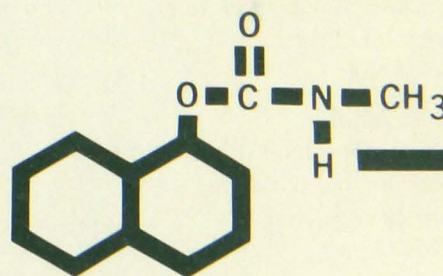
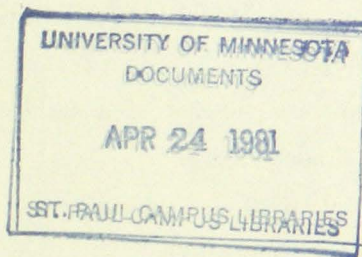


# INSECTICIDES



Extension Bulletin 387—Revised 1981  
AGRICULTURAL EXTENSION SERVICE  
UNIVERSITY OF MINNESOTA

This archival publication may not reflect current scientific knowledge or recommendations.  
Current information available from University of Minnesota Extension: <http://www.extension.umn.edu>

## Contents

General precautions for using pesticides .....	4
Safety precautions and first aid .....	4
Minnesota poison information centers .....	5
Protecting honey bees from insecticides .....	5
Pesticide toxicity and LD <sub>50's</sub> .....	6
Acute oral and dermal LD <sub>50's</sub> for insecticides .....	6
Forms of insecticides .....	8
Calculating dosage and rates of application .....	8
Sprayer calibration .....	10
Description of insecticides, miticides .....	11
Chlorinated hydrocarbons .....	11
Carbamates .....	12
Organophosphates .....	13
Sulfonates, carbonates, botanicals, and miscellaneous groups .....	17

## Legal Restrictions on Use of Pesticides

The Federal Insecticide, Fungicide, and Rodenticide Act and the Minnesota Pesticide Act of 1976 require those who use or supervise the use of certain pesticides with restricted uses to be certified.

The labels of pesticides with restricted uses will contain information regarding these restrictions. Be sure to read all labels thoroughly and use any pesticide only for the crops and pests listed on the label.

Information about applicator certification may be obtained from your County Extension Director or the Minnesota Department of Agriculture. The U.S. Environmental Protection Agency (EPA) has designated the following pesticides for restricted use:

aldicarb (Temik)	endrin	methyl parathion
aluminum phosphide (Phostoxin)	ethyl parathion	mevinphos (Phosdrin)
azinphos methyl (Guthion)	hydrocyanic acid	sodium cyanide
calcium cyanide	isofenphos (Amaze)	sulfotepp
demeton (Systox)	methomyl (Lannate, Nudrin)	tepp
	methyl bromide	

*Authors of this publication are J. A. Lofgren, professor and extension entomologist; D. M. Noetzel, associate professor and extension entomologist; P. K. Harein, professor and extension entomologist; M. E. Ascerno, assistant professor and extension entomologist; and L. K. Cutkomp, professor, Entomology, Fisheries, and Wildlife.*

EPA has announced a **final order** classifying the following insecticides for restricted use.

Insecticide	Restricted uses and formulations	Insecticide	Restricted uses and formulations
carbofuran (Furadan)	All concentrates, suspensions, and wettable powders 40% and greater.	ethoprop (Mocap)	Emulsion concentrates 40% and greater.
chlorfenvinphos (4072)	All concentrates, solutions, or emulsions 21% and greater.	fenamiphos (Nemacur)	Emulsion concentrates 35% and greater.
dioxathion (Delnav)	Concentrates, solutions, or emulsions 30% and greater; domestic uses of solutions 3% and greater.	fensulfothion (Dasanit)	Emulsion concentrates and solutions 63% and greater; e.c. 43% and greater in combination with disulfoton 21% and greater; e.c. 32% and greater in combination with disulfoton 32% or greater.
disulfoton (DiSystem)	Concentrates 65% and greater; emulsion concentrates 21% and greater in combination with fensulfothion 43% and greater; e.c. 32% and greater in combination with 32% fensulfothion and greater. Solutions 95% and greater for seed treatment. Granules 10% and greater indoors (greenhouse).	fonofos (Dyfonate)	Emulsion concentrates 44% and greater.
		monocrotophos (Azodrin)	Liquids 19% and greater.
		phorate (Thimet)	Liquids 65% and greater. Granules on rice.
		phosphamidon (Dimecron)	Liquids 75% and greater; dusts 1.5% and greater.
		Lindane is a restricted-use material in Minnesota and can only be used by or under the supervision of a certified applicator for specified purposes.	

The following insecticides have been **proposed** for restricted use classification by EPA. After a period of time for receiving comments EPA will issue a final order regarding the classification of these insecticides. Some of these products **probably will** have restricted use labeling in 1981.

Insecticide	Restricted uses or formulations	Insecticide	Restricted uses and formulations
aldicarb (Temik)	Agricultural uses of granules 10% and greater (other uses previously restricted).	EPN	Formulations greater than 4%; granules 2% and greater.
carbofuran (Furadan)	Granules 2% and greater (except on pine and cottonwood plantation and nursery plantings).	fenamiphos (Nemacur)	Granules 10% and greater.
carbon disulfide	Grain fumigation, burrow treatments for woodchuck, ground squirrel, prairie dog, and rats.	fensulfothion (Dasanit)	Granules and fertilizer combinations 2% and greater.
chloropicrin	Formulations greater than 2%, all formulations for rodent control.	fenthion (Baytex)	All formulations for aquatic, ornamentals, and bird control uses. All liquids 70% and greater.
disulfoton (Disyston)	Granules 10% and greater; granules 2% and greater <b>except</b> seed beds and transplant beds; granules 5% and greater in combination with ethoprop 10% and greater.	fonofos (Dyfonate)	Granules 5% and greater.
dicrotophos (Bidrin)	Liquid formulations 8% and greater.	methamidophos (Monitor)	Liquids 40% and greater; dusts 2.5% and greater.
ethoprop (Mocap)	Granules and fertilizer formulations 3% and greater.	methidathion (Supracide)	All formulations except on nursery stocks, safflower, and sunflower.
		nicotine alkaloid	Formulations 14% and greater in greenhouses; all formulations on cranberries.
		oxamyl (Vydate)	Liquids 24% and greater.
		phorate (Thimet)	Granules 5% and greater.
		temephos (Abate)	Aquatic uses; liquid formulations in orchards.
		terbufos (Counter)	Granules 15% and greater.

