% pour-on in water	1 fluid oz. per 100 lb. up to 8 oz. per animal.	
		famphur (Warbex)	3.0% pour-on in water	½ fluid oz. per 100 lb. up to 4 oz. per animal. 35 days between treatments.	
toxaphene	0.5% spray dip	28 days.			

### Livestock and Poultry Pests (continued)

Pest	Host	Insecticide	Dosage	Limitation		
Face Flies	Dairy cattle	coumaphos (Co-Ral)	1% in oil	For face rubber (1 gal. per 20 ft. cable).		
		crotoxyphos (Ciodrin)	1% oil solution			
		crotoxyphos dichlorvos (Ciovap)	1¼% oil solution	} Apply as mist spray daily at not over 2 oz. per head.		
		dichlorvos	1% oil solution			
		pyrethrins+synergist	0.075% oil solution			
				dichlorvos	0.5% baited spray (1 tsp. to forehead). Once per day, morning preferable.	
				ronnel	1% oil solution	On backrubber to permit face treatment.
	Beef cattle	Same as for dairy				
		or Ciodrin	2% oil solution	} On backrubber to permit face treatment.		
		or toxaphene	5% oil solution			
Flies (horn, stable, horse) and mosquitoes	Dairy cattle	Only limited control of horse, deer, and stable flies will be achieved using the following treatments.				
		dichlorvos	1% oil spray	Not over 2 oz. per animal daily as a mist.		
		crotoxyphos (Ciodrin) (or combination of above, Ciovap)	1% oil spray	Not over 1½ oz. per animal daily as a mist.		
		coumaphos (Co-Ral)	1% on backrubbers 1% dust or as a dust bag			
		malathion	4-5% dust	At least 5 hrs. before milking.		
		methoxychlor	50% W.P. as dust (1 tbsp.)	Apply after milking not oftener than every 3 weeks.		
		synergized pyrethrins (may also contain repellents).	0.05% to 0.1%	Not over 2 oz. per animal daily as a mist.		
Flies (horn, stable, horse) and mosquitos	Beef cattle	coumaphos (Co-Ral)	0.25% spray 1% on backrubber 1% dust or as a dust bag			
		crotoxyphos (Ciodrin)	1% spray 1% oil on backrubber 3.0% dust in dust bag			
		crufomate (Ruelene)	13.4% pour-on solution in oil 0.375% spray 6.2% emulsion as pour-on	7 days before slaughter; horn flies only.		



## Livestock and Poultry Pests (continued)

Pest	Host	Insecticide	Dosage	Limitations
House Flies	Milkhouse or food processing Barns and animal housing areas	dioxathion (Delnav)	0.15% spray or dip	Not oftener than 2 weeks.
			1.5% in oil on backrubber	
		fenthion (Tiguvon)	1% in oil on backrubber	
		malathion	0.5% spray 2% in oil on backrubber. 0.6 lb. ULV† by air.	
		methoxychlor	0.5% spray, 5 or 6% in oil on backrubber.	
		ronnel (Korlan)	0.5% spray	7 days before slaughter.
			1% in oil on backrubber	
		toxaphene	0.5% spray	28 days.
			5.0% in oil on backrubber	
		trichlorfon (Neguvon)	1% spray	14 days before slaughter.
		pyrethrins dichlorvos (Vapona)	0.1% plus synergist Plastic strips	Space spray. One per 1000 cu. ft.
		pyrethrins	0.1% + synergist	} Space spray with fogger, aerosol or mist.
		dichlorvos	1.0%	
naled	0.3%			
naled	0.5% bait			
dichlorvos	0.5% bait	} Remove animals from buildings prior to spraying. Hang securely so animals cannot contact bands.		
dimethoate (Cygon, De-Fend)	1.0% residual spray			
Dimetilan (Snip)	Fly bands	Although not always required on the label, it is a good idea to remove animals from the building prior to treatment with residuals.		
malathion‡	1% residual spray 1 to 2% bait			
ronnel (Korlan)	0.5% to 1.0% residual spray			
Rabon (Gardona)	1.0% residual spray			
Rabon (Gardona) + dichlorvos	1.0% + .25% residual spray			
trichlorfon (Dipterex)	1.0% bait			
fenthion (Baytex)	1.0% residual spray			
Poultry Mites, Lice	Chickens,** Turkeys	coumaphos (Co-Ral)	½% dust 0.25% spray (1 gal. per 100 birds)	} No time limitations. 7 days. Do not repeat within 4 weeks.
		malathion	0.5% spray 4-5% dust	
		carbaryl (Sevin)	5% dust (1 lb. per 100 birds) 0.5% water mist spray (1 gal. per 100 birds)	

† ULV = ultra low volume.

‡ If flies are not easily killed, resistance may be involved; newer materials with residual effect are dimethoate, ronnel, chlorfenvinphos, and Rabon.

\*\* Malathion and coumaphos have a residue tolerance of 0.1 ppm in eggs; carbaryl has a zero tolerance.

