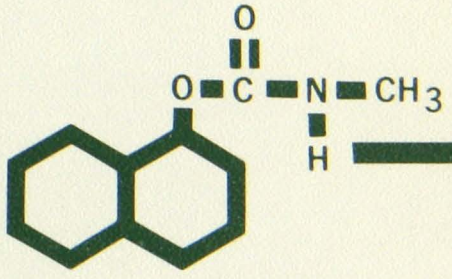
INSECTICIDES



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AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF MINNESOTA

Contents

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 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

Many organic phosphate insecticides (TEPP, parathion, methyl parathion, tetraethyl dithiopyrophosphate, EPN, demeton, azinphosmethyl, mevinphos, phorate, and disulfoton 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.

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 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 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. 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.

Minnesota poison information centers

These centers have been established by the Minnesota Department of Health *to provide* 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. 450, 451, 452
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.)
Mankato	Immanuel-St. Joseph's Hospital	507-625-4031
Marshall	Lewis Weiner Memorial Hospital	507-532-9661 Station 125
Minneapolis	Minnesota Poison Information Minn. Department of Health 717 Delaware St. S.E.	612-296-5276
	Fairview Hospital 2312 South 6th St.	612-332-0282 Ext. 313
	Hennepin County Medical Center 701 Park Ave.	612-347-3141
	North Memorial Hospital 3220 Lowry Avenue North	612-588-0616 Ext. 341, 342, 346
	Northwestern Hospital 810 E. 27th St.	612-874-4233
(Fridley)	Unity Hospital 550 Osborne Road	612-786-2200 Ext. 350
Morris	Stevens County Memorial Hospital	612-589-1313 Station 1
St. Cloud	St. Cloud Hospital	612-251-2700
St. Paul	Bethesda Hospital 559 Capitol Blvd.	612-221-2301, 2302, 2303
	St. Paul Ramsey Hospital 640 Jackson	612-222-4260 Ext. 694
	St. John's Hospital 403 Maria Avenue	612-228-3132
	St. Joseph's Hospital 69 West Exchange	612-291-3348, 291-3139,
	St. Luke's Hospital 300 Pleasant Avenue	612-298-8201
	Children's Hospital 311 Pleasant Avenue	612-227-6521 Ext. 434, 435
Virginia	Virginia Municipal Hospital	218-741-3340
Willmar	Rice Memorial Hospital	612-235-4543 Ext. 291
Worthington	Worthington Regional Hospital	507-372-2941 Ext. 156

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

Insecticides *highly toxic* to honey bees

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

Insecticides *moderately toxic* to honey bees

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

Insecticides *with low toxicity* to honey bees

Allethrin
Aramite
Bacillus thuringiensis (Thuricide, Biotrol, Dipel)
Binapacryl (Morocide)
Chlorbenside (Mitox)
Chlordimeform
Chlorobenzilate (Acaraben)
Chloropropylate (Acaralate)
Dicofol (Kelthane)
Dimite (DMC)
Dioxathion (Delnav)
Ethion (Nialate)
Methoxychlor
Oxythioquinox (Morestan)
Nicotine
Omite
Ovex (Ovotran)
Pyrethrins
Rotenone
Sabadilla
TDE (Rhothane, DDD)
Tetradifon (Tedion)
Toxaphene
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 $LD_{50's}$

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_{50}. This means the amount of insecticide that would kill (LD means lethal dose) 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_{50} 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 $LD_{50's}$ for Insecticides*

Insecticides	LD_{50} 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	——	——
Aspon	891	——	2100	——
Azinphosmethyl (Guthion)	13	11	220	220
Monocrotophos (Azodrin)	21	——	354	——
Benzene hexachloride (BHC)	1250	——	——	——
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	——
Crufomate (Ruelene)	635	460	——	——
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, 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
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	——
Fensulfothion (Dasanit)**	10	2	30	3
Fenthion (Baytex)	190	245	330	330
Fenson**	1350-1740	——	——	——
Heptachlor	100	162	195	250
Imidan (Prolate)**	147-299	——	>3160	——
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 FMC. ‡ These are 1969 figures from Chemagro.