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

It is extremely important to store and use all insecticides 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. Liquids should be stored at temperatures higher than 40° F.
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. Triple rinse and drain metal, glass or plastic containers before disposal.
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 unlined natural rubber or neoprene gloves to prevent absorption through the skin. Remove and wash contaminated absorbent clothing. Wear long sleeves. Use protective clothing if directed to on the label.

Avoid breathing any wettable powder or dust or contacting an emulsion. Use a respirator equipped with NIOSH-approved farm chemical cartridges.

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

Some organic phosphate and carbamate insecticides (TEPP, parathion, methyl parathion, tetraethyl dithiopyrophosphate, EPN, ethoprop, demeton, azinphosmethyl, mevinphos, phorate, terbufos, disulfoton, aldicarb, and carbofuran) are hazardous to humans during mixing operations and application. Contact with recently treated plants or surfaces also may be hazardous. Follow re-entry limitations listed on the label.

All of these 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 unless the label says not to.

**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**

4. Keep patient quiet and warm.
5. Physician may administer atropine as an antidote. For phosphate poisoning only, 2-PAM may be given with atropine.

If you have had these symptoms from organic phosphorous or carbamate 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 analysis of the blood made at regular intervals. Contact Dr. Hugh Thompson, Health Service, University of Minnesota, if you need assistance in locating a laboratory to conduct the blood analysis or for interpretation of the results.

### Chlorinated-hydrocarbon first aid

For chlorinated hydrocarbons (such as BHC, chlordane, endrin, lindane, methoxychlor, toxaphene, endosulfan):

1. If chemical has been swallowed, call physician immediately. Generally, if the patient is conscious, induce vomiting unless the label says not to. 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 to keep patient calm or to control convulsions.

### Poison Information Centers

Several hospitals in Minnesota and adjacent states have special offices or centers from which information about symptoms, first aid, and treatment for poisoning is available.

However, the most complete information may be obtained from the following:

Hennepin County  
 Medical Center  
 701 Park Avenue  
 Minneapolis, MN (612) 374-3141  
 collect calls accepted

Southeastern Minnesota  
 Poison Control Center  
 Methodist Hospital  
 Rochester, MN (507) 285-5123

St. Lukes Poison Center  
 St. Lukes Hospital  
 Fifth St. and Mills Avenue  
 Fargo, ND (701) 280-5575

### 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 benefitting 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 taken from the exhaustive studies by Anderson and Atkins in California.

---

#### Insecticides highly toxic to honey bees

Acephate (Orthene)	Lindane
Arsenicals	Malathion (LV or ULV)
Azinphosmethyl (Guthion)	Methamidophos (Monitor)
Carbaryl (Sevin)	Methidathion (Supracide)
Carbofuran (Furadan)	Methomyl (Lannate)
Chlorpyrifos	Methyl parathion

(Dursban, Lorsban)	Mevinphos (Phosdrin)
Diazinon (Spectracide)	Monocrotophos (Azodrin)
Dichlorvos (DDVP, Vapona)	Naled (Dibrom)
Dimethoate (Cygon)	Parathion
EPN	Phosmet (Imidan)
Fenthion (Baytex)	Phosphamidon (Dimecron)
Heptachlor	Stirofos (Gardona, Rabon)

---

#### Insecticides moderately toxic to honey bees

Abate	Endosulfan (Thiodan)
Chlordane	Endrin
Crotoxypfos (Ciodrin)	Oxydemethonmethyl
Coumaphos (Co-Ral)	(Meta-Systox R)
DDT	Phorate (Thimet)
Demeton (Systox)	Ronnel (Korlan)
Disulfoton (Di-syston)	

---

#### Insecticides with low toxicity to honey bees

Allethrin	Methoxychlor
Aramite	Nicotine
Bacillus thuringiensis	Omite
(Thuricide, Biotrol, Dipel)	Ovex (Ovotran)
Binapacryl (Morocide)	Oxythioquinox (Morestan)
Chlorbenside (Mitox)	Pyrethrins
Chlordimeform	Resmethrin
Chlorpropylate (Acaralate)	Rotenone
Dicofol (Kelthane)	Sabadilla
Dimite (DMC)	Tetradifon (Tedion)
Dioxathion (Delnav)	Toxaphene
Ethion (Nialate)	Trichlorfon (Dylox)

You can use this table in two ways. When honey bees have a high potential vulnerability you may, through 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 that will help 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> (LD means lethal dose). This means the amount of insecticide that would kill 50 percent 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 percent 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> 's in mg. /kg.			
	Oral		Dermal	
	Males	Females	Males	Females
Acephate (Orthene).....	945	866	>2000	
Aldicarb (Temik)** .....	1		5	
Aramite .....	3900	3900		
Aspon .....	891		2100	
Azinphosmethyl (Guthion) .....	13	11	220	220
Bendiocarb (Ficam <sup>(R)</sup> ) .....	143			
Binapacryl (Morocide) .....	63	58	810	720
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
Chlordimeform (Galecron, Fundal) .....	127-352		3000	
Chlorfenvinphos (Compound 4072) .....	15	13	31	30
Chlorpyrifos (Dursban, Lorsban) .....	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	
Cruformate (Ruelene) .....	635	460		
Cyhexatin (Plictran **) .....	540		>2000	
DD Mixture .....	140		2100	
DDT .....	113	118		2510
Demeton (Systox) .....	6	3	14	8
Diazinon .....	108	285	900	455
Dichlorvos (DDVP, Vapona) .....	80	56	107	75
Dicofol (Kelthane) .....	1100	1000	1230	1000
Dicrotophos (Bidrin)** .....	22		225	
Dimethoate (Cygon, De-Fend, Rebelate, Dimex) ..	215	245	400	610
Dioxathion (Delnav) .....	43	23	235	63
Disulfoton (Di-Syston) .....	7	2	15	6
Fonofos (Dyfonate)** .....	8		147	
Endosulfan (Thiodan) .....	43	18	130	74
Endrin .....	18	8	18	15

