1986 Illinois Pest Control Handbook

Suggestions for Insect, Weed, and Plant Disease Management Including Pesticide Information

Cooperative Extension Service
University of Illinois
at Urbana-Champaign
College of Agriculture
in Cooperation with
the Illinois Natural History Survey

Cooperative Extension Service
University of Illinois at Urbana-Champaign

The information in this handbook was prepared by specialists employed by the University of Illinois at Urbana-Champaign, College of Agriculture, the Cooperative Extension Service, the Illinois Natural History Survey, and the U.S. Fish and Wildlife Service. The suggestions herein are intended to provide guidelines for pest management in Illinois during the current calendar year only.

Because of changing laws and regulations, the Illinois Cooperative Extension Service assumes no liability for the recommendations. The recommendations for using pesticides that are included in this handbook are incomplete; therefore, they should be used only as guidelines. Complete instructions for the use of a specific pesticide are on the pesticide label. Read and follow the label directions and precautions before applying any pesticide. The pesticide user is responsible for applying pesticides according to label directions, as well as for problems that may arise through misapplication or misuse of the pesticide.

Not all pesticides registered for crop pests are included in this handbook. Pesticides that are effective and do not present an undue hazard to the user and the environment are suggested whenever possible. Trade names have been used for simplicity, but their use does not imply the endorsement of one product over another, nor is discrimination intended against any product.

Label changes, product cancellations, and changes in recommendations may have occurred since the publication of this handbook. Check with your county Extension adviser in agriculture if you are in doubt about a pesticide you plan to use. Announcements of new registrations, label changes, and changes in recommendations will be made through newsletters and the media.

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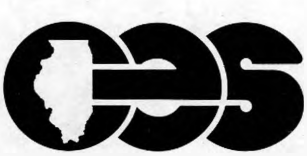

Cooperative Extension Service
University of Illinois at Urbana-Champaign

Index
(by Subject)

MISCELLANEOUS

1986 Insect Pest Management Guide

FIELD and FORAGE CROPS

You must be certified as a pesticide applicator to use restricted-use pesticides.
See your county Extension adviser in agriculture for information.

FEDERAL AND STATE LAWS

The U.S. Environmental Protection Agency is classifying pesticides for "general" or "restricted" use. Only a few pesticides have been classified (Table 1).

Commercial applicators who apply restricted-use pesticides must be certified. Commercial applicators include persons applying a pesticide for hire and governmental personnel, chemical company representatives, and others involved in demonstrational, regulatory, and public health pest control. Certification as a commercial applicator requires passing a written examination administered either by the Illinois Department of Agriculture or the Department of Public Health.

Private applicators who use restricted-use pesticides "for the purpose of producing any agricultural commodity on property owned or rented by him or as exchange labor (no compensation) on the property of another" must also be certified, either by attending an educational training program or by passing an examination.

Educational training programs for farmers (private applicators) and commercial pesticide applicators are conducted by the Cooperative Extension Service to prepare persons for certification. For additional information, consult your county Extension adviser in agriculture. The actual certification and the issuing of permits or licenses are handled by the Illinois Department of Agriculture or the Illinois Department of Public Health.

Insecticides and Classifications

At the time this publication was in preparation, several of the insecticides listed below had been recently classified for "restricted" use by the EPA. Granular formulations of Counter, Di-Syston, Dyfonate, Furadan, Mocap, and Thimet that were released for shipment by the manufacturer after September 1, 1985, must be labeled as restricted-use products.

The chemical names used in this circular may be unfamiliar to you. These names are the common, coined chemical names and as such are not capitalized (for example, terbufos). Trade names are capitalized (for example, Counter). In the table of limitations (Table 13), the trade names are listed first, with the common name in parentheses following the trade name. In the tables of suggestions, only the trade name is listed.

Table 1. Insecticide Classifications

Common name	Trade name	Classification
acephate	Orthene	unclassified
Bacillus thuringiensis	Dipel, Thuricide, Bactur, SOK	unclassified
carbaryl	Sevin	unclassified
carbofuran	*Furadan	restricted[a]
carbophenothion	Trithion	unclassified
chlorpyrifos	Lorsban	unclassified
diazinon	Diazinon	unclassified
dimethoate	Cygon	unclassified
disulfoton	*Di-Syston	restricted[a]
ethion	Ethion	unclassified
ethoprop	*Mocap	restricted[a]
fenvalerate	*Pydrin	restricted
flucythrinate	*Pay-Off	restricted
fonofos	*Dyfonate	restricted[a]
malathion	Cythion, malathion	unclassified
methidathion	*Supracide	restricted
methomyl	*Lannate, *Nudrin	restricted[b]
methoxychlor	methoxychlor	unclassified
methyl parathion	*Methyl parathion	restricted
methyl parathion (microencapsulated)	*Penncap-M	restricted
permethrin	*Ambush, *Pounce	restricted
phorate	*Thimet	restricted[a]
phosmet	Imidan	unclassified
terbufos	*Counter	restricted[a]
trichlorfon	Dylox	unclassified
trimethacarb	Broot	unclassified

[a] All granular formulations released for shipment by the manufacturer after September 1, 1985, are restricted.
[b] All formulations except water-soluble packages, 25% wettable powder, and granulars are restricted.

Asterisks (*) are used throughout this circular to indicate insecticides classified for "restricted" use.

Prepared by Kevin L. Steffey, Donald E. Kuhlman, and Stephen P. Briggs, Extension Entomologists.

CIRCULAR 899 (revised annually)

Special Local Need Registrations

Section 24(c) of the amendments to the Federal Insecticide, Fungicide, and Rodenticide Act of 1972 allows states the right to register pesticides for use within the state to meet special local needs (SLN). The authority for state registration of pesticides is the Illinois Department of Agriculture. A special label, which lists the new 24(c) uses, is printed by the formulator. A copy of this label must be in the possession of the operator during application of the pesticides.

POLICY STATEMENT

The *Illinois Insect Pest Management Guide: Field and Forage Crops* (Circular 899) is revised annually and is intended for use during the current calendar year only. Not all insecticides registered for crop pests are included in this circular. Insecticides that are effective and do not present an undue hazard to the user or the environment are suggested whenever possible.

Trade names have been used for simplicity, but their usage does not imply the endorsement of one product over another, nor is discrimination intended against any product.

This guide for insect control is based on research results from the Illinois Natural History Survey, the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture.

Be sure to check with your county Extension adviser in agriculture if you are in doubt about an insecticide you plan to use. We will make announcements of new labels and changes in recommendations through the news media to keep you up to date.

REFERENCES

Fact sheets (designated by NHE numbers) discussing nonchemical control methods, descriptions of specific insects, and their life history and biology can be obtained from the office of the county Extension adviser in agriculture or by writing to Entomology Extension, 172 Natural Resources Building, 607 East Peabody Drive, Champaign, IL 61820.

PEST-MANAGEMENT SCOUTING PROGRAMS

Integrated Pest Management (IPM) is a systematic method of looking for pests in the field, of determining whether any control measures are needed, and if there is a problem, of deciding on the proper measures to use. Pest scouting enables farmers to detect and control pest outbreaks before significant yield losses occur. Because decisions on chemical control are based on economic thresholds, IPM programs eliminate unnecessary pesticide use.

Pest scouting has been accepted as an important management tool by many Illinois farmers. As farming costs increase, growers are realizing the advantages of treating a field only when an economically harmful pest population occurs, rather than treating it automatically regardless of the situation. By using pesticides on this basis, farmers have a better chance of reducing management costs.