Acute Oral and Dermal LD_{50}'s for Insecticides* (continued)

Insecticides	LD_{50} in mg./kg.			
	Oral		Dermal	
	Males	Females	Males	Females
Malathion	1375	1000	> 4444	> 4444
Methiocarb (Mesurol)**	130-135	——	> 200	——
Metaldehyde**	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
Mirex	740	600	> 2000	> 2000
Ethoprop (Mocap)**	61	——	26	——
Methadimophos (Monitor)	21	19	118	——
Naled (Dibrom)	250	——	800	——
Nicotine sulfate	——	83	——	285
Omite**	2500	——	——	——
Acephate (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
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	——
Stirofos (Gardona, Rabon)	4000-5000**	1125	>5000	74000
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, 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. 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.

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:

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 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 0.95 liter
1 gallon = 4 quarts, or 128 fluid ounces or 3.8 liters
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 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 feett 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 lb/A = 1.12 kg/Ha
1 kg/Ha = 0.9 lb/A
5 kg/Ha = 4.5 lb/A
1 quintal = 100 kg, or 221 lb

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—wettable 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
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	1/5 lb.	¾ lb.	1½ lb.	2 lb.	5 lb.	10 lb.	20 lb.		
50	1/6 lb. (2½ oz.)	½ lb.	1 lb.	1½ lb.	4 lb.	8 lb.	16 lb.	40 lb.	
75	1/10 lb. (1½ oz.)	⅓ lb.	⅔ lb.	1 lb.	2½ lb.	5 lb.	10 lb.	25 lb.	50 lb.
Emulsifiable concentrate *(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.

3. Drive exactly ⅛ 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 ⅛ 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, Miticides (Toxicities indicated are based on acute oral LD_{50} of the technical grade)

CHLORINATED HYDROCARBONS

Aldrin[1]. There are no recommended uses for aldrin in Minnesota.

Benzene hexachloride (BHC)[1] See Lindane

Chlorbenside (Mitox(R))

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

Chlordane. Most uses are suspended during cancellation hearings in progress.

Principal formulations:	4 and 8 lb/gal EC.* 40% WP, 5-10% dusts, 5-33% G, 2-3% oil solutions, fertilizer mixtures.
Principal uses:	Termite control, soil treatment for wireworms, cutworms, white grubs in corn.
Toxicity:	Low.
Chemical name:	Octachlorohexahydro methanoindene.

Chlorobenzilate (Acarben(R))

Principal formulations:	4 lb/gal EC, 25% WP, 4% dust, pressurized sprays.
Principal uses:	Mite control on food, feed, and ornamental plants.
Toxicity:	Low.
Chemical name:	Ethyl 4, 4'-dichlorobenzilate.

DDT[1] There are no recommended uses for DDT in Minnesota.

Dicofol (Kelthane(R))

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.

Dieldrin[1]

Principal formulations:	1.5 lb/gal EC, 50% WP.
Principal uses:	Recommended only for termite control by PCO's in Minnesota.
Toxicity:	High.
Chemical name:	Hexachloro epoxy octahydrodimethanophthalene.

Endosulfan (Thiodan(R))

Principal formulations:	2 lb/gal EC, 25 and 50% WP, 1% D, 10% G, aerosol.

[1] Restricted use pesticide in Minnesota.
* WP=Wettable powder, EC=emulsifiable concentrate.
** PCO=pest control operator.

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.

Endrin[1] There are no recommended uses for endrin in Minnesota.

Fenson

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

Heptachlor[1] Most uses suspended during cancellation hearings.

Principal formulations:	25% G, 2 lb/gal EC., 25% WP. Seed treaters.
Principal uses:	Soil insects of corn. PCO use for termites.
Toxicity:	Moderate.
Chemical name:	Heptachlorotetrahydro-4, 7-methanoindene.

Lindane[1]

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;
Toxicity:	nursery pests.
Chemical name:	Moderate. Gamma isomer of benzene hexachloride.

Methoxychlor

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(R) (Hooker HRS-16)

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).

Perthane(R)

Principal formulation:	4 lb/gal EC, 50% WP, 10% D.
Principal uses:	In combination with other compounds for cabbage worm control, certain household insects, and clothes moths.
Toxicity:	Low.
Chemical name:	1,1 dichloro-2,2-bis (p-ethylphenyl ethane).

TDE (DDD)[1] There are no recommended uses in Minnesota.

Toxaphene

Principal formulations:	6 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(R))

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.

[1] Restricted use pesticide in Minnesota.

Carbaryl (Sevin(R), Sevimol(R), Sevin-4-oil(R))

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-methylcarbamate.