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

Insecticides	LD <sub>50</sub> 's in mg. /kg.			
	Oral		Dermal	
	Males	Females	Males	Females
EPN	36	8	230	25
Ethoprop (Mocap)**	61		26	
Ethion	65	27	245	62
Ethylene dibromide	146	117	300	
Ethylene dichloride	770		3890	
Famphur (Warbex)**	35-62		1460-5093	
Fensulfothion (Dasanit)**	10	2	30	3
Fenthion (Baytex)	190	245	330	330
Fenson**	1350-1740			
Fenvalerate (Pydrin)	451**		1000**	
Isofenphos (Amaze)	38	28	162	315
Kinoprene (Enstar)	4900	5000	9000	
Lead Arsenate		1050		>2400
Lethane 384	90		250-500**	
Lindane	88	91	1000	900
Malathion	1375	1000	>4444	>4444
Methiocarb (Mesuroil)**	130-135		>200	
Metalddehyde**	1000			
Methidathion (Supracide)	25-48		375	
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
Methamidophos (Monitor)	21	19	118	
Monocrotophos (Azodrin)	21		354	
Naled (Dibrom)	250		800	
Nicotine sulfate		83		285
Omite**	2500			
Ovex (Ovotran)	2050			
Oxydemetonmethyl (Meta Systox-R)	65	75	250	
Oxythioquinox (Morestan)	1800	1100	>2000	>2000
Paradichlorobenzene	>1000	>1000		
Parathion	13	4	21	7
Pentac**	3160		>3160	
Permethrin (Ambush, Pounce)	>4000**		>4000**	
Perthane	>4000	>4000		
Phorate (Thimet)	2	1	6	3
Phosmet (Imidan Prolate)**	147-299		>3160	
Phosolone (Zolone)**	100-180		>1000	
Phosphamidon (Dimecron)	24	24	143	107
Pirimicarb (Pirimor)	294**		>500**	
Propoxur (Baygon)	95	86	>1000	72400
Pyrethrum	1870	820	2060	
Resmethrin (SBP-1382)		4230		
Ronnel (Korlan, Trolene)	1250	2630		>5000
Rotenone**	50-75		940	
Ryania	1200		>4000	
Stiropfos (Gardona, Rabon)	4000-5000**	1125	>5000	74000
Temephos (Abate)	1000-3000	13000	1024-1782	4000
TEPP	1		2	
Terbufos (Counter)	4.5	9.0	1**	
Tetradifon (Tedion)**	>14,700		>10,000	
Thanite**	1600		>6000	
Toxaphene	90	80	1075	780
Trichlorfon (Dipterex, Dyllox, Neguvon)	630 (450-500)	560	5000**	>2000
Vendex	2631		>2000	

## Forms of Insecticides

1. **Dusts (D)** 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 that 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 that 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. Flowable formulations are forms of wettable powder premixed into a paste or slurry.

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. Some wettable and soluble powders are packaged in water soluble bags that are dropped into the sprayer tank as it is filling.

4. **Emulsifiable concentrates (E.C.)** are liquids that 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 because emulsions damage some types of foliage.

5. **Oil solutions (S)** 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 (G)** are ready-to-use preparations of the insecticide in or on particles of a carrier, such as sand, clay, or corncob grits. 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, fumigants, 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:

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

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:

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

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 1 percent malathion spray?

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

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

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

Example:

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

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

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

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

Example:

How much 25 percent methoxychlor emulsion concentrate (2 pounds per gallon) is needed to make 50 gallons of a 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 0.95 liter
- 1 gallon = 4 quarts, or 128 fluid ounces, or 3.8 liters
- 1 gallon (United States) = 0.83 (approximately  $\frac{3}{4}$ ) gallon (British or Imperial)
- 1 gallon (British or Imperial) = 1.2 gallons (United States)
- 1 gallon water (United States) weighs 8.345 pounds
- 1 liter = 1.06 quarts, or 0.26 gallon
- 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, or 0.4 hectare
- 1 mile = 5,280 feet, 1,760 yards, 320 rods, or 1.61 kilometers
- 1 rod = 5½ yards, or 16½ feet
- 1 hectare = 2.47 acres
- 1 kilometer = 0.62 mile
- 1 pound/acre = 1.12 kilograms/hectare
- 1 pound/gallon = 120 grams/liter
- 1 kilogram/hectare = 0.9/acre
- 5 kilograms/hectare = 4.5 pounds/acre
- 1 quintal = 100 kilograms, or 221 pounds

### 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 wetable 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.
pounds	amount of wettable powder to use per acre							
15	13 oz.	1¾ lb.	3 lb., 5 oz.	5½ lb.	6½ lb.	13 lb.	20 lb.	26½ lb.
25	8 oz.	1 lb.	2 lb.	3 lb.	4 lb.	8 lb.	12 lb.	16 lb.
40	5 oz.	10 oz.	1¼ lb.	1¾ lb.	2½ lb.	5 lb.	7½ lb.	10 lb.
50	4 oz.	8 oz.	1 lb.	1½ lb.	2 lb.	4 lb.	6 lb.	8 lb.
75	3 oz.	6 oz.	12 oz.	1 lb.	1 lb., 5 oz.	2 lb., 11 oz.	4 lb.	5 lb., 3 oz.

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

Formulation to use in 100 gal- lons of water	Desired concentration of finished spray, percent									
	0.01	0.03	0.06	0.1	0.25	0.5	1.0	2.5	5.0	
Wettable powders (percent)										
15	½ lb.	1½ lb.	3 lb.	5⅓ lb.	13½ lb.	27 lb.	54 lb.			
25	⅓ lb.	1 lb.	2 lb.	3 lb.	8 lb.	16 lb.	32 lb.			
40	⅕ lb.	¾ lb.	1½ lb.	2 lb.	5 lb.	10 lb.	20 lb.			
50	⅙ lb. (2½ oz.)	½ lb.	1 lb.	1½ lb.	4 lb.	8 lb.	16 lb.	40 lb.		
75	⅒ lb. (1½ oz.)	⅓ lb.	⅔ lb.	1 lb.	2½ lb.	5 lb.	10 lb.	25 lb.	50 lb.	
Emulsifiable con- centrate (pounds per gallon)										
1	¾ pt.	1 qt.	2 qt.	3 qt.	2 gal.	4 gal.	8 gal.	20 gal.	40 gal.	
1½	1⅓ cup	1½ pt.	3 pt.	½ gal.	1⅓ gal.	2⅔ 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	⅓ cup	½ pt.	1 pt.	1½ pt.	½ gal.	1 gal.	2 gal.	5 gal.	10 gal.	
5	2 fluid oz.	6 fluid oz.	¾ pt.	2⅔ cups	3 pt.	3 qt.	1¾ gal.	4 gal.	8 gal.	
6	1¾ fluid oz.	⅔ cup	1½ cups	1 pt.	2⅔ pt.	5 pt.	1½ gal.	3⅓ gal.	6⅔ gal.	
8	1 fluid oz.	¼ pt.	½ pt.	¾ pt.	1 qt.	½ gal.	1 gal.	2½ gal.	5 gal.	