Pest scouting programs have been initiated by several pest-management consulting firms throughout the state. In addition to pest scouting, most offer other services such as soil testing and nematode monitoring.

PESTICIDE SAFETY

Certain precautionary steps should be taken when handling insecticides. The insecticides suggested in this publication can be poisonous to the applicator. The farmer or applicator is expected to protect himself, his workers, and his family from needless exposure.

When using insecticides, apply all the scientific knowledge available to make sure that there will be no illegal residue on the marketed crop. Such knowledge is condensed on the label. READ THE LABEL CAREFULLY AND FOLLOW THE INSTRUCTIONS. The label should be recent and not from a container several years old. Do not exceed the maximum rates suggested. Observe the interval between application and harvest. Apply only to crops for which use has been approved. Keep records of pesticide use for each field. Record the product used, the trade name, the percentage content of the insecticide, the dilution, the rate of application per acre, and the date or dates of application.

Always handle insecticides with respect. The person most likely to suffer ill effects from insecticides is the applicator. Accidents and careless, needless overexposure can be avoided. Following these rules will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke, eat, or drink while handling or using insecticides.
3. Keep your face turned to one side when opening, pouring from, or emptying insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of the reach of children, irresponsible persons, and animals; store preferably in a locked building. Do not store near livestock feeds. Better yet, buy no more pesticide than you will use, thus eliminating a pesticide storage and disposal problem.
6. Triple rinse, bury, or burn all empty insecticide containers or take them to an appropriate sanitary landfill.
7. Do not put the water-supply hose directly into the spray tank or blow out clogged nozzles or spray lines with your mouth.
8. Wash with soap and water exposed parts of the body and clothes contaminated with insecticides.

9. Do not apply to fish-bearing or other waters.

10. Do not leave puddles of spray on impervious surfaces or apply insecticides near dug wells or cisterns.

11. Do not apply insecticides, except in an emergency, to areas with abundant wildlife.

12. Do not spray or dust when weather favors drift.

13. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

Refer to the *Illinois Pesticide Applicator Study Guide* for more information concerning safe handling of pesticides and treatment of pesticide poisoning.

POTENTIAL FOR SOIL INSECT PESTS IN CORN

There are many factors that affect soil insect populations and their potential to damage corn. The type of crop rotation greatly influences whether a soil insect problem will occur and what kind it will be. Weather, weeds, soil type, planting date, hybrid, tillage, and natural enemies also influence insect populations. Knowledge about soil insect damage in a particular field during previous years is also helpful because infestations tend to occur in the same fields and in the same area.

Illinois Extension entomologists have estimated the probability of the occurrence of soil insect pests in corn on the basis of cropping sequence (Table 2). These estimates can serve as a guide to determine the risk of damage caused by soil insects and the need for applying a soil insecticide at planting.

Corn After Soybeans. The potential for soil insect problems in corn after soybeans is generally low, and the use of soil insecticides rarely pays. Corn rootworms rarely cause damage to corn after soybeans. In most fields, a diazinon + lindane planter-box seed treatment will be adequate to protect against attack by seedcorn beetles, seedcorn maggots, and wireworms. Scout the field for cutworm damage as the plants emerge from the soil.

White grubs are an occasional problem in corn after soybeans.

Corn After Corn. The potential for rootworm damage is moderate to severe wherever corn follows corn in Illinois. A rootworm soil insecticide may be needed in most fields of corn after corn. Wireworms are occasionally a problem in the southern part of Illinois. Scout for cutworm damage.

Corn After Grass Sod. Wireworms and white grubs are potential problems. Apply a labeled soil insecticide at planting time. Scout for cutworm damage.

Corn After Sorghum. A planter-box seed treatment of diazinon or diazinon + lindane will protect the corn seeds against seedcorn maggots. Scout the fields for cutworms as the corn emerges. Corn rootworms are rarely a problem where corn follows sorghum.

Corn After Legumes. Cutworms, grape colaspis, grubs, and wireworms occasionally damage corn planted after clover and alfalfa. In addition, adult northern corn rootworms are sometimes attracted to legumes or to blooming weeds in legumes for egg laying, particularly in years when beetles are forced to leave adjacent fields of drouth-stressed corn to seek food. A soil insecticide should be considered for this cropping sequence.

Corn After Small Grain. There is a slight potential for damage by wireworms, seedcorn beetles, and seedcorn maggots in corn after small grain, particularly wheat. In most instances, a diazinon + lindane planter-box seed treatment will be adequate. If wireworms are present, use a soil insecticide at planting time. Excessive

Table 2. Probability Estimates of Economic Soil Insect Damage in Corn and Suggestions for Control According to Cropping Sequence, Illinois

Crop preceding corn	Insect pest							Need for a soil insecticide	Recommended pest management practices
	Wireworm	Cutworm	Corn rootworm	White grub	Seedcorn maggot	Billbug	Grape colaspis		
Soybeans	1:500	1:25	1:10,000	1:1,000	1:150	1:100	1:1,000	very low	Use planter-box seed treatment; scout for cutworms.
Corn	1:200	1:100	2:3	1:1,000	1:50	1:100	1:5,000	mod-high	Scout for rootworm beetles; treat corn if population exceeds 1 per plant at any time during August.
Small grain	1:100	1:50	1:100	1:250	1:50	1:200	1:5,000	low	Bait for wireworms prior to planting.
Legume	1:25	1:25	1:50	1:150	1:10	1:50	1:4	low-mod	Bait for wireworms prior to planting.
Grass sod	1:10	1:25	1:500	1:10	1:25	1:50	1:1,000	mod-high	Use soil insecticide for wireworms and white grubs; if no-till, scout for foliar insect damage as corn emerges.

weed cover in small grain stubble fields may have been attractive to northern corn rootworm beetles for egg laying as the beetles moved from adjacent fields of drouth-stressed corn.

CORN ROOTWORM SITUATION

Problem Area

Populations of northern and western corn rootworm beetles were extremely high in 1985. Although the potential for rootworm damage to corn following corn is greatest in the northern two-thirds of the state, moderate to severe damage to corn roots by larvae may occur in any field where corn follows corn in Illinois.

Rootworm Control Problems, 1985

Corn rootworm larval control with soil insecticides was erratic in Illinois during 1985, in both farmers' fields and research trials. Instances of poor control were observed with all rootworm soil insecticides, carbamates and organophosphates, over a wide geographical area with various soil types and weather conditions. An investigation of some of the problem fields has disclosed several factors that probably contributed to poor control with the insecticides. The factors that stand out but are not easily quantifiable include dry soil conditions during May, June, and July, above-average rootworm larval populations, and improper calibration of insecticide applications (rates that were too low).

In some fields, lack of rain prevented the movement of the insecticide from the soil surface or off the granular carrier to the area where rootworm larvae were feeding. Early planting also may have been a contributing factor in some fields because soil insecticides applied in April could have lost much of their potency by the time eggs hatched. Undoubtedly, several of these conditions in combination could have affected the performance of soil insecticides.

Unfortunately the factors that influence the performance of soil insecticides under field conditions are not well understood. Recent research indicates that the breakdown of some soil insecticides by soil microorganisms is accelerated after repeated applications of the same compound. The soil microorganisms use the insecticide as an energy source. As a result, the insecticide has a progressively shorter residual time in the soil. This seems to be most prevalent in fields where the same soil insecticide has been used for several consecutive years; however, the pattern is neither clearcut nor predictable. In all probability, environmental conditions combined with accelerated degradation of the insecticides by microorganisms are major causes for rootworm control problems.