### Livestock and Poultry Pests (continued)

Pest	Host	Insecticide	Dosage	Limitations
Sheep Keds	Sheep	coumaphos (Co-Ral)	0.25% spray ½% dust	15 days. 15 days.
		dioxathion (Delnav)	0.15% spray or dip	Not oftener than 2 weeks.
		diazinon	0.03-0.06% spray or 2% dust	14 days. 14 days.
		malathion	0.05% spray	No time limitations.
		methoxychlor	0.5% spray	
		ronnel (Korlan)	0.25% dip or spray	28 days. No more frequently than every 2 weeks.
Wool maggots	Sheep	diazinon	0.3% spray or dip	Do not dip or spray animals less than 2 weeks old.
		coumaphos (Co-Ral)	0.125% spray or dip or dip	Do not treat lambs under 3 months old. Do not treat in conjunction with oral drenches or other medication.
		ronnel (Korlan)	0.5% spray or dip	Hand apply with brush as wash on and around infested areas.
Scab Mites	Sheep			Scabies in sheep, is reportable to the State Sanitary Livestock Board. Thus any suspicious skin involvement should be checked by a veterinarian and handled according to his judgment.
Mange Mites (Sarcoptic) and Lice	Swine	lindane*	0.06% as spray or dip 1.0% dust	Do not treat before animals are 3 months old or sows within 40 days of farrowing; must be 30 days before slaughter, dips 60 days. If growth rates approach 200 lb. in 150 days, another chemical should be used.
			0.2% in oil on backrubber	
		malathion	0.6% spray or dip 0.5% on rubbing devices 4 to 5% dust	No time limitations.
		toxaphene	0.6% spray or dip 5% dust 5.0% on rubbing devices	Do not treat before animals are 3 months old. 28 days.
Lice only	Swine	coumaphos (Co-Ral)	0.25% spray	
		crotoxyphos (Ciodrin)	0.25% spray	No oftener than once a week.
		crotoxyphos-dichlorvos (Ciovap)	0.25% spray	
		dioxathion (Delnav)	0.15% dip or spray	No oftener than once in every 2 weeks.
		methoxychlor	0.5% dip or spray	No time limitations.
		ronnel (Korlan)	0.25% spray or dip	No oftener than once in 2 weeks.

\* (See footnote on page 2.)

## 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. For special problems, follow recommendations given below.
Ants	Lawn	chlordane	5% to 10% dust or granular 50% W. P., 3 tbsp. per gal. water 45% E. C., 5 tsp. per gal. water	¼ lb. per 100 sq. ft.  Apply as spray to 100 sq. ft.  Apply as spray to 100 sq. ft.
		diazinon	4 fl. oz. 4 lb. E. C. per 3 gal. water	Spot treat nests.
				Note: Liquid sprays may be used as a drench on individual ant nests. Water broadcast treatments thoroughly. Keep children and pets off until dry.
Aphids	Trees, shrubs	malathion	2 pt. 50% E. C. per 100 gal., or 2 tsp. per gal. water	Apply thoroughly to all foliage
		dimethoate (Cygon, De-Fend) Meta Systox R	1½ pt. 2.67 lb. E. C. per 100 gal. 1½ tsp. per gal. 1½ pt. per 100 gal.	May be toxic to some plants; check restrictions on label.
				Note: Some aphids, such as elm cockscomb gall, elm leaf, woolly apple, woolly elm, and woolly elm bark, may be controlled with dormant sprays described under scale insects.
Borers	Borers usually attack trees which are low in vigor, damaged, or suffering from drought, lack of nutrients, or winter injury. To prevent borer attack, trees should be well watered and fertilized, if needed; prune out dead or dying branches and properly dress all wounds. Cut and destroy dead trees.			
Caterpillars and sawflies	Various trees and shrubs	Most leaf-chewing caterpillars and sawfly larvae may be controlled by spraying the foliage with 2 lb. 50% methoxychlor per 100 gal. of water (2 tbsp. per gal.), or with carbaryl (1½ lb. of 80% W.P. or Sevimol 4) as directed on the label. <i>Bacillus thuringiensis</i> (DiPel, Thuricide, Biotrol) will also control some of the defoliating caterpillars, especially cankerworms. 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.		
		<b>Time to control</b>		
Cankerworms, spring and fall	Elm, apple, oak, maples, boxelder, and other trees	Apply at first sign of injury, usually early in May.		
Eastern tent caterpillars	Wild cherry, apple, mountain ash, other	Early to mid-May, when tents first appear		
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		
Red-humped, yellow-necked, variable oak leaf caterpillars	Oak, maple	August, September		
Walnut caterpillar	Walnut	July to September		