### 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).
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. Some labels will give the rate in terms of the amount of the product per 1,000 feet of row or other area.
3. Consult the manufacturer's recommendations 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 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 and Miticides (Toxicities indicated are based on acute oral LD<sub>50</sub> of the technical grade)

##### CHLORINATED HYDROCARBONS

**Benzene hexachloride (BHC)**<sup>1</sup> See Lindane.  
**Chlorbenside (Mitox)**<sup>(R)</sup>

Principal formulation: 40% WP.\*  
Principal uses: Mites on fruit and ornamental crops.  
Toxicity: Low.  
Chemical name: p-chlorobenzyl, p-chlorophenyl sulfite.

**Chlordane.** Most uses have been canceled.

Principal formulations: 4 and 8 lb/gal EC.\* 40% WP, 5-10% (D), 5-33% G, 2-3% oil solutions, fertilizer mixtures.  
Principal uses: Termite control.  
Toxicity: Low.  
Chemical name: Octachlorohexahydro methanoindene.

**Chlorobenzilate (Acarben)**<sup>(R)</sup>

Principal formulation: 4 lb/gal EC.  
Principal uses: Mite control on fruits and ornamentals.  
Toxicity: Low.  
Chemical name: Ethyl 4,4-dichlorobenzilate.

**Dicofol (Kelthane)**<sup>(R)</sup>

Principal formulations: 35% WP, 4 lb/gal EC, 1.6 lb/gal EC.  
Principal uses: Mite control on fruits, vegetables, ornamentals, field crops, and buildings.  
Toxicity: Low.  
Chemical name: 1,1,bis(4-chlorophenyl), 2,2,2-trichloroethanol.

\*WP = wettable powder.  
EC = emulsifiable concentrate.  
D = dust.  
SP = soluble powder.  
\*\*PCO = pest control operator.

**Endosulfan** (Thiodan<sup>(R)</sup>)  
 Principal formulations: 2 lb/gal EC, 25 and 50% WP, 1% D, 10% G, aerosol.  
 Principal uses: Control of a broad spectrum of insects and mites on vegetable, fruit, and ornamental crops. Also used against greenhouse pests.  
 Toxicity: Moderate.  
 Chemical name: Hexachloro hexahydro-6,9-methanobenzodioxathiepin-3-oxide.

**Fenson**  
 Principal formulations: 50% WP.  
 Principal uses: Mite control on fruit.  
 Toxicity: Low.  
 Chemical name: p-chlorophenyl ester of benzenesulfonic acid.

**Lindane**  
 Principal formulations: 1.6 lb/gal EC, 25% WP. Seed treaters.  
 Principal uses: Seed treatment for wireworms, seed corn, beetle, and maggot control; greenhouse pests; swine mange and lice; nursery pests.  
 Toxicity: Moderate.  
 Chemical name: Gamma isomer of benzene hexachloride.

**Methoxychlor** (Marlate<sup>(R)</sup>)  
 Principal formulations: 50% WP, 2 lb/gal EC, 5-10% D, aerosols.  
 Principal uses: Household insects, vegetable and fruit pests, horn fly control on cattle, control of some shade tree and ornamental pests.  
 Toxicity: Low.  
 Chemical name: 2,2-bis (p-methoxyphenyl), 1,1,1-trichloroethane.

**Pentac**<sup>(R)</sup>  
 Principal formulations: 50% WP, 1.6 lb/gal EC.  
 Principal uses: Mite control on trees, shrubs, ornamentals, and greenhouse crops.  
 Toxicity: Low.  
 Chemical name: Bis (pentachloro 2,4 cyclopentadien-1-4).

**Toxaphene** (Attac<sup>(R)</sup>)  
 Principal formulations: 6 and 8 lb/gal EC, 50% WP, 10 to 20% D.

Principal uses: Control of cutworms, grasshoppers, armyworms on crops, and for certain livestock pests.  
 Toxicity: Moderate.  
 Chemical name: Chlorinated camphene.

**CARBAMATES**

**Aldicarb** (Temik<sup>(R)</sup>)  
 Principal formulations: 10% G.  
 Principal uses: Soil treatment for sugar beet root maggots, as a systemic insecticide on potatoes and certain greenhouse crops.  
 Toxicity: High.  
 Chemical name: 2 methyl-2-(methylthio) propionaldehyde O-(methyl-carbamoyl) oxime.

**Bendiocarb** (Ficam<sup>(R)</sup>, Tattoo<sup>(R)</sup>)  
 Principal formulations: 80% WP, 20% WP, 1% D, 18% fly spray.  
 Principal uses: Primarily insects in homes, food stores, and warehouses by professional applicators.  
 Toxicity: Moderate.  
 Chemical name: 2,2-dimethyl-1,3-benzodioxol-4-yl-N-methyl-carbamate.

**Carbaryl** (Sevin<sup>(R)</sup>, Sevimol<sup>(R)</sup>, Sevin-4-oil<sup>(R)</sup>)  
 Principal formulations: 80% WP, 50% WP, 4 lb/gal flowable, 4 lb/gal in oil, 5% bait.  
 Principal uses: Broad spectrum of pests of fruit, vegetables, field crops, ornamentals. Not effective against most aphids.  
 Toxicity: Low.  
 Chemical name: 1 naphthyl N-methyl-carbamate.

**Carbofuran** (Furadan<sup>(R)</sup>)  
 Principal formulations: 10% G, 4 lb/gal flowable.  
 Principal uses: Corn rootworms, European corn borer, grasshoppers, alfalfa weevil, sugarbeet root maggot, soil applied systemic for potatoes.  
 Toxicity: High.  
 Chemical name: 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methyl-carbamate.

**Methiocarb** (Mesuro<sup>(R)</sup>)  
 Principal formulations: 2% bait, 75% WP.  
 Principal uses: Slug control, some fruit insects, bird repellent.  
 Toxicity: Moderate.  
 Chemical name: 4-(methylthio)-3,5-xylyl methylcarbamate.

**Methomyl** (Lannate<sup>(R)</sup>, Nudrin<sup>(R)</sup>)  
 Principal formulations: 90% soluble powder, 1.9 lb/gal liquid concentrate.  
 Principal uses: Loopers, corn earworms, European corn borers, aphids, potato insects.  
 Toxicity: High.  
 Chemical name: 2-methyl-2-(methylthio) propionaldehyde 0-(methyl-carbamoyl) oxime

**Oxamyl** (Vydate<sup>(R)</sup>)  
 Principal formulations: 2 lb/gal EC.  
 Principal uses: Promising for ornamentals. Also a nematocide.  
 Toxicity: High.  
 Chemical name: Methyl N'N'-dimethyl-N-[(methyl-carbamoyl)oxy]-1-thioxamimidate.