Are the rootworms more tolerant to the soil insecticides? Although this has not been confirmed, some research data suggest that some slight change in susceptibility has occurred with some compounds. Unfortunately most tests to detect resistance are conducted with the adult stage rather than the damaging larval stage. So at this point, tolerance to insecticides cannot be ruled out.

Determining Potential for Damage in 1986

Corn growers should base the need for using a rootworm soil insecticide in 1986 on the abundance of rootworm beetles in cornfields during late summer of 1985. Generally, if beetle numbers reached or exceeded 0.75 per plant at any time during late July, August, or September, 1985, plan to apply a rootworm soil insecticide if the field is to be replanted to corn in 1986.

However, if the field scouted in 1985 was corn following any crop other than corn, the threshold (beetles per plant) is lower. The ratio of female to male beetles in first-year corn is usually higher than in continuous corn. The females apparently migrate into first-year cornfields, so most of the beetles found there are females. As a consequence, the threshold for determining whether to rotate away from corn or to use a soil insecticide in 1986 may be as low as 0.5 beetle per plant.

Fields of corn planted in late May or June, 1985, may have extensive rootworm damage if replanted to corn in 1986. During August and September, rootworm beetles are especially attracted to late planted or late maturing fields. Seeking fresh pollen and silks to feed on, the beetles lay millions of eggs in these fields. Planting the fields to a crop other than corn in 1986 is suggested to reduce the rootworm population.

SUGGESTIONS FOR ROOTWORM CONTROL, 1986

In recent years, the performance of rootworm soil insecticides has been quite variable. They have performed effectively at some locations and have been marginal or ineffective at others. This trend could continue in 1986. An immediate solution to the phenomenon of erratic rootworm soil insecticide performance is not readily available. Perhaps there is none. It is entirely possible that changes brought about by treating millions of acres of corn with soil insecticides over the past 20 years have introduced an era when rootworm control with current soil insecticides will be highly variable.

Looking to 1986, you should seriously consider crop rotation, particularly in fields where there is a high probability of rootworm damage. Other alternatives include applications of a soil insecticide at planting or at cultivation. Considering the erratic performance of planting-time treatments in 1985, a cultivator application in early June near the beginning of rootworm egg hatch should be an effective option. However, for most farmers planting time treatments of a soil insecticide will be the predominant method of rootworm control.

If you use a soil insecticide at planting, plan to check fields in early to mid June to determine whether damage is occurring. If so, a cultivator application may be needed.

Crop Rotation

Crop rotation is an extremely effective way to prevent damage by northern and western corn rootworm larvae. If feasible, do not grow corn two years in succession in the same field. First-year corn following soybeans will generally not require a soil insecticide for rootworm control.

Although rootworm beetles can be found in "clean" or weed-free soybean fields, and may even lay a few eggs there, the number of eggs is not great enough to warrant the use of a soil insecticide on corn the following season. In a few instances, rootworm larval damage has occurred to corn planted after soybeans when the bean field had been heavily infested with volunteer corn or weeds during August. Adult northern and western corn rootworms were attracted to these weedy soybean fields to deposit eggs. As a result, root damage by larvae occurred the following season. Good weed control in soybeans will prevent rootworm damage in corn following soybeans. Soybean fields with 5,000 or more volunteer corn plants per acre will usually warrant treatment for rootworm control the following year if planted to corn.

Corn rootworm beetles deposit the vast majority of their eggs in cornfields. The larvae cannot survive on the roots of broadleaf crops (soybeans or alfalfa) or broadleaf weeds. Consequently, when a crop other than corn, soybeans for example, is planted in a field with soil containing millions of rootworm eggs, the rootworm larvae die before becoming egg-laying beetles.

Soil Insecticides

The suggestions for rootworm control that follow are based on research conducted by entomologists in Illinois and other states.

At Planting. Apply Broot 15GX, Counter 15G, Dyfonate 20G or 4EC, Furadan 15G or 4F, Lorsban 15G, Mocap 15G, or Thimet 20G at the suggested rate (see Table 3). IMPORTANT: Read the suggestions in the section on alternating rootworm soil insecticides.

The rates suggested in Table 3 should not be exceeded for rootworm control. Research has shown that increasing the rates of soil insecticide application does not improve rootworm control. Increasing the rate of the product will not solve rootworm control problems and may even accelerate the onset of resistance in the rootworm population.

Proper calibration, placement, and incorporation of rootworm soil insecticides will improve the likelihood of good control. See the section "Calibration for Granular Soil Insecticides" in this circular. With the exception of Mocap, the soil insecticides are labeled for application in a 7-inch band ahead of the planter press wheel or firming wheels. Counter 15G and Furadan 15G can also be applied in the seed furrow for rootworm control. Mocap 15G is labeled for application behind the press wheel or firming wheels. All insecticides should be lightly incorporated with spring tines or drag chains mounted behind the planter units.

Soil insecticides will give 50 to 70 percent control of corn rootworm larvae. This degree of control is adequate to prevent economic levels of larval damage in most fields. But in some heavily infested fields enough larvae may survive to cause economic levels of root damage, and beetle populations may be large enough to interfere with pollination.

Planting-time treatments applied in early April may provide only marginal control. Consider a cultivator

Table 3. Soil Insecticides Suggested for Rootworm Control, Illinois, 1986

Insecticide[a]	Time of application	Ounces of product per 1,000 ft. of row	Amount of product needed per acre			
			40″ rows	38″ rows	36″ rows	30″ rows
Broot 15GX	At planting	8	6.7 lb.	7.0 lb.	7.4 lb.	8.7 lb.
*Counter 15G	At planting or cultivation	8	6.7 lb.	7.0 lb.	7.4 lb.	8.7 lb.
*Dyfonate 20G	At planting or cultivation	6	5.0 lb.	5.3 lb.	5.6 lb.	6.7 lb.
*Dyfonate 4E	At planting	2.4 fl. oz.	2 pints	2⅛ pints	2¼ pints	2¾ pints
*Dyfonate 4E	Preplant	Broadcast	3 quarts	3 quarts	3 quarts	3 quarts
*Furadan 15G	At planting or cultivation	8	6.7 lb.	7.0 lb.	7.4 lb.	8.7 lb.
*Furadan 4F	At planting or cultivation	2.4 fl. oz.	2 pints	2⅛ pints	2¼ pints	2¾ pints
Lorsban 15G	At planting or cultivation	8	6.7 lb.	7.0 lb.	7.4 lb.	8.7 lb.
Lorsban 4E	At cultivation	2.4 fl. oz.	2 pints	2⅛ pints	2¼ pints	2¾ pints
*Mocap 15G	At planting or cultivation	8	6.7 lb.	7.0 lb.	7.4 lb.	8.7 lb.
*Thimet 20G	At planting or cultivation	6	5.0 lb.	5.3 lb.	5.6 lb.	6.7 lb.

[a] Consult text for more information. LIQUID FORMULATIONS ARE HIGHLY TOXIC.

* Use restricted to certified applicators only.

application in late May or early June in such fields, rather than a treatment at planting time.

Liquid formulations. Dyfonate 4E or Furadan 4F may be mixed with water and applied as a spray in a 7-inch band ahead of the press wheel. They may also be mixed with liquid fertilizer and used with a split-boot applicator at planting.

Incompatibility or crop injury may be a problem in treatments using a liquid insecticide with a liquid fertilizer at planting. The insecticide *must* be compatible with the fertilizer. Conduct a test before planting to make certain that the two are physically compatible. Maintain agitation in the tank after mixing and during application to prevent separation. **Use caution when handling liquid insecticide formulations.**

At Cultivation. Apply Counter 15G, Dyfonate 20G, Furadan 15G or 4F, Lorsban 15G or 4E, Mocap 15G, or Thimet 20G on both sides of the row at the base of the plants just ahead of the cultivator shovels. Cover the insecticides with soil. The best time to apply a basal treatment of a soil insecticide by cultivator is in late May or early June, near the beginning of egg hatch.