Carbofuran (Furadan(R))

Principal formulations:	10% G. 4 lb/gal flowable.
Principal uses:	Corn rootworms, European corn borer, soil applied systemic for potatoes, grasshoppers, alfalfa weevil, sugarbeet root maggot.
Toxicity:	High.
Chemical name:	2,3-dihydro-2, 2-dimethyl-7-benzofuranyl methylcarbamate.

Methiocarb (Mesurol(R))

Principal formulations:	2% bait, 75% WP.
Principal uses:	Slug control, some fruit insects, bird repellant.
Toxicity:	Moderate.
Chemical name:	4-(methylthio)-3,5-xylyl methylcarbamate.

Methomyl (Lannate(R), Nudrin(R))

Principal formulations:	90% Soluble powder, 1.9 lb/gal liquid concentrate.
Principal uses:	Loopers, earworms, European corn borers, aphids, potato insects.
Toxicity:	High.
Chemical name:	S-methyl-N-[(methylcarbamoyl)oxy] thioacetimidate.

Pirimor(R)

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(R))

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

Abate(R)

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

Acephate (Orthene(R))

Principal formulations:	15% emulsifiable concentrate.
Principal uses:	Aphids, loopers, caterpillars, thrips on ornamentals. Similar to Monitor in activity.
Toxicity:	Low.
Chemical name:	O,S-Dimethyl acetylphosphor-amidothioate.

Aspon(R)

Principal formuations:	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(R))

Principal formulations:	50% WP, 2 lb/gal SC and LC.
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(4*H*)-ylmethyl]phosphorodithioate.

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

Bomyl(R)

Principal formulation:	Bait.
Principal uses:	House fly control
Toxicity:	High.
Chemical name:	Dimethyl-1,3-di(carbomethoxy)-1-propen-2-yl phosphate.

Carbophenothion (Trithion(R))

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.

Chlorfenvinphos (Birlane(R), 4072)

Principal formulations:	2 lb/gal EC.
Principal uses:	Fly control.
Toxicity:	High.
Chemical name:	Diethyl-1-(2,4-dichlorovinyl), 2-chlorovinyl phosphate.

Chlorpyrifos (Dursban(R) Lorsban (R))

Principal formulations:	2 lb/gal EC, 4 lb/gal EC, 0.5 solution, 0.5% G, 1% G, 6 lb/gal fogging concentrate, 15% G, seed treater.
Principal uses:	Household insects, lawn and turf insects, mosquito control, corn rootworm.
Toxicity:	Moderate.
Chemical name:	0,0-diethyl 0-(3,5,6-trichloro-2 pyridyl) phosphorothioate.

Coumaphos (Co-Ral(R))

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-benzopyran-7-yl) phosphorothioate.

Crotoxyphos (Ciodrin(R))

Principal formulations:	3% D, 1.1 lb/gal EC, mixtures with other materials.
Principal uses:	Flies and lice on livestock.
Toxicity:	Moderate.
Chemical name:	Dimethyl phosphate of *alpha*-methylbenzyl 3-hydroxy- cis-crotonate.

Crufomate (Ruelene(R))

Principal formulations:	25% WP, 2 lb/gal EC, 35.7% dip conc., 13.5% Pour-On, 9.4% solution.
Principal uses:	Cattle grub, louse, and horn fly control on cattle.
Toxicity:	Low.
Chemical name:	0 methyl 0-(4-tert-butyl-2-chlorophenyl) methyl phosphoramidate.

Cythioate (Proban(R))

Principal formulation:	10% tablet or bolus.
Principal uses:	Systemic treatment of dogs for ectoparasites.
Toxicity:	Moderate.
Chemical name:	0,0-dimethyl *0-p*-sulfamoylphenyl phosphorothioate.

Demeton (Systox(R))

Principal formulations:	2 lb/gal EC, 6 lb/gal EC.
Principal uses:	A foliar systemic for sap-sucking insects on field, fruit, vegetable, and ornamental crops.
Toxicity:	High.
Chemical name:	0,0-diethyl 0 (and S)-[2-(ethylthio) ethyl] phosphorothioates.

Diazinon(R) (SpectracideR)

Principal formulations:	2% D, 4 lb/gal EC. 4% solution, 2, 4, and 14% G, 50% WP, mixture with methoxychlor, Alfatox(R).