**Pirimicarb** (Pirimor<sup>(R)</sup>) Manufacture discontinued.  
 Principal formulations: 50% wettable powder.  
 Principal uses: Aphids in the greenhouse and on potatoes.  
 Toxicity: Moderate.  
 Chemical Name: 2(dimethylamino)-5,6-dimethyl-4-pyrimidinyl dimethyl carbamate.

**Propoxur** (Baygon<sup>(R)</sup>)  
 Principal formulations: 1.4 lb/gal oil solution concentrate, 1.5 lb/gal spray concentrate, 1.5 lb/gal EC.  
 Principal uses: Cockroaches, other household pests, certain lawn and turf insects.  
 Toxicity: Moderate.  
 Chemical name: 2-(1-methylethoxy) phenyl methylcarbamate.

---

**ORGANOPHOSPHATES**

**Acephate** (Orthene<sup>(R)</sup>)  
 Principal formulations: 15% emulsifiable concentrate; 75% S.P.  
 Principal uses: Aphids, grasshoppers, loopers, caterpillars, thrips on ornamentals and other crops.

Toxicity: Low.  
 Chemical name: O,S-Dimethyl acetyl-phosphor-amidothioate.

**Aspon**<sup>(R)</sup>  
 Principal formulations: 13% emulsifiable concentrate, 67% E.C. (PCO) and 5% granular.  
 Principal uses: Sod webworm and chinch bug control on turf.  
 Toxicity: Low.  
 Chemical name: 0,0,0,0-tetrapropyl dithiopyrophosphate.

**Azinphosmethyl** (Guthion<sup>(R)</sup>)  
 Principal formulations: 50% WP, 2 lb/gal SC and LC, flowable.  
 Principal uses: Broad spectrum of pests of fruits, vegetables, ornamentals.  
 Toxicity: High.  
 Chemical name: 0,0 Dimethyl S-[4-oxo-1,2,3-benzotriazin-3 (4H)-ylmethyl] phosphorodithioate.

**NOTE:** There is also available an ethyl homolog, Ethyl Guthion.

**Bolstar**<sup>(R)</sup>  
 Principal formulations: 6 lb/gal. EC.  
 Principal uses: Promising against lepidopterous larvae.  
 Toxicity: Moderate.  
 Chemical name: O-Ethyl 0[4-methylthio) phenyl]S-propyl phosphorodithioate.

**Bomyl**<sup>(R)</sup>  
 Principal formulation: Bait.  
 Principal uses: House fly control.  
 Toxicity: High.  
 Chemical name: Dimethyl-1,3-di(carbomethoxy)-1-propen-2-yl phosphate.

**Carbophenothion** (Trithion<sup>(R)</sup>)  
 Principal formulations: 4 lb/gal EC, 25% WP, 4% D.  
 Principal uses: Broad spectrum. Insect and mite control on fruit, vegetables, and ornamentals.  
 Toxicity: High.  
 Chemical name: 0,0-diethyl S-(p-chlorophenyl thiomethyl) phosphorothioate.

<b>Chlorfenvinphos</b> (Birlane <sup>(R)</sup> , 4072)	Principal formulations: 2 lb/gal EC.	Toxicity: Moderate.
Principal uses: Fly control.	Chemical name: 0,0-dimethyl 0- <i>p</i> -sulfa-	moylphenyl phosphorothioate.
Toxicity: High.		
Chemical name: Diethyl-1-(2,4-dichloro-		
vinyl), 2-chlorovinyl		
phosphate.		
<b>Chlorpyrifos</b> (Dursban <sup>(R)</sup> Lorsban <sup>(R)</sup> )	Principal formulations: 2 lb/gal EC, 4 lb/gal	
Principal uses: Household insects,	EC, 0.5 solution, 0.5% G,	
lawn, turf and shade tree	1% G, 6 lb/gal fogging	
insects, mosquito control,	concentrate, 15% G, seed	
corn rootworms, cutworms,	treater.	
sugarbeet root maggot.		
Toxicity: Moderate.		
Chemical name: 0,0-diethyl 0-(3,5,6-tri-		
chloro-2 pyridyl) phos-		
phorothioate.		
<b>Coumaphos</b> (Co-Ral <sup>(R)</sup> )	Principal formulations: 25% WP, 0.5% and 5% D.	
Principal uses: Cattle grub, louse, and		
fly control on livestock.		
Toxicity: High.		
Chemical name: 0,0-diethyl 0-3-(chloro-4-		
methyl-2 oxo-2H)-1-benzo-		
pyran-7-yl) phosphoro-		
thioate.		
<b>Crotoxyphos</b> (Ciodrin <sup>(R)</sup> )	Principal formulations: 3% D, 1.1 lb/gal EC,	
Principal uses: Flies and lice on livestock.	mixtures with other	
Toxicity: Moderate.	materials.	
Chemical name: Dimethyl phosphate of		
<i>alpha</i> -methylbenzyl		
3-hydroxy-cis-crotonate.		
<b>Crufomate</b> (Ruelene <sup>(R)</sup> ) No longer manufactured.	Principal formulations: 25% WP, 2 lb/gal EC,	
Principal uses: Cattle grub, louse, and	35.7% dip conc., 13.5%	
Toxicity: Low.	Pour-On, 9.4% solution.	
Chemical name: 0 methyl 0-(4-tert-butyl-2-		
chlorophenyl) methyl phos-		
phoramidate.		
<b>Cythioate</b> (Proban <sup>(R)</sup> )	Principal formulation: 10% tablet or bolus.	
Principal uses: Systemic treatment of		
dogs for ectoparasites.		
<b>Demeton</b> (Systox <sup>(R)</sup> )	Principal formulations: 2 lb/gal EC, 6 lb/gal	
Principal uses: A foliar systemic for sap-	EC.	
Toxicity: High.		
Chemical name: 0,0-diethyl 0 (and S)-		
[2-(ethylthio) ethyl]		
phosphorothioates.		
<b>Diazinon</b> <sup>(R)</sup> (Spectracide <sup>(R)</sup> )	Principal formulations: 2% D, 4 lb/gal EC. 4%	
Principal uses: Household insects, broad	solution, 2, 4, and 14% G,	
spectrum of pests of	50% WP, mixture with	
field, fruit, vegetable,	methoxychlor, Alfatox <sup>(R)</sup> .	
and ornamental crops;		
houseflies; nuisance		
invaders.		
Toxicity: Moderate.		
Chemical name: 0-0-diethyl 0-(2-isopropyl-		
4-methyl-6-pyrimidinyl)		
phosphorothioate.		
<b>Dichlorvos</b> (Vapona <sup>(R)</sup> , DDVP)	Principal formulations: 2 lb/gal EC, plastic strips	
Principal uses: Fly and mosquito control,	and dog collars, in mixture	
flea, PCO use for some	with Ciodrin. <sup>(R)</sup>	
household insects, green-	(Ciovap <sup>(R)</sup> ).	
house pests.		
Toxicity: High.		
Chemical name: 2-2 dichlorovinyl dimethyl		
phosphate.		
<b>Dimethoate</b> (Cygon <sup>(R)</sup> , De-Fend <sup>(R)</sup> , Rebelate <sup>(R)</sup> ,	Principal formulations: 2 lb/gal EC, 2.67 lb/gal	
Dimex 267 <sup>(R)</sup> )	EC, 4lb/gal EC, 25% WP.	
Principal uses: Systemic control of broad		
spectrum of pests of		
fruit, field, vegetable, and		
ornamental crops;		
houseflies.		
Toxicity: Moderate.		
Chemical name: 0,0-dimethyl S-(N-methyl-		
carbamoylmethyl) phos-		
phorodithioate.		