A cultivation-time application of a soil insecticide is an alternative to a planting-time application or may be used as a "rescue" treatment if the planting-time insecticide fails to control rootworm larvae. In either case, you should dig up several plants and examine the roots and surrounding soil for rootworm larvae and damage. If you find 3 or more larvae per plant and the field was not treated at planting, a cultivator application is warranted. If the field was treated at planting and rootworm larvae and damage are obvious in June, plan to apply a cultivator treatment. "Obvious" rootworm damage is characterized by brown root tips and roots that have been tunneled in or chewed back toward the base of the plant.

Soil moisture may affect both application and effectiveness of cultivation-time treatments. Fields that are too wet may never be cultivated. On the other hand, the insecticide may not perform satisfactorily if the soil is too dry.

Suggestions For Alternating Rootworm Soil Insecticides. Avoid using the same insecticide in consecutive years or in fields where it has had recent performance problems. The continuous use of one insecticide may enable soil microorganisms to break it down rapidly or may hasten the onset of insect resistance. *Illinois entomologists encourage growers to consider alternating rootworm soil insecticides, rather than using one product for several consecutive years.* Consider the following suggestions for alternating rootworm soil insecticides:

1. If performance of a soil insecticide has been poor in a particular field in recent years, do not use the same insecticide in that field in 1986.

2. Consider alternating organophosphate (Counter, Dyfonate, Lorsban, Mocap, and Thimet) and carbamate (Broot and Furadan) soil insecticides. Keep in mind, however, that growers generally have had no advance warning of poor control where problems have occurred.

3. Avoid using carbamates in consecutive years.

4. Avoid using the same organophosphate in consecutive years.

Laboratory and field research indicates that using the same rootworm soil insecticide for several consecutive years can eventually lead to erratic, if not poor, rootworm control. This first became apparent in Illinois during the mid-1960s when northern and western corn rootworms developed resistance to aldrin and heptachlor, about 5 years after these compounds were first used in the field.

Buxten, a carbamate soil insecticide introduced in 1967, gave good rootworm control until the early 1970s, but was dropped from University of Illinois's recommendations in 1974 after problems with control had developed. Furadan, also a carbamate soil insecticide, was used by many farmers with excellent results from 1969 until 1975 when control became erratic. More recently, Amaze, an organophosphate that had provided excellent rootworm control in research trials, was removed from the soil insecticide market by the manufacturer following poor rootworm control in 1983 — only 3 years after being registered.

A lesson to be learned from the preceding scenario is that extensive and continuous use of any one compound may contribute to erratic results and to its eventual failure.

Control of Rootworm Beetles to Prevent Egg Laying

Research conducted during the mid 1970s indicated that properly timed sprays to prevent rootworm beetles from laying eggs could eliminate the need for a soil insecticide the following year. However, the procedure is not foolproof. Factors beyond the control of the operator, such as beetle migration and weather, may minimize the treatment's effectiveness.

Growers who have experienced erratic rootworm control with soil insecticides the past few years and who are committed to a continuous corn program may look to beetle control as an alternative, or an addition, to soil insecticides at planting. Ideally, one properly timed spray should *replace* a soil insecticide. Unfortunately, some fields will require two sprays to combat extended beetle emergence and egg laying. Two sprays or a spray plus a soil insecticide the following season may hasten the onset of rootworm resistance to insecticides.

A rootworm beetle suppression program should be employed only if the fields are under the supervision of trained pest management personnel in weekly scouting programs. Careful field scouting is a requirement.

Summary: Planning Your Rootworm Control Program

A management plan for rootworms should be long range (not a year at a time) and include crop rotation, insecticide rotation, cultivator treatments, and scouting to determine the need for rootworm control.

1. Alternate corn with another crop when possible, particularly in fields where rootworm beetles averaged 0.75 or more per plant last summer, or if the soil insecticide did not give effective rootworm control in 1985.

2. If you intend to grow corn after corn and rootworm beetles averaged 0.75 or more per plant in corn after corn or 0.5 beetle per plant in first-year corn last summer, apply a rootworm soil insecticide at planting time. Apply the rate suggested in Table 3 and consider our suggestions for alternating rootworm soil insecticides.

3. Consider a cultivation-time application of a rootworm soil insecticide if you intend to plant in early April or if your planting-time insecticide does not provide effective control.

4. Scout for rootworm beetles in July and August, 1986, to determine the potential for rootworm larval damage in 1987.

Scouting to Determine Rootworm Potential in 1987

The abundance of rootworm beetles in a cornfield in July and August is an excellent indicator of future rootworm problems. Corn growers can determine the potential for rootworm damage in 1987 by counting western and northern corn rootworm beetles from mid-July through August, 1986, in this way:

1. Make 3 or more counts for western and northern corn rootworm beetles at 7- to 10-day intervals between mid-July and late August in fields to be replanted to corn.

2. Examine 5 plants selected at random in each of 10 areas of the field. Count all of the western and northern corn rootworm beetles on 50 plants each time. The counts take about 45 minutes in a 40-acre field.

3. As you approach a plant, move quietly to avoid disturbing the beetles. Count the beetles on the entire plant, including the ear tip, tassel, leaf surface, and behind the leaf axils.

4. Record the number of beetles you find per plant. If the average is more than 0.75 beetle per plant in corn after corn or 0.5 beetle per plant in first-year corn for any sampling date, plan to rotate away from corn or apply a rootworm soil insecticide to corn in 1987. If populations do not exceed an average of ½ beetle per plant for any sampling date, a soil insecticide will not be needed the following season.

Rootworm Life Cycle

Western and northern corn rootworm beetles deposit their eggs in the soil at the base of the corn plants or between rows during August and September. The eggs overwinter in the soil and begin hatching in late May. Egg hatch usually takes place over a period of 3 to 5 weeks. Consequently, in July and August all stages of the corn rootworm — egg, larva, pupa, and adult — may be found. The rootworm larvae feed on the roots of corn plants during June, July, and August. When a larva is fully grown (½ inch), it builds a cavity in the soil and goes into the pupal or resting stage. After 5 to 10 days, the beetle emerges from the soil. The development from egg hatch to adult emergence takes 27 to 40 days. After the females emerge from the soil and mate, 14 days or more elapse before they begin laying eggs. Rootworm beetles may deposit as many as 1,000 eggs; an average of 500 per female is probably common. Most egg laying in Illinois occurs after August 1.

CORN CUTWORMS

The occurrence and extent of cutworm infestations are difficult to predict each year. *Sandhill, dingy,* and *claybacked cutworms* all overwinter in Illinois as partially grown larvae, but their populations are seldom widespread. As a result, they cause damage early in the growing season in scattered areas. Sandhill cutworms are a problem in sandy areas almost every year. Dingy and claybacked cutworms occur more frequently in corn planted after sod or forage legumes than in other crop rotations.

Black cutworms do not overwinter in Illinois, so outbreaks are difficult to forecast. Infestations of black cutworm larvae arise from eggs laid by moths that fly into Illinois in the early spring. A statewide program of monitoring black cutworm pheromone traps provides information about the time and intensity of spring moth flights.