Principal uses:	Household insects, broad spectrum of pests of field, fruit, vegetable, and ornamental crops, houseflies; nuisance invaders.
Toxicity:	Moderate.
Chemical name:	0-0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate.

Dichlorvos (Vapona(R), DDVP)

Principal formulations:	2 lb/gal EC, plastic strips and dog collars, in mixture with Ciodrin,(R) (Ciovap(R)).
Principal uses:	Fly and mosquito control, fleas, PCO use for some household insects, greenhouse pests.
Toxicity:	High.
Chemical name:	2-2 dichlorovinyl dimethyl phosphate.

Dimethoate (Cygon(R), De-Fend(R), Rebelate(R), Dimex 267(R))

Principal formulations:	2 lb/gal EC, 2.67 lb/gal EC, 4 lb/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) phosphorodithioate.

Dioxathion (Delnav(R))

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:	S,S'(-p-dioxane-2,3-diyl) 0,0-diethyl phosphorodithioate(cis and trans isomers).

Disulfoton (DiSyston(R))

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, sugarbeet root maggot.
Toxicity:	High.
Chemical name:	0,0 diethyl S-[2-(ethylthio) ethyl] phosphorodithioate.

EPN

Principal formulation:	25% WP.
Principal uses:	European corn borer, fruit pests.
Toxicity:	High.
Chemical name:	0-ethyl 0-p-nitrophenyl, phenylphosphonothioate.

Ethion

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:	0,0,0'0'-tetraethyl S, S'-methylene bisphosphorodithioate.

Ethoprop (Mocap(R))

Principal formulations:	10% G.
Principal uses:	Corn rootworms, wireworms.
Toxicity:	High.
Chemical name:	0-ethyl S, S-dipropyl phosphorodithioate.

Famphur (Warbex(R))

Principal formulations:	13.2% Pour-on; feed pre-mix concentrate.

Principal uses:	Cattle grub and louse control on cattle.
Toxicity:	High.
Chemical name:	0,0-dimethyl 0 [p-(dimethyl-sulfamoyl) phenyl] phosphorothioate.

Fensulfothion (Dasanit(R))

Principal formulations:	15% G, 6 lb/gal spray concentrate.
Principal uses:	Corn rootworms, onion maggot, promising against other soil insects and nematodes.
Toxicity:	High.
Chemical name:	0,0-diethyl 0 p-[(methylsulfinyl) phenyl] phosophorothioate.

Fenthion (Baytex(R), Entex(R), Tiguvon(R))

Principal formulations:	4 lb/gal EC, 25% WP, 93% concentrate, 3% solution.
Principal uses:	Flies, mosquitoes; certain pests of ornamentals; household pests.
Toxicity:	Moderate.
Chemical name:	0,0 dimethyl 0[4-(methylthio) m-tolyl] phosphorothioate.

Fonofos (Dyfonate(R))

Principal formulations:	10 and 20% G, 4 lb/gal EC.
Principal uses:	Corn rootworm and sugarbeet root maggot Corn rootworm, wireworm, sugarbeet root maggot control, promising for other soil insects.
Toxicity:	High.
Chemical name:	0-ethyl S-phenyl ethylphosphonodithioate.

Gardona(R) (See Rabon(R))

Malathion (Cythion (R))

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.
Chemical name:	0,0-dimethyl dithiophosphate of diethyl mercaptosuccinate.

Methidathion (Supracide(R))

Principal formulations:	2 lb/gal EC.
Principal uses:	Alfalfa and sunflower insects.
Toxicity:	High.
Chemical name:	S-(2-methoxy-5-oxo-$\triangle^2$-1,3,4-4-yl methyl) 0,0 dimethyl phosphorodithioate.

Methyl parathion (Penncap M(R))

Principal formulations:	25% EC, microencapsulate.
Principal uses:	Aphids on field crops, sunflower insects, corn earworm, European corn borer.
Toxicity:	High.
Chemical name:	0,0-dimethyl 0-*p*-nitrophenyl phosphorothioate.

Mevinphos (Phosdrin(R))

Principal formulations:	4 lb/gal EC, 10.3 lb/gal soluble concentrate.
Principal uses:	Commercial fruit and vegetable pests.
Toxicity:	High.
Chemical name:	*alpha* isomer of 2-carbomethoxy-1-methylvinyl dimethyl phosphate.