<b>Dioxathion</b> (Delnav <sup>(R)</sup> , Deltic <sup>(R)</sup> )	Principal formulations: 2 lb/gal EC, 8 lb/gal EC, 15% and 30% EC livestock formulations.	Principal uses: Insects and mite pests of fruit, livestock ectoparasites.	Toxicity: Moderate.	Chemical name: 0,0-diethyl-S-(and 0)-[2-ethylthio) ethyl]phosphorothioates.	Principal uses: Cattle grub and louse control on cattle.	Toxicity: High.	Chemical name: 0,0-dimethyl 0 [p-(dimethyl-sulfamoyl) phenyl] phosphorothioate.
<b>Disulfoton</b> (DiSyston <sup>(R)</sup> )	Principal formulations: 6 lb/gal liquid conc., 15% G, low conc. granules and mixtures with fertilizer.	Principal uses: Soil applied systemic for potatoes, other vegetables and ornamentals, aphid control on certain field crops, sugar beet root maggot.	Toxicity: High.	Chemical name: 0,0 diethyl S-[2-(ethylthio) ethyl] phosphorodithioate.	<b>Fensulfothion</b> (Dasanit <sup>(R)</sup> )	Principal formulations: 15% G, 6 lb/gal spray concentrate.	Principal uses: Corn rootworms, onion maggot, root maggots.
<b>EPN</b>	Principal formulation: 25% WP.	Principal uses: European corn borer, fruit pests.	Toxicity: High.	Chemical name: 0-ethyl 0-p-nitrophenyl, phenylphosphorothioate.	<b>Fenthion</b> (Baytex <sup>(R)</sup> , Entex <sup>(R)</sup> , Tiguvon <sup>(R)</sup> )	Principal formulations: 4 lb/gal EC, 25% WP, 93% concentrate, 3% solution.	Principal uses: Flies, mosquitoes; certain pests of ornamentals; household pests.
<b>Ethion</b>	Principal formulations: 25% WP, 4 lb/gal EC, 5% G, mixture with oil.	Principal uses: Fruit pests, onion maggot, scales and mites of some fruit, vegetables, and ornamentals.	Toxicity: High.	Chemical name: 0,0,0'-tetraethyl S, S'-methylene bisphosphorodithioate.	<b>Fonofos</b> (Dyfonate <sup>(R)</sup> )	Principal formulations: 10 and 20% G, 4 lb/gal EC.	Principal uses: Corn rootworm, wireworm, sugarbeet root maggot control.
<b>Ethoprop</b> (Mocap <sup>(R)</sup> )	Principal formulations: 10% and 15% G., 6 lb/gal EC.	Principal uses: Corn rootworms, wireworms.	Toxicity: High.	Chemical name: 0-ethyl S-phenyl ethylphosphorodithioate.	<b>Isofenphos</b> (Amaze <sup>(R)</sup> )	Principal formulations: 20% G, 6 lb/gal EC.	Principal uses: Soil insecticide, corn rootworm.
<b>Famphur</b> (Warbex <sup>(R)</sup> )	Principal formulations: 13.2% Pour-on; feed pre-mix concentrate.				<b>Malathion</b> (Cythion <sup>(R)</sup> )	Principal formulations: 5 lb/gal EC, 95% concentration for ULV, 25% WP, 4% dust, in mixtures for home and garden.	Principal uses: Broad spectrum of household and garden pests; fruit, vegetable, and field crop pests, especially aphids; stored grain protectant; flies and mosquitoes.