Certain factors favor black cutworm outbreaks. The most important factors may be late planting and preplant weed infestations. Fields that are tilled and planted late are more likely to develop a preplant weed infestation than fields that are planted early. These late-planted fields with weeds are more attractive to cutworm moths as a site on which to deposit their eggs.

Currently, two options are available for cutworm control: applications of soil insecticides to prevent damage and rescue treatments after the infestation appears.

Because of the uncertainty in predicting which fields will have light, moderate, or heavy infestations of cutworms, it may be more feasible to use rescue treatments for cutworm outbreaks rather than to use a preplant or planting-time treatment unnecessarily.

Based on the relatively low incidence of cutworm problems over the past 25 years, a grower may find an economic advantage to the wait-and-see system, which involves field scouting rather than a costly always-apply program in which the soil insecticide is routinely applied at or before planting for a problem that may not exist.

Rescue (or emergency) treatments to control outbreaks of cutworms include sprays of Ambush, Lorsban, Pay-

Off, Pounce, or Pydrin, or Sevin pelletized bait. Broadcast the pelletized bait on the surface, but do not incorporate. Ambush, Lorsban, Pay-Off, Pounce, and Pydrin sprays should also be broadcast.

The keys to effective cutworm control with the rescue treatments are the amount of surface moisture and the movement of the worms. Control may be poor, regardless of the insecticide used, if the topsoil is dry and crusted and the worms are working below the soil surface. When the soil is dry, the high rate of Ambush, Lorsban, Pay-Off, Pounce, or Pydrin is recommended.

To determine the need for rescue treatments, scout the fields during plant emergence, particularly those fields considered to be high-risk. Early detection of leaf-feeding or of cutting by cutworms is vital. When the corn plants are beginning to emerge, check the fields for leaf-feeding, cutting, wilting, or missing plants. Small cutworm larvae (less than ½ inch) feed on the leaves and do not begin cutting plants until they are about half grown.

A control measure is needed on corn in the 2-leaf stage if 3 percent or more of the plants are cut and if there are 2 or more cutworms per 100 plants. At the 4-leaf stage, control is justified if 3 percent or more of the plants are cut and if there are 4 or more worms per 100 plants. A single cutworm will cut fewer of the 4-leaf plants than those in the 2-leaf stage.

Planting-time treatments are relatively effective in controlling light to moderate infestations, but control may be unsatisfactory for heavy infestations. Lorsban 15G, Mocap 15G, Dyfonate 20G, Counter 15G, and Furadan 15G are registered for the control of cutworms in corn. Lorsban 15G has provided the best cutworm control in research trials. The Mocap and Dyfonate labels state that under heavy infestations of cutworms, enough cutworms may survive to cause some crop damage, so a rescue treatment may be necessary. Counter and Furadan are labeled for "suppression of cutworms." In fields with a history of cutworm problems or in high-risk fields, Lorsban 15G should give the most consistent control of cutworms.

Pre-emergent sprays of Ambush, Pounce, and Pydrin may be applied in fields where the probability of cutworm damage is great.

Preplant broadcast treatments of Lorsban 4E and Dyfonate 4E are also registered for corn cutworm control. Lorsban is labeled at rates of 1 to 2 quarts per acre; the higher rate is suggested. Dyfonate is labeled for "suppression of black cutworms" at 4 quarts per acre. Both insecticides should be incorporated into the top 2 to 4 inches of soil immediately after application.

Replanting may be required if cutworm damage is extremely severe. Before replanting apply Lorsban 4E as a broadcast spray at 3 to 4 pints per acre, and incorporate the insecticide into the top 2 to 4 inches of soil. Or you can apply a labeled granular insecticide. If the cutworm infestation is heavy, the Lorsban spray will be more effective.

WIREWORMS

Wireworms may attack the seed or drill into the base of the stem below ground level, damaging or killing the growing point. Damage will show up as wilted, dead, or weakened plants and spotty stands. Wireworm larvae are yellowish-brown and wirelike; several species are known to attack corn. They live for two to five years in a field in the larval stage, feeding on the roots of grasses and crops. Their presence is often related to the crops or weeds that were in the field two to four years before damage to the corn. Most reports of damage to corn have been in fields where corn follows soybeans or where there has been a corn-soybean-small grain rotation. The adult (a click beetle) prefers to deposit its eggs in small-grain stubble or in grassy fields.

Attempts to control wireworms with an insecticide rescue treatment after the damage appears are not very successful. Therefore, if an infestation is known to be present, an insecticide should be applied at planting.

Wireworms are usually most damaging in bottomlands or in poorly drained areas on upland soils. Low spots in the field often have the heaviest populations.

The proportion of fields of corn affected by wireworms in Illinois is small (less than 1 percent) and does not justify the widespread use of a soil insecticide on first-year corn after soybeans. A diazinon + lindane planter-box seed treatment may help deter the wireworms from attacking the seed but will not protect the seedling.

Checking for Wireworms

A technique using baits has been developed for evaluating wireworm potential before planting. The bait stations should be established 2 to 3 weeks before the anticipated planting date. Fields where small grain or grasses have been grown the preceding 2 or 3 years are the best candidates for bait stations.

Since wireworm infestations are usually not uniform within a field, it will be necessary to place the bait stations randomly throughout the field. One bait station per acre is desirable. As a minimum, place 2 stations at the highest elevation in a field, 2 on a slope, and 2 in the lowest area.

Follow this procedure for baiting:

1. Use a mixture of 1 cup of untreated wheat and 1 cup of untreated shelled corn at each station.

2. Bury the bait about 4 inches deep. It is also desirable to cover the ground over each bait station with an 18-inch square of black plastic. The plastic collects solar heat and speeds germination of the corn and wheat, which entices overwintering wireworms.

3. Mark each station with a flag or stake.

4. Dig up the bait stations in 10 to 14 days and count the number of wireworms.

Need for Treatment

If you find an average of one wireworm per bait station, use a labeled soil insecticide. In some instances, several wireworms may be found in one bait station and none in others. Wireworm infestations tend to concentrate in some locations. It may be possible to limit treatment to areas where the concentration is heaviest.

WHITE GRUBS

Several species of economically important white grubs have 3-year life cycles. Peak years of damage usually occur during the year following large flights of May beetles, the adult stage of white grubs. The beetles prefer to lay their eggs in ground covered with vegetation, such as weedy soybean fields and sod.

The C-shaped white grub larvae chew on the roots and root hairs of corn seedlings. During peak years of damage, the grubs feed all season long. Damage to a cornfield is most apparent in the spring. Symptoms of white grub injury visible aboveground are irregular emergence, reduced stands, and stunted or wilted plants. The damage is usually spotty throughout the field.

There are no effective rescue treatments for white grubs after the damage appears. However, if plants show symptoms of injury, dig around the root system of several corn plants. If white grubs are causing the problem and replanting is warranted, use a labeled soil insecticide.

PLANTER-BOX SEED TREATMENTS

Corn. Use a seed treatment in fields that do not receive a soil insecticide at planting time. A planter-box seed treatment with diazinon will protect germinating corn against attack by seedcorn beetles and maggots. A diazinon + lindane planter-box seed treatment protects seed from attack by seedcorn maggots, seedcorn beetles, and wireworms. Lorsban 50-SL is labeled as a slurry treatment on seed before planting to protect germinating seed against injury by seedcorn maggots and beetles. NOTE: Excess dust from the seed treater may interfere with the electronic monitor in air planters.

Some seed may have already been treated with a certain combination of insecticide and fungicide. Addition of diazinon + lindane may cause planter units to gum up. Consult your seed or insecticide dealer to obtain specific information about seed treatment combinations.