### Tree, Shrub, and Lawn Insects (continued)

Pest	Where found	Insecticide	Dosage	Remarks
Spiny elm caterpillars	Elm		Late May, early June	
Brown-headed ash sawflies	Ash		Late May, early June	
Red-headed pine sawflies	Jack pine		Late June, early July	
Jack-pine sawflies	Jack pine		Late May, early June	
Introduced pine sawflies	White pine		Early feeding in June, again in August	
Spruce budworms	Fir, spruce		As buds break and again 10 days later	
Galls	Most deciduous trees, especially oak, hackberry, maple, linden, elm	Chemical control of the insects or mites that cause galls usually is not satisfactory. Most galls do not seem to cause much injury. Pruning out and destroying infested twigs or leaves sometimes reduces the problem.		
Elm bark beetles	Elm	methoxychlor	25% E.C.; 40 gal. per 100 gal. total spray (mist blowers) 8 gal. per 100 gal. (hydraulic sprayers)	See Ext. Folder 211, "The Dutch Elm Disease." Cover all bark surfaces thoroughly as spring dormant spray. Cut and destroy dead elms.
Leaf beetles	Many deciduous trees, especially willow, elm, cottonwood, aspen	methoxychlor or carbaryl (Sevin)	2 lb. 50% W. P. per 100 gal. or 2 tbsp. per gal. water	Apply when adult beetles appear; repeat when larvae appear.
Leafhoppers	Many trees and shrubs, especially caragana	carbaryl	2 lb. 50% W. P. per 100 gal. or 2 tbsp. per gal. water	} Foliage spray  Commercial operators only. Work into soil under tree canopy early in spring.
		methoxychlor	2 to 4 lb. 50% W. P. per 100 gal. or 2 to 4 tbsp. per gal. water	
Leafminers	Birch	diazinon	½ oz. 50% W.P. per gal.	} Foliage spray  Commercial operators only. Work into soil under tree canopy early in spring.
		oxydemetonmethyl (Meta-Systox-R)	1½ tsp. 25% E.C. 2.5 oz. 15 G	
		disulfoton	3 oz. 10% G. per in. trunk diameter	
Mites ("red spider," spider mites)	Many trees and shrubs, especially evergreens and ornamentals	chlorobenzilate or chloropropylate	1 qt. 25% E. C. per 100 gal. or 2 tsp. per gal. water	} Foliage spray  Commercial operators only. Work into soil under tree canopy early in spring.
		dicofol (Kelthane)	2 lb. 18½% W. P. per 100 gal. or 2 tbsp. per gal. water	
		ovex	1½ lb. 50% W. P. per 100 gal. or 2 tbsp. per gal. water	
		tetradifon (Tedion)	1½ lb. 25% W. P. per 100 gal.	
		malathion	2 pt. 57% E.C. per 100 gal. or 2 tsp. per gal. water	
		Plictran	4 to 6 oz. 50% W.P. per 100 gal.	Usually requires two or three treatments at 7- to 10-day intervals.  May injure tender new growth of some plant species.

## Tree, Shrub, and Lawn Insects (continued)

Pest	Where found	Insecticide	Dosage	Remarks
Night crawlers, earthworms	Lawn, turf	chlordan		Will help reduce numbers of night crawlers when used as recommended for white grubs.
Scale insects				
Dormant spray:				
Oystershell European elm Scurfy Cottony maple European fruit lecanium		dormant oils or dormant oil plus ethion or diazinon	2 to 3 gal. per 100 gal. water as labeled	Apply in fall after all growth has stopped or in spring before buds open but when temperature is above freezing.
Spring spray at time of insect hatch	2 pt. 57% emulsion concentrate of malathion per 100 gal. water, or 2 lb. 50% W.P. of carbaryl.			
European fruit Lecanium	Elm, fruit trees		malathion 2 pt. 57% E.C. per 100 gal.	Apply late June, early July (about when catalpas bloom).
Oystershell Cottony maple	Many shade, fruit, ornamental trees, shrubs		carbaryl 2 lb. 50% W.P.	Apply when apple petals have fallen (early June).
Scurfy	Elm, maple, hackberry		Thoroughly cover foliage, twigs, and branches. Repeat in 10-15 days if infestation is heavy.	Apply late June, July.
Pine needle	Pines, spruce			Apply June and July.
				Apply late May (when lilacs bloom).
White grub	Lawn, turf	chlordan	2½ lb. 10% dust or granular per 1,000 sq. ft. 8 fl. oz. of 45% E. C. per 1,000 sq. ft.	Note: Apply to seedbed before seeding or sodding or apply to the surface of established turf and soak thoroughly. May be combined with lawn fertilizer. Following soaking, keep children and pets off treated area until dry.
Sod webworms	Lawn, turf	carbaryl (Sevin) chlordan	2 cups 50% W. P. per 1,000 sq. ft. in 20 to 25 gal. water. 1 to 2 lb. 10% granules or 8 fluid oz. 45% E. C. per 1,000 sq. ft.	
		Chlorpyrifos (Dursban)	5 lb. ½% granular or 1½ fl. oz. 22% E.C. per 1,000 sq. ft.	Will also control cutworms and chinchbugs.
		diazinon	1 lb. 14% granules or ¼ pt 50% E. C. per 1,000 sq. ft.	
		ethion	4 tbsp. of 8 lb. E. C. or 8 tbsp. of 4 lb. E. C. per 1,000 sq. ft. in 20-25 gal. water.	
		trichlorfon (Dylox, Proxol)	2½ to 3 oz. of 80 S.P. per 1,000 sq. ft.	
Slugs	Ornamentals, lawns, turf	chlorpyrifos (Dursban)	1 lb. actual toxicant per acre. Professional applicators only.	
		Mesurool mexacarbamate (Zectran)	1 to 1.3 lb. per acre (0.32 oz. per 1000 sq. ft.) 1½ qt. per 100 gal. Use one gal. per 130 to 180 sq. ft.	
		Mesurool mexacarbamate (Zectran) Metaldehyde		Apply bait to soil in infested areas. Do not apply directly to food crops.