Toxicity:	Low.	Toxicity:	Moderate.
Chemical name:	0,0-dimethyl dithiophosphate of diethyl mercaptosuccinate.	Chemical name:	1,2-dibromo-2,2-dichloroethyl dimethyl phosphate.
<b>Methamidophos</b> (Monitor <sup>(R)</sup> )		<b>Oxydemetonmethyl</b> (Meta-Systox-R <sup>(R)</sup> )	
Principal formulations:	4 lb/gal EC.	Principal formulations:	2 lb/gal EC and in mixtures for garden use.
Principal uses:	Potato insects, certain other vegetable pests, especially aphids and loopers.	Principal use:	Foliar systems for aphids, mites, leafhoppers on several field, vegetable, fruit, and ornamental crops.
Toxicity:	High.	Toxicity:	High.
Chemical name:	0,S-dimethyl phosphorimidothioate.	Chemical name:	S-[2-(ethylsulfinyl)-ethyl]0,0-dimethyl phosphorothioate.
<b>Methidathion</b> (Supracide <sup>(R)</sup> )		<b>Parathion, ethyl</b>	
Principal formulations:	2 lb/gal EC.	Principal formulations:	2 and 8 lb/gal EC, 15 and 25% WP, 10% G.
Principal uses:	Alfalfa and sunflower insects.	Principal uses:	Aphids, mites, and other pests of commercial field, fruit, and vegetable crops.
Toxicity:	High.	Toxicity:	High.
Chemical name:	S-(2-methoxy-5-oxo- $\Delta^2$ -1,3,4-thiadiazolin-4yl)=methyl) 0,0 dimethyl phosphorodithioate.	Chemical name:	0,0-diethyl 0- <i>p</i> -nitrophenyl phosphorothioate.
<b>Methyl parathion</b> (PennCap M <sup>(R)</sup> )		<b>Phorate</b> (Thimet <sup>(R)</sup> )	
Principal formulations:	25% EC, microencapsulated.	Principal formulations:	15% and 20% G.
Principal uses:	Aphids on field crops, corn earworm, European corn borer.	Principal uses:	Corn rootworm, soil systemic on potatoes, some other vegetables.
Toxicity:	High.	Toxicity:	High.
Chemical name:	0,0-dimethyl 0- <i>p</i> -nitrophenyl phosphorothioate.	Chemical name:	0,0 diethyl S-[(ethylthio)methyl] phosphorodithioate.
<b>Mevinphos</b> (Phosdrin <sup>(R)</sup> )		<b>Phosmet</b> , (Imidan <sup>(R)</sup> , Prolate <sup>(R)</sup> )	
Principal formulations:	4 lb/gal EC, 10.3 lb/gal soluble concentrate.	Principal formulations:	50% WP.
Principal uses:	Commercial fruit and vegetable pests.	Principal uses:	Alfalfa weevil, broad spectrum of fruit pests and of trees and shrubs. As Prolate <sup>(R)</sup> livestock pests.
Toxicity:	High.	Toxicity:	Moderate.
Chemical name:	<i>alpha</i> isomer of 2-carbomethoxy-1-methylvinyl dimethyl phosphate.	Chemical name:	N-(mercaptomethyl) phthalimide, S-(0,0-dimethyl phosphorodithioate).
<b>Monocrotophos</b> (Azodrin <sup>(R)</sup> )		<b>Phosphamidon</b> (Dimecron <sup>(R)</sup> )	
Principal formulations:	3.2 lb/gal EC.	Principal formulation:	8 lb/gal EC.
Principal uses:	Potato insects.	Principal uses:	Certain commercial vegetable and fruit pests, mainly aphids, mites, and leafhoppers.
Toxicity:	High.	Toxicity:	High.
Chemical name:	Dimethyl phosphate of 3-hydroxyl-N-methylcis crotonamide.		
<b>Naled</b> (Dibrom <sup>(R)</sup> )			
Principal formulations:	4 and 8 lb/gal EC, fly baits.		
Principal uses:	Flies and mosquitoes, broad spectrum of vegetable and fruit pests.		



Chemical name: 2 chloro-diethylcarbamoyl-1-methyl vinyl dimethyl phosphate.

**Ronnel** (Korlan<sup>(R)</sup>). No longer manufactured.

Principal formulations: 2 lb/gal EC, 2.5% pressurized spray, 5% smear.

Principal uses: Household insect pests, livestock ectoparasites, fly control.

Toxicity: Low.

Chemical name: 0,0-dimethyl 0 (2,4,5-trichlorophenyl) phosphorothioate.

**Stirofos** (Rabon<sup>(R)</sup>)

Principal formulations: 50% WP, 3% D, 2 lb/gal EC; in mixture with dichlorvos (RaVap<sup>(R)</sup>).

Principal uses: Fly control.

Toxicity: Low.

Chemical name: 2-chloro-1-(2,4,5 trichlorophenyl) vinyl dimethyl phosphate.

**Temephos** (Abate<sup>(R)</sup>)

Principal formulations: 4 lb/gal EC, 1,2 and 5% G.

Principal uses: Mosquito larvacide.

Toxicity: Low.

Chemical name: 0,0-dimethyl phosphorothioate 0,0-diester with 4,4'-thiodiphenol.

**TEPP**. No longer manufactured.

Principal formulations: 40% EC.

Principal use: Greenhouse.

Toxicity: Very high.

Chemical name: Tetra ethyl pyrophosphate.

**Terbufos** (Counter<sup>(R)</sup>).

Principal formulations: 15% G.

Principal uses: Corn rootworm, wireworm control on corn, sugarbeet root maggot.

Toxicity: High.

Chemical name: S-(*tert*-butylthio) methyl 0,0-diethyl phosphorodithioate.

**Trichlorfon** (Dipterex<sup>(R)</sup>, Dylox<sup>(R)</sup>, Neguvon<sup>(R)</sup>, Proxol<sup>(R)</sup>)

Principal formulations: 80% SP, 4 lb/gal solution, 1.5 lb/gal in oil.

Principal uses: Baits, houseflies, livestock pests; cutworms, webworms, and similar insects on several field, vegetable, and ornamental crops.

Toxicity: Low.

Chemical name: Dimethyl (2,2,2-trichloro-1 hydroxyethyl) phosphonate.

---

## SULFONATE, CARBONATES, BOTANICALS, AND MISCELLANEOUS GROUPS

**Allethrin** (also d-Trans Allethrin)

Principal formulations: In aerosols and pressurized sprays.

Principal uses: Household insects and fly control.

Toxicity: Low.

Chemical name: cis, trans- ( $\pm$ )-2, 2-dimethyl-3-(2-methylpropenyl) cyclopropane carboxylic acid ester of ( $\pm$ )-2 allyl-4 hydroxy-3-methyl-2-cyclopenten-1-one.

**Bacillus thuringiensis** (Thuricide<sup>(R)</sup>, Biotrol<sup>(R)</sup>, Dipel<sup>(R)</sup>)

Principal formulations: Various strains and formulations of the bacterium are available, mostly in WP form.

Principal uses: Leaf feeding caterpillars, such as European corn borer, cabbage worms, loopers; some defoliators of trees and shrubs.

Toxicity: Low.

Chemical name: Same.

**Cyhexatin** (Plictran<sup>(R)</sup>)

Principal formulation: 50% WP.

Principal uses: Mites on fruit and ornamentals.

Toxicity: Moderate.

Chemical name: (tricyclohexylhydroxystannane).

**Fenvalerate** (Pydrin<sup>(R)</sup>)

Principal formulations: 2.4 lb/gal. EC.

Principal uses: Promising pyrethroid effective against a wide range of insects, especially lepidopterous larvae. Labeled for potatoes.

Toxicity: Low.

Chemical name: Cyano (3-phenoxyphenyl) methyl 4-chloro-alpha-(1-methylethyl)benzeneacetate.