Soybeans. Use a diazinon or diazinon + lindane seed protectant to prevent damage to germinating soybeans from seedcorn maggots. Follow the label directions for application. The potential for damage is greatest during cool, wet springs when germination is slow.

CALIBRATION FOR GRANULAR SOIL INSECTICIDES

Calibrate the applicators for granular soil insecticides before the planting season begins. In some instances, poor control is caused by applying rates that are too low. Proper calibration will help avoid this problem. Most soil insecticide bags have a list of suggested settings for the particular model of applicator. The settings are based on planting speed. The *beginning settings* are helpful, but be sure to check your actual application rate under your own operating conditions.

Follow these steps for calibrating the applicator:

1. Calibration of granular applicators for soil insecticides is usually based on ounces of product needed per 1,000 feet of row. Consult the insecticide label or Table 3 for labeled rates for rootworm control. These rates are expressed in ounces per 1,000 feet of row and in pounds of product per acre.
2. Consult the label or manufacturer's recommendation for an approximate application setting. Adjust the setting on each hopper.
3. Select an area for a test run, preferably in the field so that speed and traction conditions are constant. Measure off 1,000 feet.
4. Fill the hoppers and attach a plastic bag or container to each delivery tube to catch the granules from each hopper.
5. Drive the premeasured distance (1,000 feet) at the same speed to be used during the planting operation.
6. Weigh the material collected from each hopper. Use a scale that weighs in ounces (e.g., a postal scale or a diet scale).
7. Compare the quantity (ounces) per bag against those given in Table 3. To obtain one pound of active ingredient per acre the following amounts of material should be collected:

Formulation, percent	Oz. collected per 1,000 ft.
10	12
15	8
20	6

8. Recalibrate if the difference in quantity applied during the calibration process is more than 10 percent over or under the rate suggested on the label.

EUROPEAN CORN BORERS

Corn borer moths begin to emerge in late May in southern Illinois and mid- to late June in the central and northern regions. The females lay most of their eggs in the evening. They spend the daylight hours in fencerows and other protected areas.

First-generation borers reduce yields by stalk-tunneling, which weakens the plant and destroys the tissue used to transport food within the plant.

Corn that is planted early (the fields with the tallest corn) should be monitored closely from mid-June to

early July for signs of whorl-feeding by corn borer larvae. The fields with the tallest corn in mid-June are the most attractive to moths laying eggs for the first generation. Control is warranted if 50 percent or more of the plants have fresh whorl-feeding and live borers are present. Seed production fields should be treated when 15 to 25 percent of the plants have whorl-feeding and larvae are present.

Corn hybrids have varying degrees of tolerance or resistance to leaf-feeding by first-generation borers. Consider this trait when selecting varieties for 1985.

Corn planted late is most attractive to moths laying eggs for the *second generation.* Yield losses caused by second-generation borers are a result of stalk breakage and ear drop, as well as physiological damage. Corn-borer entrance holes also provide avenues for stalk rot organisms. Monitor fields from mid-July to mid-August for egg masses or newly hatched larvae of the second brood.

To assess the potential for second-generation corn borers, start checking for egg masses when moth flight is under way. Examine a minimum of 25 plants, selected at random throughout the entire field, and count the number of egg masses that are found on each plant. Although the moths usually lay their eggs on the two or three leaves above or below the developing ear, you should check all the leaves. One technique is to remove the leaves one by one, starting at the bottom of the plant, and carefully scan them for egg masses.

The eggs, which are deposited in masses of 15 to 30, overlap like the scales of a fish. Calm nights favor egg deposition by the moths. The absence of hard, beating rains during moth emergence also increases the potential for infestations.

Egg masses are flat and about half the size of your little fingernail. Newly deposited eggs are white, then turn pale yellow, and become darker just before hatching. Eggs that are about to hatch have distinct black centers. These are the black heads of the larvae that are visible through the translucent eggshell. The eggs hatch in 3 to 7 days, depending on the temperature. The female moth hides in grass and weeds during the day. Noncrop areas that border cornfields may harbor large numbers of corn borer moths during the day. Check these areas for moths as you enter the field to determine the potential for corn borer infestation.

Treatment is warranted when you find 1 egg mass for every two plants. Because peak egg laying generally occurs over a period of 2 to 4 weeks, it will be necessary to resample fields if egg masses are not present on half of the plants during the initial survey. If cumulative counts (taken 1 week apart) exceed 1 egg mass for every two plants, apply a treatment.

For best results, treatment should be applied soon after egg hatch to kill the young larvae before they bore into the plant. The larvae begin tunneling into the stalks about 10 days after hatching. Because egg laying for the second generation extends over a 3- to 4-week period, timing of insecticide application should be precise. Occasionally, two treatments may be necessary for satisfactory control.

CORN LEAF APHIDS

Corn leaf aphids are small, soft-bodied, greenish-blue plant lice about the size of a pinhead. They do not overwinter in Illinois. Winged corn leaf aphids, blown into Illinois on southwesterly winds during mid- to late June, become established within the whorl leaves of the corn plant. These aphids give birth to living young. In the absence of predators, parasites, diseases, and hard beating rains, aphid populations may increase very rapidly.

Corn leaf aphids cause damage by sucking moisture and nutrients from the corn plant. Soil moisture stress and heavy infestations on the upper leaves and tassel may result in barren plants or reduced ear size. The critical period for damage is during tassel emergence through pollination. If aphids are allowed to cover the tassel and upper two or three leaves, yield losses are likely to occur.

Fields should be scouted for aphids, beginning about one week before tassel emergence. Pull and unroll the whorl leaves of plants selected at random to check for aphids. Treatment is suggested if 50 percent of the plants have 100 or more corn leaf aphids per plant during tassel emergence and if *plants are under drouth stress.* Aphid populations usually decline after pollination is complete. However, treatment may be warranted following pollination if aphid populations continue to cover the tassel and one or two of the upper leaves.

REDUCED TILLAGE AND NO-TILL CORN INSECT PESTS

Concern about insect problems should not keep growers from adopting conservation tillage practices. The soil-insect complex in corn, which is similar in many ways in conventional and reduced-tillage systems, can be readily controlled by applying soil insecticides at planting time. Outbreaks of insects feeding on foliage can usually be controlled with properly timed insecticide treatments. Close monitoring of fields to detect insect outbreaks is essential, regardless of the tillage system.

Weather conditions and the type of crop rotations determine to a great extent whether a soil insect problem will occur and what kind it will be. In some instances, tillage may also influence the kind and abundance of an insect pest. Some tillage operations favor specific pests. Others tend to reduce pest problems. The general expectation is that insect infestations will be more pronounced where no-tillage is used in corn than where conventional or reduced-tillage systems are used.

No-Till Pests

Insect problems occur more frequently in no-till corn than in any other conservation tillage system and are often more serious. Crop residue left by the use of no-till practices provides a stable environment for pest survival and development. Pests occurring under these conditions include *European corn borer, cutworms, armyworm, common stalk borer, wireworms, seedcorn maggots, billbugs, slugs,* and *mice.* Soil insecticides may be needed on no-till corn following corn (in rootworm area), grass sod, legumes, or following any crop in which grasses and broadleaf weeds are prevalent.

Soil Insect Control

Select a soil insecticide that will control the anticipated soil insect pest. Consult Table 5 for suggestions. If a soil insecticide is not applied at planting, a diazinon planter-box seed protectant will give protection against seedcorn maggots and seedcorn beetles.

Surface residues from no-till and reduced-tillage systems may present some problems with the placement and incorporation of granular soil insecticides applied at planting. To be most effective, the soil insecticide should be incorporated into the upper ½ inch of soil, and not just broadcast on the surface. Granules remaining on the soil surface are degraded by sunlight, resulting in erratic or poor control.