## Stored Grain Insects

Grain in Minnesota is generally safe from infestation by stored grain insects before harvest. The only exception may be where grain is cut and swathed adjacent to storage bins being treated with an insecticide in preparation for the new crop. Stored-grain insects will migrate from treated bins, at least temporarily.

Accumulations of post-harvest grain or grain products is a primary target for insect infestations especially if it is stored with or adjacent to last year's crop or in storage facilities also used for livestock or where livestock feed is housed.

Inspect grain at 30-day intervals, especially during the summer and autumn months, to determine if treatment is needed. Check for insects by taking the grain temperature and by looking for the insects themselves. To take the grain temperature, fasten a thermometer to a stick and sink it into the grain 2 feet below the surface. If insects are active, the temperature will be above 65° F. and may range as high as 100° F. To inspect for insects, insert a grain probe in the center of the bin 2 feet below the grain surface. Sift the grain samples through a 10 to 12 mesh to the inch screen to separate-out insects.

### Prevention

#### Spraying Facilities:

Thoroughly clean combines, trucks, wagon beds, elevators, and bins. Spray the surfaces of the equipment that will be in contact with the grain with one of the following insecticides 2 to 6 weeks before harvest:

Pesticide formulation	Amount of Pesticide Formulation Per 2 Gallons of Water
methoxychlor 50% W.P. ....	12 oz.
or	
methoxychlor 25% E.C. ....	1 qt.
or	
pyrethrins 6% E.C. com- bined with piperonyl butoxide 60% .....	1½ pts.
or	
malathion — premium grade (Cythion) 57% E.C. ....	½ pt.

oz. = ounce  
qt. = quart  
pt. = pint

W.P. = wettable powder  
E.C. = emulsifiable concentrate

Spray to the point of run-off using 1 gallon of total formulation (one of the insecticides listed above) per 500 sq. ft. of surface. Allow treated surfaces to dry before contacting grain. Also spray, if possible, the outside walls of the bins to a height of 6 feet and the ground to a distance of 6 feet out from the foundation of each bin.

If it is not possible to remove the old grain, then it should be checked carefully for stored-grain insects and, if needed, treated with recommended residual insecticides or fumigants before adding new grain.

Grain stored with less than 12% moisture, below 70° F. and with a low amount of dockage or cracked grain is relatively safe from significant damage by stored-grain insects.

#### Grain Protectants:

Insect infestations are prevented or reduced by treating small grains and shelled corn as it is moved into storage.

malathion	1 pt. premium-grade E.C. per 2 to 5 gal. water per 1,000 bu.
malathion	1% premium-grade of wheat flour dust, 60 lb. per 1,000 bu.
synergized pyrethrins	1 qt. of pyrethrins 6% combined with piperonyl butoxide 60% E.C. in 3 to 5 gal. of water per 1,000 bu. Spray onto the grain stream as it goes into storage.

## Stored Grain Insects (continued)

### Surface Grain Treatments:

malathion	½ to 1 pint premium-grade E.C. in 2 gal. water per 1,000 sq. ft. of grain surface area.
malathion	1% premium-grade of wheat flour dust, 30 lb. per 1,000 sq. ft.
synergized pyrethrins	8 oz. of pyrethrins 6% combined with piperonyl butoxide 60% E.C. in 1 to 2 gal. of water per 1,000 sq. ft. of grain surface.

Apply the spray evenly over the surface immediately after the grain is loaded into storage and leveled off. Repeat if necessary.

The Indian-meal moth is generally found in the top 6 to 12 inches of stored shelled corn and is becoming a similar pest in stored soybeans, especially in areas just south of Minnesota. At the same time there is evidence from some areas that this moth is developing resistance to malathion. If malathion is ineffective, apply synergized pyrethrins, fumigants, or a refined mineral oil. The mineral oil must be unsulfonated, technically white, 100-200 seconds viscosity, and free of objectionable odors. Two quarts of the mineral oil should be applied per 100 square feet of corn surface.

A new preventative treatment for Indian-meal moths is to suspend 1 dichlorvos (Vapona) "No-Pest Strip" per 1,000 cubic ft. of space over the binned grain. The dichlorvos is effective against adult moths only. These "Vapona" strips must be in place before moths begin to emerge in early spring. This treatment is usually effective for 3 months.