<b>Nicotine sulfate</b>		<b>Toxicity:</b>	Low.
Principal formulations:	Liquid concentrate; smoke.	<b>Chemical name:</b>	6 methyl-2,3-quinoxal-dithiol cyclic S, S dithio-carbonate.
Principal uses:	Aphid control in home gardens, and in greenhouse.		
<b>Toxicity:</b>	Moderate.		
<b>Chemical name:</b>	Same.		
<b>Diflubenzuron (Dimilin<sup>(R)</sup>)</b>		<b>Permethrin (Ambush<sup>(R)</sup>, Pounce<sup>(R)</sup>, Ectiban<sup>(R)</sup>, Atroban<sup>(R)</sup>, Praemax<sup>(R)</sup>)</b>	
Principal formulation:	25% wettable powder.	Principal formulation:	2.4, 3.2 lb/gal EC.
Principal uses:	Certain forest insects. Promising against a wide range of insects. Kills by inhibiting cuticle development in immature insects.	Principal uses:	Promising pyrethroid effective against a wide range of insects, especially lepidopterous larvae.
<b>Toxicity:</b>	Low.	<b>Toxicity:</b>	Low.
<b>Chemical name:</b>	N[(4-chlorophenyl) amino carbonyl] 2,6 difluorobenzamide.	<b>Chemical name:</b>	M-phenoxybenzyl ( $\pm$ )-cis, trans-3-(2,2 dichlorovinyl) 2, 2-dimethyl cyclopropane carboxylate.
<b>Kinoprene (Enstar 5 E<sup>(R)</sup>)</b>		<b>Pyrethrins (Pyrethrum)</b>	
Principal formulation:	5 lb/gal EC.	Principal formulations:	Variety of aerosols, household sprays, and garden preparations.
Principal uses:	Whiteflies and aphids on ornamental plants in greenhouses.	Principal uses:	Flies and mosquitoes, household pests, stored-product insects, garden insects.
<b>Toxicity:</b>	Low.	<b>Toxicity:</b>	Low.
<b>Chemical name:</b>	2-propenyl (E,E)-3-7,11-trimethyl-2,4-dodecadienote.	<b>Chemical name:</b>	Pyrethrins I and II, esters of chrysanthemum carboxylic acids and pyrethrolone.
<b>Methoprene (Altosid<sup>(R)</sup>)</b>		<b>Resmethrin (SBP-1382<sup>(R)</sup>)</b>	
Principal formulation:	10% liquid concentrate.	Principal formulation:	Aerosol generator, 24.3% E.C.
Principal uses:	Mosquito control, hornfly control on range cattle. A synthetic insect growth regulator (IGR).	Principal uses:	Whitefly, fungus gnat adults and flower thrips in the greenhouse and for certain flying and crawling insects indoors. Mosquitoes.
<b>Toxicity:</b>	Low.	<b>Toxicity:</b>	Low.
<b>Chemical name:</b>	[Isopropyl(E,E)-11-methoxy 3,7,11-trimethyl 2,4-dodecadienoate].	<b>Chemical name:</b>	(5-Benzyl-3-furyl) methyl 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate.
<b>Omite</b>		<b>Rotenone</b>	
Principal formulation:	30% WP, 6 lb/gal EC.	Principal formulations:	0.5 to 5% D and WP. Also in mixtures for home gardens.
Principal uses:	Mites on fruit.	Principal uses:	Vegetable garden pests.
<b>Toxicity:</b>	Low.	<b>Toxicity:</b>	Moderate (High to fish).
<b>Chemical name:</b>	2-( <i>p</i> - <i>tert</i> -butylphenoxy) cyclohexyl 2-propynyl sulfite.	<b>Chemical name:</b>	Same (a product from plants, <i>Derris</i> and <i>Lonchocarpus</i> ).
<b>Ovex (Ovotran<sup>(R)</sup>)</b>		<b>Ryania</b>	
Principal formulation:	50% WP.	Principal formulations:	40% D, 100% WP.
Principal uses:	Mites on fruit.	Principal uses:	European corn borer, codling moth.
<b>Toxicity:</b>	Low.		
<b>Chemical name:</b>	<i>p</i> -chlorophenyl <i>p</i> -chlorobenzene sulfonate.		
<b>Oxythioquinox (Morestan<sup>(R)</sup>)</b>			
Principal formulation:	25% WP.		
Principal uses:	Mites on fruit and ornamentals.		

<p><b>Toxicity:</b> Low.</p> <p><b>Chemical name:</b> Derived from a plant, <i>Ryania speciosa</i>.</p>	<p><b>Principal uses:</b> fly control products. Oil solutions to 10%. Fly control, household insects, home gardens.</p>
<p><b>Sabadilla</b></p> <p><b>Principal formulations:</b> 10 and 20% D.</p> <p><b>Principal uses:</b> Squash bug and some other plant bugs.</p> <p><b>Toxicity:</b> Low.</p> <p><b>Chemical name:</b> Derived from a plant, <i>Schoenocaulon sp.</i></p>	<p><b>Toxicity:</b> Low to medium, depending on product.</p> <p><b>Chemical names:</b> Thanite<sup>(R)</sup> = isobornyl thiocynoacetate; Lethane 60<sup>(R)</sup> = thiocynoethyl laurate; Lethane 384<sup>(R)</sup> = butoxy-thio-cyanodiethyl ether.</p>
<p><b>Tetradifon (Tedion<sup>(R)</sup>)</b></p> <p><b>Principal formulations:</b> 25% WP.</p> <p><b>Principal uses:</b> Mites on fruit and ornamental crops.</p> <p><b>Toxicity:</b> Low.</p> <p><b>Chemical name:</b> <i>p</i>-chlorophenyl 2,4,5-trichlorophenyl sulfone.</p>	<p><b>Vendex<sup>(R)</sup></b></p> <p><b>Principal formulation:</b> 50% W.P.</p> <p><b>Principal uses:</b> Mites on ornamentals, fruit and greenhouse crops.</p> <p><b>Toxicity:</b> Low.</p> <p><b>Chemical name:</b> Hexakis (2-methyl-2-phenylpropyl)-distan-noxane</p>
<p><b>Thiocyanates (Lethane<sup>(R)</sup>, Thanite<sup>(R)</sup>)</b></p> <p><b>Principal formulations:</b> Usually in mixtures of</p>	

---

#### Other publications in this series:

Insecticide Suggestions to Control Insect Pests of Field Crops—Extension Bulletin 388

Insecticide Suggestions to Control Household Insects—Extension Folder 412

Insecticide Suggestions to Control Livestock and Poultry Pests—Extension Folder 413

Insecticide Suggestions to Control Tree, Shrub, Lawn, and Turf Insects—Extension Folder 414

Insecticide Suggestions to Control Greenhouse and Floriculture Pests—Extension Bulletin 392

---

The information given in this publication is for educational purposes only. References to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Minnesota Agricultural Extension Service is implied.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Norman A. Brown, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108. We offer our programs and facilities to all people without regard to race, creed, color, sex, national origin, or handicap.

30e

UNIVERSITY OF MINNESOTA



3 1951 D02 064 675 0