NOTE: Before using Broot, Dyfonate, Mocap, or Thimet on no-till corn, be sure that soil moisture is low enough to ensure closing of the seed furrow to prevent the insecticide granules from contacting the seed. Crop injury may occur with these products.

Aboveground Insect Pests

Aboveground insects will be more of a problem in no-till corn than under reduced or conventional tillage. Corn planted in grass sod or fall-seeded rye is vulnerable to attack by *armyworms.* The moths lay eggs on the grasses during April or early May. After vegetation is killed by a herbicide, the larvae move to the young corn seedlings and feed on them. Control is justified when 25 percent of the plants are being damaged. Rescue treatments are effective, but a spray volume of 15 to 20 gallons per acre will improve coverage and control.

Instances of damage to corn by the *common stalk borer* have been greater in no-till corn than with other tillage systems. Moths of this insect deposit their eggs on weeds in late August and September. When a herbicide is applied in the spring to no-till corn in fields previously infested with host weeds, the newly hatched stalk borer larvae move from the dead vegetation and attack newly emerging corn plants. Rescue treatments may give erratic control of common stalk borer because the chemicals cannot reach the worms inside the stem. To reduce the potential of stalk borer damage in a subsequent season, it is essential to have good weed control within a field during August and September, when moths are laying eggs.

FORAGE INSECTS

Alfalfa weevils may cause moderate to severe damage to the first cutting of alfalfa in most areas of Illinois. In the southern counties, where a lot of egg laying takes place in the fall, alfalfa-weevil larval damage occurs early in the spring. Damage to the first cutting in northern Illinois is more likely to occur if hay harvest is delayed. Otherwise the injury to alfalfa in the northern counties will occur on the stubble and new growth of the second cutting.

Numbers of alfalfa weevils are regulated to a large extent by winter weather. During a cold, open winter the mortality rate is high in overwintering weevil populations; during mild winters the mortality rate is low.

A parasitic wasp and a fungal disease organism that attack alfalfa weevil larvae sometimes regulate weevil numbers in the spring. Although the wasp and the fungus will be present in alfalfa fields in 1986, we cannot yet predict their effect on weevil numbers.

Alfalfa growers in southern and central Illinois should inspect their fields closely in April, May, and June. Early larval damage appears as pinholes in the growing terminals. As the larvae grow, they skeletonize the leaves, and damaged fields appear tattered. Growers in northern Illinois should look carefully for larval damage in May and June. All growers should examine the stubble after the first cutting, because larval and adult feeding can slow or halt new growth. Follow the suggestions in Circular 1136, "Alfalfa Weevil Pest Management Program," to determine the need and proper timing of a treatment. If this circular is unavailable, a rule of thumb is to treat when 25 percent of the tips are being skeletonized. This threshold is 40 percent in northern Illinois where damage occurs later in the season.

Potato leafhoppers may cause moderate to severe damage to the second and third cuttings of alfalfa in all areas of Illinois. However, population levels are difficult to predict because the leafhoppers do not survive the winter in Illinois. They migrate from southern states into Illinois during May and June.

Damage first appears as a yellow, wedge-shaped area at the tip of the leaf and is more evident during dry weather. Many people confuse the damage with diseases or nutrient deficiency.

Table 4. Economic Thresholds for Potato Leafhoppers on Alfalfa

Alfalfa height (inches)	Average number of leafhoppers per sweep of sweep net
0-3	0.2
3-6	0.5
6-12	1.0
12 or taller	1.5

Damage may begin on the new growth as soon as the first hay crop is removed. Stunting and yellowing are signs of leafhopper injury. A swarm of leafhoppers at the time of the first cutting also indicates that there may be a problem in the new growth. The economic threshold for leafhoppers varies with the height of the alfalfa (see Table 4). A treatment is justified when the number of leafhoppers exceeds the economic threshold.

BEAN LEAF BEETLES

Bean leaf beetles overwinter as adults under debris in fencerows, wooded areas, and other protected sites. The survival of the overwintering beetles depends on the winter weather. A mild winter increases the chances for a large population in the spring. In addition, if soybeans are planted early, the beetles will establish themselves early. The availability of soybeans during the early part of the season is essential for the survival of bean leaf beetles. The survival of large numbers early in the season generally means an even larger population in August. On the other hand, a severe winter and later planted soybeans will reduce the number of bean leaf beetles in the spring.

The beetles may cause considerable leaf-feeding injury to double-cropped soybeans and late maturing soybean varieties. Insecticide treatments are recommended during the critical pod-set and pod-fill stages when defoliation exceeds 20 percent. The greatest concern, however, is caused by the beetles' pod-feeding damage, which leaves scars on many pods. These scars predispose the pods to fungal infections. A treatment is recommended when 5 to 10 percent of the pods are damaged.

CHEMICAL INJURY TO SOYBEANS

There have been instances of phytotoxicity to soybeans when organic phosphate soil insecticides were used. The problems have occurred where growers started planting soybeans without first emptying the insecticide boxes. Organic phosphate soil insecticides applied in soybean fields treated with Sencor or Lexone may cause injury to a soybean crop, according to information on the labels.

Table 5. Field Corn

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Armyworms	*Furadan 15G	1[b]	Band, furrow	Apply as a planting-time treatment for early season control of armyworms in corn planted no-till in grass sod or small grains.
	*Ambush, *Pounce	0.1-0.2	Broadcast	At first migration, or when worms are eating leaves above ear level. Ambush, Lorsban 4E, Pounce, and Pydrin can also be applied as a preemergent treatment in no-till corn.
	Dylox	½-1		
	*Lannate, *Nudrin	¼-½		
	Lorsban 4E	½-1		
	malathion	1		
	*Penncap-M	½-¾		
	*Pydrin	0.1-0.2		
	Sevin	1		
Billbug	**Counter 15G	1[b]	Band, furrow	At planting.
	Lorsban 15G	1-2[b]	Band	
	Lorsban 4E	2	Broadcast-PPI[c]	
	Lorsban 4E	1-1½	Broadcast	Apply as a postemergence rescue treatment with ground equipment when damage appears.
Chinch bug	Lorsban 4E	1[b]	Spray at base of plant.	At start of migration from small grains. Use only ground equipment and apply 20 to 40 gallons of finished spray per acre.
	*Pydrin	0.1-0.2[b]		
	Sevin	2[b]		
Common stalk borer	*Ambush, *Pounce	0.1-0.2	Broadcast	Furadan 15G applied at 2-3 lb. a.i./acre at planting time may provide early season suppression of common stalk borers. Apply postemergence sprays when damage first appears. See labels for specific instructions about effective control.
	Lorsban 4E	1-1½		
	*Pydrin	0.15-0.2[b]		
Corn earworm	*Lannate, *Nudrin	½	Overall spray or directed toward ear zone	Justified only in seed corn fields. Treatments are rarely effective for the control of earworms after worms enter ear tips. Ambush and Pounce have 24(c) labels for control of corn earworms in seed production fields.
	*Pydrin	0.1-0.2		
Corn leaf aphid	Lorsban 4E	½-1	On foliage	Apply during late whorl to early tassel when 50% of plants have light to moderate infestations and plants are under drouth stress.
	malathion	1		
	*Penncap-M	½-¾		

Table 5. Field Corn (continued)