## Control

**Fumigation:** Fumigants are applied to binned grain to stop established insect infestations. Best fumigation results are obtainable using the following guidelines:

1. Level the grain. Remove or breakup any crust in the grain.
2. Seal all cracks making the bin as air-tight as possible.
3. Fumigate on a still day preferably when the **grain** temperature is above 70° F. Wind causes rapid leakage of the gas and results are poor.
4. Methods of applying fumigants vary with the type of fumigant, commodity and storage facility. Most farm storages will use the gravity penetration method. Apply the correct amount of fumigant as a coarse spray evenly over the surface of the grain. Cover the grain with a tarpaulin if there is a large air-space above the grain.
5. The operator should stay out of the bin. Apply the fumigant from outside of the bin. Do not breathe vapor or fumes. Use a recommended gas mask with canister, and always work in pairs.
6. Keep the bin closed for at least 72 hours. Do not enter the bin during or after fumigation until gases have been thoroughly removed by aeration.
7. When under fumigation, the storage bins should be locked and identified with "DANGER — KEEP OUT" signs to prevent entry and avoid accidents.

Some of the recommended fumigant dosages are tabulated below:

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	3
Carbon tetrachloride-ethylene dibromide, 95-5 .....	4	2	8	4
Carbon tetrachloride-ethylene dichloride, 3-1 .....	6	3	8	4
Carbon tetrachloride-ethylene dichloride-ethylene dibromide, 60-35-5 .....	4	2	8	4

## Stored Grain Insects (continued)

Use other liquid fumigant mixtures as labeled.

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

Type of storage	Grain temperature	Dosage (per 1,000 bu.)	
		Tablets	Pellets
Concrete or steel elevator tanks	54-59° F.	150	500
	60-68° F.	90	300
	over 68° F.	60	200
Round steel bins ("Butler" type)	54-59° F.	180	600
	60-68° F.	120	400
	over 68° F.	90	300

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

Read and follow all precautions listed on the labels for each different fumigant. Repeat fumigants may be necessary. Information about other fumigants is available from the Department of Entomology, Fisheries and Wildlife, University of Minnesota.

## Greenhouse and Floricultural Pests

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The major crops and their major pests are as follows:

African violets .....	Cyclamen mites, also spider mites, Pritchard mealybug, occasionally aphids
Azaleas .....	Spider mites, cyclamen mites, whiteflies, greenhouse thrips, leaf miner, leaf roller
Begonias .....	Cyclamen mite probably most serious, thrips
Cacti (succulent plants) .....	Mealybugs, scale insects
Camellias .....	Aphids, thrips, leaf miners, spider mites
Carnations .....	Aphids, thrips, spider mites
Chrysanthemums .....	Aphids, leaf miners ( <i>Phytomyza atricornis</i> )
Cyclamens .....	Cyclamen mite, spider mites, aphids
Foliage plants .....	Root aphids, foliar aphids, scale insects, mealybugs
Geraniums .....	Aphids, whiteflies, plume moth ( <i>Platyptilia pica</i> )
Lilies .....	Aphids
Orchids .....	Orchid fly ( <i>Eurytoma orchidearum</i> ), slugs
Poinsettias .....	Mealybug, whitefly, spider mites, scale insects, root aphids
Roses .....	Spider mites, thrips, aphids, midge, leafrollers
Snapdragons .....	Spider mites, aphids, cyclamen mite, whiteflies

## Greenhouse and Floricultural Pest Control

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
Ants	SPRAYS OR DUSTS chlordane diazinon dieldrin*	5% dust or 2½ lb. of 40% W.P. 1 to 2 lb. 50% W.P. 2% dust, 1 lb. of 50% W.P. or 1½ qt. of 18.6% E.C.	} Apply 1 lb. of dust or 1 gal. spray per 1,000 sq. ft. soil along walks. Do not apply to foliage.



## Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
<b>Aphids</b>			
	<b>AEROSOLS and VAPORS</b>		
	dichlorvos (Vapona)	6 oz. smoke generator for 10,000 cu. ft.; 2 oz of 81% E.C. per 10,000 cu. ft. on steam pipes.	Close greenhouse vents for 2 hours after treatment.
	naled (Dibrom)	2 fl. oz. of 4 lb. E.C. per 10,000 cu. ft. on steam pipes	
	parathion	10% aerosol using 1 lb. per 50,000 cu. ft.	Causes leathery leaves on gardenias; not recommended on asters and white cyclamen.
	sulfotepp (Dithio)	Smoke or 5% aerosol bomb using 1 lb. per 50,000 cu. ft.	
	<b>SPRAYS</b>		
	diazinon	1 lb. 50% W.P. or 1 pt. 50% E.C.	
	endosulfan (Thiodan)	1 lb. 50% W.P. or 1 qt. 24% E.C.	3% dusts may also be used.
	malathion	2 lb. 25% W.P. or 1½ pt. 57% E.C.	Dosage doubled for scale insects. Injury occurs to some crassulas, cucurbits, ferns, petunias, orchids, sweet peas. Phytotoxicity greatest with E. C. Dusts may also be applied.
	<b>SOIL TREATMENT</b>		
	oxydemetonmethyl (Meta-Systox-R)	1½ pt. of 2 lb. E.C. For soil drench use 1 tablespoon in 3 gal.; 3 gal. treats 100 6-inch pots.	Causes leaf scorch on Easter Lily; injury noted on mum varieties: Hurricane, Iceberg, Whitecap, and Pennant.
	aldicarb (Temik)	30-40 oz. Temik 10 G/ 1000 sq. ft. on soil surface	Should give 8 weeks protection; approved on mums, Gerberas, roses, carnations, Easter lilies, and snapdragons.
<b>Caterpillars (various species)</b>	carbaryl (Sevin)	2 lb. of 50% W.P. or 1 qt. of 80% sprayable	Except for older stages of cabbage looper.
	methoxychlor	2 lb. of 50% W.P.	Preferred for sensitive foliage.
	trichlorfon (Dylox)	2 to 3 lb. of 50% soluble powder	Some injury to certain varieties of carnation and zinnia.
<b>Centipedes, symphylids</b>	lindane*	10 oz. of 25% W.P. per 1,000 sq. ft.	Work into soil. Steam sterilization is also advised.