Methadimophos (Monitor(R))

Principal formulations:	4 lb/gal EC.
Principal uses:	Potato insects, certain other vegetable pests, especially aphids and loopers.
Toxicity:	High.
Chemical name:	0,S-dimethyl phosphoramidothioate.

Monocrotophos (Azodrin(R))

Principal formulations:	3.2 lb/gal EC
Principal uses:	Potato insects.
Toxicity:	High.
Chemical name:	Dimethyl phosphate of 3-hydroxyl-N-methyl-ciscrotonamide.

Naled (Dibrom(R))

Principal formulations:	4 and 8 lb/gal EC, fly baits.
Principal uses:	Flies and mosquitoes, broad spectrum of vegetable and fruit pests.
Toxicity:	Moderate.
Chemical name:	1,2-dibromo-2,2-dichloroethyl dimethyl phosphate.

Oxydemetonmethyl (Meta-Systox-R(R))

Principal formulations:	2 lb/gal EC and in mixtures for garden use.
Principal use:	Foliar systems for aphids, mites, leafhoppers on several field, vegetable, fruit, and ornamental crops.
Toxicity:	High.
Chemical name:	S-[2-(ethylsulfinyl)-ethyl] 0,0-dimethyl phosphorothioate.

Parathion

Principal formulations:	2 and 8 lb/gal EC, 15 and 25% WP, 10% G.
Principal uses:	Aphids, mites, and other pests of commercial field, fruit, and vegetable crops.
Toxicity:	High.
Chemical name:	0,0-diethyl 0-*p*-nitrophenyl phosphorothioate.

Phorate (Thimet(R))

Principal formulations:	15% G.
Principal uses:	Corn rootworm, soil systemic on potatoes, some other vegetables.
Toxicity:	High.
Chemical name:	0,0 diethyl S-[(ethylthio)methyl] phosphorodithioate.

Phosmet, (Imidan(R), Prolate(R))

Principal formulations:	50% WP.
Principal uses:	Alfalfa weevil, broad spectrum of fruit pests of trees and shrubs. As Prolate(R) livestock pests.
Toxicity:	Moderate.
Chemical name:	N-(mercaptomethyl) phthalimide, S-(0,0-dimethyl phosphorodithioate).

Phosphamidon (Dimecron(R))

Principal formulation:	8 lb/gal EC.
Principal uses:	Certain commercial vegetable and fruit pests, mainly aphids, mites, and leafhoppers.
Toxicity:	High.
Chemical name:	2 chloro-diethylcarbamoyl-1-methyl vinyl dimethyl phosphate.

Ronnel (Korlan(R))

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(R))

Principal formulations:	50% WP, 3% D, 2 lb/gal EC; in mixture with dichlorvos (RaVap(R)).
Principal uses:	Fly control.
Toxicity:	Low.
Chemical name:	2-chloro-1-(2,4,5 trichlorophenyl) vinyl dimethyl phosphate.

TEPP

Principal formulations	40% EC.
Principal use:	Greenhouse.
Toxicity:	Very high.
Chemical name:	Tetra ethyl pyrophosphate.

Terbufos (Counter(R))

Principal formulations:	15% G.
Principal uses:	Corn rootworm, wireworm control. Promising against other soil insects.
Toxicity:	High.
Chemical name:	S-(*tert*-butylthio) methyl 0,0-diethyl phosphorodithioate.

Trichlorfon (Dipterex(R), Dylox(R), Neguvon(R), Proxol(R))

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

Bacillus thuringiensis (Thuricide(R), Biotrol(R), Dipel(R))

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.

Chlordimeform (Galecron(R), Fundal(R))*

Principal formulations:	4 lb/gal EC, and 95% SP of the monohydrochloride.
Principal uses:	Mites on fruit, cabbage worms, loopers on cole crops.
Toxicity:	Moderate.
Chemical name:	N'-(4-chloro-tolyl)-N,N-dimethyl-formamidine and the monohydrochloride.

* Temporarily withdrawn from market.

Nicotine sulfate

Principal formulations:	Liquid concentrate
Principal uses:	Aphid control in home gardens.
Toxicity:	Moderate.
Chemical name:	Same.