\* Restricted use pesticide, see statement on page 2.

## Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
Cutworms	carbaryl	2 lb. of 50% W.P. or 1¼ lb. 80% W.P. or 5% bait	} Soil treatment.
	chlordan	5% to 10% dust, 2 lb. 50% W.P. or 2 pints 45% E.C.	
	dieldrin*	2% dust, 1 lb. of 50% W.P. or 1 qt. of 19.5% E.C.	
Cyclamen mites	dicofol (Kelthane)	1 lb. of 35% W.P. 1 pt. of 18.5% E.C.	} Make 2 or 3 applications at 2-week intervals. Use sanitation and isolation during clean-up period.
	endosulfan	2 lb. of 25% W.P. or 1 qt. of 24% E.C.	
Fungus gnats	chlordan	1 qt. of 75% E.C.	} Drench soil for best larval control. Treat soil weekly until infestation is controlled. Surface dusting controls adults.
	dieldrin*	1 lb. of 50% W.P. or 1 pt. of 19.5% E.C.	
	malathion	4% dust or 1½ to 2 pts. of 57% E.C.	
	lindane*	10 oz. of 25% W.P. per 10,000 sq. ft.	
Grasshoppers	carbaryl	2 lb. of 80% W.P.	
	chlordan	1 lb. of 50% W.P.	
	malathion	2 pt. of 57% E.C.	
Leafhoppers	carbaryl	2 lb. of 50% W.P.	
	diazinon	½ lb. of 50% W.P.	
Leaf miners and foliar nematodes	diazinon	2 lb. 50% W.P.	
	malathion	1½ pt. of 57% E.C. 2 lb. 25% W.P.	
	oxydemetonmethyl (Meta-Systox-R)	1½ pt. of 2 lb. E.C. Soil drench may be used as given under aphids	
	parathion	1 lb. of 25% W.P. 1 pt. 25% E.C.	Avoid excessive treatment of asters, gardenias, and white cyclamen.
	SOIL TREATMENT aldicarb (Temik)	30-40 oz. of Temik 10 G/ 1000 sq. ft. on soil surface (⅛ tsp./6" diam. pot)	Approved on mums and Gerberas.
Leaf rollers	carbaryl (Sevin)	2 lb. of 50% W.P. or 1¼ lb. of 80% W.P.	
	trichlorfon (Dylox)	2 to 3 lb. of 50% soluble powder	Some injury to certain varieties of carnation and zinnia.

\* Restricted use pesticide, see statement on page 2.

## Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks	
Mealybugs	SPRAYS			
	diazinon	2 lbs. of 50% W.P. or 1 pt. of 50% E.C.		
	lindane*	½ lb. of 25% W.P. or 8 oz. of 20% E.C.		
	malathion	3 lb. of 25% W.P. or 1½ pt. of 57% E.C.		
	parathion	1 lb. of 25% W.P.	Repeat in 3 to 4 weeks.	
	VAPORS, AEROSOLS			
	dichlorvos (Vapona)	6 oz. smoke generator for 10,000 cu. ft. 1 oz. of 81% E.C. per 10,000 cu. ft. on steam pipes		
	malathion	15% bomb using 1 lb. per 50,000 cu. ft. 1 10% bomb at 1 lb. per 50,000 cu. ft.		
	naled	2 fl. oz. of 4 lb. E.C. per 10,000 cu. ft. on steam pipes		
	sulfotepp	15% bomb using 1 lb. per 50,000 cu. ft.		
		SOIL TREATMENT		
	aldicarb (Temik)	30-40 oz. of Temik 10 G/1000 sq. ft. on soil surface (½ tsp./6" diam. pot)	Approved on Poinsettias.	
Plume moth	carbaryl (Sevin)	2 lb. of 50% W.P. or 1 qt. of 80% sprayable	} Principal geranium pest } Sprays preferable to aerosols, especially on older larvae.	
	trichlorfon (Dipterex, Dylox)	2-3 lb. of 50% soluble powder		
Roaches	chlordane diazinon dieldrin*	} same as for ants		
Scale insects	diazinon dichlorvos dimethoate (Cygon) malathion parathion sulfotepp	} same as for mealybugs	} 3 or 4 applications, but repeat as necessary. Best control when crawlers are present.	
Slugs, snails	MesuroI	1 lb. of 2% bait per 1000 sq. ft.	Apply once every 2 weeks to soil, using fresh material.  Apply 1 gal. mixture per 130-180 sq. ft. soil or turf. 1 lb. per 1200 sq. ft.	
	metaldehyde, or proprietary baits containing metaldehyde	2 oz. of 15% dust per 100 sq. ft. or 1 oz. of 20% E.C. to cover 100 sq. ft.		
	Zectran	3 tsp. of 2 lb. E.C. per gal.		
		2% meal bait		

\* Restricted use pesticide, see statement on page 2.

## Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks
Sowbugs (pillbugs)	chlordane	5% to 10% dust	
	diazinon	1 lb. of 50% W.P. or 1 pt. of 50% E.C.	
	lindane*	1 lb. of 25% W.P.	
Spider mites			
	<b>SPRAYS</b>		
	carbophenothion (Trithion)	1 pt. of 4 lb. flowable or 2 lb. of 25% W.P.	Do not treat Crassula and maiden hair fern.
	chlorobenzilate	1 lb. of 25% W.P. or 1 pt. of 25% E.C.	Not as effective when sulfur is used.
	dicofol (Kelthane)	1 lb. of 35% W.P. or 1 pt. of 18.5% E.C.	Incompatible with sulfur.
	dimethoate (Cygon)	1 to 1½ pt. of 2.67 lb. E.C.	
	malathion	1½ pt. 57% E.C.	
	Morestan	½ lb. of 25% W.P.	Certain rose varieties damaged.
	Omite	½ lb. of 30% W.P.	
	oxydemetonmethyl (Meta-Systox-R)	1½ pt. of 25% E.C.	
	Pentac	½ lb. of 50% W.P.	Certain varieties of mums may be damaged.
	Plictran	1 oz. of 50% W.P.	
	tetradifon (Tedion)	½ lb. of 50% W.P. 1 qt. of 12.3% E.C.	Avoid treatment of White Butterfly and Cinderella roses.
	<b>AEROSOLS</b>		
	chlorobenzilate	10% bomb for 50,000 cu. ft.	
	dichlorvos	6 oz. for 10,000 cu. ft. or paint 1 fl. oz. of 81% E.C. per 10,000 cu. ft. on steam pipes	
	malathion	15% bomb using 1 lb. for 50,000 cu. ft.	
	parathion	10% bomb for 200,000 cu. ft.	
	sulfotepp	15% bomb to 200,000 cu. ft.	
	<b>VAPORS OR SMOKES</b>		
	naled	Paint 1 fl. oz. of 58% E.C. per 10,000 cu. ft. on steam pipes	Corrosive to metals.
	sulfotepp	15% sulfotepp, using 1¼ oz. to 5,000 cu. ft.	
	tetradifon (Tedion)	Paint 10 oz. of 50% W.P. as slurry to steam pipes for 200,000 cu. ft.	
	tetradifon 15% + sulfotepp, 12.5%	Smoke generator 6 oz. for 10,000 cu. ft.	
	<b>SOIL TREATMENT</b>		
	aldicarb (Temik)	30-40 oz. of Temik 10 G/1000 sq. ft. on soil surface (½ tsp./6" diam. pot)	Should control mites for 40-60 days; approved on mums, Poinsettias, Gerberas, roses, carnations, orchids, and snapdragons
Spittle bugs	endosulfan (Thiodan)	1 lb. of 50% W.P. or 1 qt. of 24% E.C. or 3% dust	
	lindane*	½ lb. of 25% W.P. or 8 oz. of 20% E.C.	

\* Restricted use pesticide, see statement on page 2.