Dimilin(R)

Principal formulations:	25% wettable powder.
Principal uses:	Certain forest insects. Promising against a wide range of insects. Kills by inhibiting cuticle development in immature insects.
Toxicity:	Low.
Chemical name:	N[(4 chlorophenyl) amino] carbaryl] 2,6 difluorobenzamide, or: 1-(4-chlorophenyl)-3(2,6 difluoro benzoyl) urea.

Methoprene (Altosid(R))

Principal formulations:	10% liquid concentrate.
Principal uses:	Mosquito control, hornfly control on range cattle. A synthetic insect grown regulator (IGR).
Toxicity:	Low.
Chemical name:	[Isopropyl(E,E)-11-methoxy 3,7,11-trimethyl 2,4-dodecadienoate].

Omite

Principal formulation:	30%WP, 6 lb/gal EC.
Principal uses:	Mites on fruit.
Toxicity:	Low.
Chemical name:	2-(p-tert-butylphenoxy) cyclohexyl 2-propynyl sulfite

Ovex (Ovotran(R))

Principal formulations:	50% WP.
Principal uses:	Mites on fruit.
Toxicity:	Low.
Chemical name:	*p*-chlorophenyl *p*-chlorobenzene sulfonate.

Oxamyl (Vydate(R))

Principal formulations:	2 lb/gal EC.
Principal uses:	Promising for ornamentals. Also a nematocide.
Toxicity:	High.
Chemical name:	*Methyl N'N'*-dimethyl-*N*-[(methylcarbamoyl)oxy]-1-thiooxamimidate.

Oxythioquinox (Morestan(R))

Principal formulations:	25% WP.
Principal uses:	Mites on fruit and ornamentals.
Toxicity:	Low.
Chemical name:	6 methyl-2,3-quinoxaldithiol cyclic S, S dithiocarbonate.

Plictran(R)

Principal formulations:	50% WP.
Principal uses:	Mites on fruit and ornamentals.
Toxicity:	Moderate.
Chemical name:	Tricyclohexyltin hydroxide.

Pyrethrins (Pyrethrum)

Principal formulations:	Variety of aerosols, household sprays, and garden preparations.
Principal uses:	Flies and mosquitoes, household pests, stored-product insects, garden insects.
Toxicity:	Low.
Chemical name:	Pyrethrins I and II, esters of chrysanthemum carboxylic acids and pyrethrolone.

NOTE: Synthetic pyrethrins like products such as allethrin and resmethrin are available also.

Rotenone

Principal formulations:	0.5 to 5% D and WP. Also in mixtures for home gardens.
Principal uses:	Vegetable garden pests.
Toxicity:	Moderate (High to fish).
Chemical name:	Same (a product from plants, *Derris* and *Lonchocarpus*).

Ryania

Principal formulations:	40% D, 100% WP.
Principal uses:	European corn borer, codling moth.
Toxicity:	Low.
Chemical name:	Derived from a plant, *Ryania speciosa*

Sabadilla

Principal formulations:	10 and 20% D.
Principal uses:	Squash bug and some other plant bugs.
Toxicity:	Low.
Chemical name:	Derived from a plant, *Schoenocaulon sp.*

Tetradifon (Tedion(R))

Principal formulations:	25% WP.
Principal uses:	Mites on fruit and ornamental crops.
Toxicity:	Low.
Chemical name:	*p*-chlorophenyl 2,4,5-trichlorophenyl sulfone.

Thiocyanates (Lethane(R), Thanite(R))

Principal formulations:	Usually in mixtures of fly control products. Oil solutions to 10%.
Principal uses:	Fly control, household insects, home gardens.
Toxicity:	Low to medium, depending on product.
Chemical names:	Thanite(R) = isobornyl thiocyanoacetate; Lethane 60(R) = thiocyanoethyl laurate; Lethane 384(R) = butoxy-thio-cyanodiethyl ether.

Other publications in this series:

Extension Bulletin 388 — Insecticide Suggestions to Control Insect Pests of Field Crops.
Extension Bulletin 389 — Insecticide Suggestions to Control Household Insects.
Extension Bulletin 390 — Insecticide Suggestions to Control Livestock and Poultry Pests.
Extension Bulletin 391 — Insecticide Suggestions to Control Tree, Shrub, Lawn, and Turf Insects.
Extension Bulletin 392 — Insecticide Suggestions to Control Greenhouse and Floriculture Pests.

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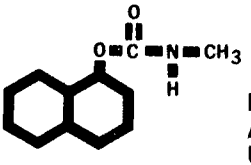

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