## Greenhouse and Floricultural Pest Control (continued)

Pest	Insecticide, miticide	Dosage per 100 gal. spray unless otherwise stated	Remarks	
Springtails	<b>SOIL TREATMENT</b>			
	chlordane	1 lb. of 40% W.P. or ½ pt. of 75% E.C.		
	diazinon	1 lb. of 50% W.P. 1 pt. of 50% E.C. 2% dust watered in		
Symphylids (see Centipedes)	carbaryl (Sevin)	1 qt. of 80% sprayable 1 lb. of 4 lb. flowable		
Tarnished plant bugs and other plant bugs	carbaryl (Sevin)	2 lb. of 50% W.P.		
Thrips	diazinon	1 lb. of 50% W.P. 1 pt. of 50% E.C., 2% dust		
	dieldrin*	½ lb. of 50% W.P. or 1 pt. of 19.5% E.C.	For evaporative cooling pads add 2 pt. of 19.5% E.C. dieldrin per 100 gal. circulating water.	
	heptachlor*	1 lb. of 25% W.P. or 1 pt. of 25% E.C.		
	lindane*	½% to 1% through evaporative pads		
		<b>SOIL TREATMENT</b> aldicarb (Temik)	30-40 oz. Temik 10 G/ 1000 sq. ft. soil surface (½ tsp./6" diam. pot)	Approved on mums, Poinsettias, Gerberas. Aldicarb only recommended for thrips on Chrysanthemums.
Whiteflies	<b>SPRAYS</b>			
	azinphosmethyl (Guthion)	1½ pt. of 2 lb. E.C. 1 lb. of 50% W.P.	Applications should be made at 10-14 day intervals until infestation is under control. Azinphosmethyl will also control aphids.	
	diazinon	2 lb. of 50% W.P.		
	endosulfan (Thiodan) or endosulfan plus malathion or parathion	Same as for aphids  1 lb. of 50% W.P. plus 3 lb. of 25% W.P. or 1 lb. of 25% W.P.	See remarks under aphids.	
	<b>VAPORS, AEROSOLS</b>			
	dichlorvos (Vapona)	6 oz. for 10,000 cu. ft. or paint 1 fl. oz. of 81% E.C. per 10,000 cu. ft. on steam pipes	Close greenhouse vents for 2 hours after application.	
	endosulfan (Thiodan)	1 lb. 10% aerosol per 50,000 cu. ft.		
	sulfotepp (Dithio)	5% bomb using 1 lb. per 50,000 cu. ft.		
		<b>SOIL TREATMENT</b> aldicarb (Temik)	30-40 oz. Temik 10G/ 1000 sq. ft. soil surface (½ tsp./6" diam. pot)	Should control white flies for 3 to 4 weeks.

\* Restricted use pesticide, see statement on page 2.

## Resistance of Certain Aphids (particularly Green Peach Aphid) and Red Spider Mites

There appears to be no easy way of minimizing the development of resistance except to minimize or avoid using certain chemicals. On the other hand there are a few guidelines which may be helpful, such as:

- (1) Prevent introduction of new strains from other sources by careful inspection of the plants upon receipt; preferably isolate for a time before a treatment; if an infestation is present give a thorough treatment before permitting the plants to be mixed with the others.
- (2) Keep conditions as cool and unfavorable for the aphids and mites as possible without interfering with the growing conditions of the plants.
- (3) Make each treatment thorough.
- (4) Alternate effective insecticides; change from one type of chemical grouping to another. In the case of aphids, there are three major insecticide groups. With spider mites, there are more possibilities. Materials used along with their classifications are given below:

**Aphids:** (1) *Chlorinated hydrocarbons*—endosulfan (Thiodan), lindane. (2) *Organophosphates*—carbophenothion (Trithion), demeton (Systox), dichlorvos (DDVP), diazinon, dimethoate (Cygon), malathion, naled (Dibrom) oxydemetonmethyl (Meta Systox R), parathion, phorate (Thimet), Sulfotepp (Dithio). (3) *Carbamate*—aldicarb (Temik).

**Red Spider Mites:** (1) *Chlorinated hydrocarbons*—chlorobenzilate, dicofol (Kelthane), Pentac; (2) *Organophosphates*—carbophenothion (Trithion), demeton, dichlorvos, dimethoate, naled, oxydemetonmethyl, parathion, phorate, schradan, sulfotepp (3) *Carbamate*—aldicarb (Temik). (4) *An organic carbonate*—Morestan; (5) *Sulfur compounds* (not phosphates)—teradifon (Tedion), (6) *Organotin compound*—Plictran.

## Toxicity and Hazard

The hazard from insecticides is not only dependent upon the toxicity of the chemical but how it is used and what form of the insecticide might be contacted.

For human safety when using aldicarb (Temik 10 G) use rubber gloves and a respirator when in an enclosure; never use treated plants for food or feed purposes; do not market potted plants within 4 weeks after treatment; wait 100 days before planting food crops in treated soil.

The following table illustrates relative hazard differences due to the physical state (++++ = very hazardous, + least hazardous.)

Physical State	Lungs	Hazard through skin	By Mouth
Droplets of:			
Emulsions	++	+++	+
Wettables or Flowables	++	++	+
Solutions	++	+++	+
Smokes	+++	+	+
Vapors (aerosols)	++++	+	+
Dusts	+++	++	+
Granules	+	++	++

The highly toxic (less than 5 gram or 1/6 oz. active ingredients for a man):

phorate (Thimet)	mevinphos (Phosdrin)
demeton (Systox)	carbophenothion (Trithion)
endrin	azinphosmethyl (oral) (Guthion)
parathion	aldicarb (Temik)

The moderately toxic: (1/6 oz. to 2 oz. for a man)

aldrin	heptachlor	dichlorvos
chlordane	lindane	diazinon (oral)
DDT	endosulfan	naled (Dibrom)
dielrin	toxaphene	oxydemetonmethyl (oral)
azinphosmethyl (dermal) (Guthion)		(Meta-Systox-R)