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Corn rootworm beetles	diazinon spray Imidan Lorsban 4E malathion *Penncap-M *Pounce *Pydrin Sevin	½ ½ ½-1 1 ½ 0.1-0.2 0.1-0.2 1	Overall spray or directed toward ear zone	To protect pollination, treat before 75% of plants have silked, if there are 5 or more beetles per plant, and if silk clipping is observed.
Corn rootworm larvae	Broot 15GX **Counter 15G **Dyfonate 20G, 4E **Furadan 15G *Furadan 4F Lorsban 15G **Mocap 15G **Thimet 20G	1[b] 1[b] 1[b] 1[b] 1[b] 1[b] 1[b] 1[b]	Band Band, furrow Band Band, furrow Band Band Band Band	At planting. Counter 15G, Dyfonate 20G, Furadan 15G and 4F, Lorsban 15G and 4E, Mocap 15G, and Thimet 20G can also be applied at cultivation time.
Cutworms	*Ambush, *Pounce Lorsban 15G Lorsban 4E *Pydrin	0.1-0.2 1[b] 1-2 0.1-0.2	PRE[d] Band at planting Broadcast-PPI[c] PRE[d]	Counter 15G, Dyfonate 20G, Furadan 15G, and Mocap 15G will control light to moderate infestations of cutworms.
	*Ambush, *Pounce Lorsban 4E *Pay-Off *Pydrin Sevin bait	0.1-0.2 1-1½ 0.04-0.08 0.1-0.2 1-2	Broadcast-PE[c] Broadcast-PE[c] Broadcast-PE[c] Broadcast-PE[c] Broadcast-PE[c]	Apply as a postemergence rescue treatment when 3 percent or more of the plants are cut in the 2-leaf stage and there are 2 or more cutworms per 100 plants. At the 4-leaf stage, control is justified if 3 percent or more of the plants are cut and there are 4 or more worms per 100 plants.
European corn borer, first generation	*Ambush, *Pounce diazinon 14G Dipel 10G **Dyfonate 20G **Furadan 15G, 4F Lorsban 15G *Penncap-M	0.1-0.2 1 See label 1 1 1 1	On upper ⅓ of plant and into whorl	When 50% or more of the plants have fresh whorl-feeding and live borers are present. Sprays are most effective when directed over the row, rather than broadcast.
European corn borer, second generation	diazinon 14G **Dyfonate 20G **Furadan 15G, 4F Lorsban 15G *Penncap-M	1 1 1 1 1	On foliage	Apply at first hatch when half of the plants have egg masses, or when cumulative counts, made one week apart, exceed 1 egg mass for every 2 plants.
Fall armyworm	Dylox *Lannate, *Nudrin Lorsban 4E	1 ½ 1	On foliage	Treat when 35% of plants have whorl damage and if worms are present. Ground sprays directed over the row are more effective than broadcast sprays. Treatments to control worms in ear tips are not effective.
Flea beetles	*Ambush diazinon spray Lorsban 4E *Penncap-M Sevin	0.1-0.2 ½[b] 1[b] ½[b] 1[b]	Over row as spray	When leaves on seedling plants are severely damaged and some plants are being killed.
Grasshoppers	Cygon diazinon spray *Furadan 4F Lorsban 4E malathion *Penncap-M *Pydrin Sevin	½ ½ ⅛-¼ ¼-½ 1 ¼-¾ 0.1-0.2 ½-1½	On foliage	As needed. The higher rates are suggested for control of adult grasshoppers.
Hop vine borer	None labeled	..	...	Postemergence sprays of Ambush, Pounce, Pydrin, or Lorsban may give some control if applied when damage first appears.
Japanese beetle	Sevin	1	On foliage	During the silking period to protect pollination if less than 75% of plants are silked and there are 3 or more beetles per ear.

Table 5. Field Corn (continued)

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Picnic, sap beetles	diazinon spray	1	On foliage	Justified only in seed corn fields when beetles are feeding on ear tips.
	*Lannate	½		
	malathion	1		
	Sevin	1		
Seedcorn beetles	**Counter 15G	1[b]	Band, furrow	At planting.
	**Dyfonate 20G	1[b]	Band	
	Lorsban 15G	1[b]	Furrow	
	**Thimet 20G	1[b]	Band	
	diazinon	See label	On seed	Use formulations that are prepared as seed treaters.
	diazinon + lindane	See label	On seed	
	Lorsban 50-SL	See label	On seed	
Seedcorn maggots	**Counter 15G	1[b]	Band, furrow	At planting.
	**Dyfonate 20G	1[b]	Band	
	**Furadan 15G	1[b]	Furrow	
	Lorsban 15G	1[b]	Furrow	
	**Thimet 20G	1[b]	Band	
	diazinon	See label	On seed	Use formulations that are prepared as seed treaters. Seed treatments should be considered for fields that do not receive a soil insecticide at planting.
	diazinon + lindane	See label	On seed	
	Lorsban 50-SL	See label	On seed	
Sod webworm	Lorsban 4E	½-1	Broadcast	At time of initial attack.
Southwestern corn borer	diazinon 14G	1-2	On foliage	Direct granules over row. Apply when 25% of the plants have egg masses or larvae on leaves. Early-planted corn usually escapes damage. Sprays are most effective when directed over the row, rather than broadcast.
	**Dyfonate 20G	1		
	**Furadan 15G, 4F	1		
	Lorsban 15G, 4E	1		
	*Penncap-M	1		
	*Pydrin	0.1-0.2		
Spider mites	Cygon	½	On foliage	Begin control if the majority of plants are infested with mites severe enough to cause some yellowing or browning of the lower leaves before dent stage.
	diazinon spray	½		
	**Di-Syston 15G	1		
	ethion spray	1		
	**Thimet 20G	1		
	Trithion	1		
Symphylans	**Counter 15G	1[b]	Band, furrow	At planting.
	*Dyfonate 4E	2	Broadcast-PPI[c]	
	Lorsban 15G	1-1½[b]	Band	
	Lorsban 4E	1-2	Broadcast-PPI[c]	
	**Mocap	1[b]	Band	
Thrips	malathion	1	On foliage	When severe wilting and yellowing of leaves are noticed.
White grubs	**Counter 15G	1[b]	Band, furrow	At planting.
	Lorsban 15G	1-2[b]	Furrow	
	Lorsban 4E	2	Broadcast-PPI[c]	
	**Thimet 20G	1[b]	Band	
Wireworms	**Counter 15G	1[b]	Band, furrow	At planting.
	**Furadan 15G	1[b]	Band, furrow	
	Lorsban 15G	2[b]	Band, furrow	
	Lorsban 4E	2	Broadcast-PPI[c]	
	**Mocap 15G	1[b]	Band	
	**Thimet 20G	1[b]	Band	
Woollybear caterpillars	None labeled	..	...	Silk clipping caused by caterpillars does not generally warrant control.

* Use restricted to certified applicators only.

** Granular formulations of Counter, Di-Syston, Dyfonate, Furadan, Mocap, and Thimet released for shipment by the manufacturer after September 1, 1985, are restricted.

[a] See Table 13 for insecticide restrictions.

[b] Based on 40-inch row spacing. Increase rates for narrow rows.

[c] PPI Pre-plant incorporated.

[d] PRE Preemergent application.

[e] PE Postemergent application.

Table 6. Soybeans

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Bean leaf beetle	*Ambush, *Pounce	0.05-0.1	On foliage	Before bloom: when defoliation reaches 30%, at least 1 cotyledon per foot of row is destroyed, and there are 5 or more beetles per foot of row. Bloom to pod fill: when defoliation reaches 20% and there are 16 or more beetles per foot of row. Seed maturation: when 5 to 10% of the pods are damaged, the leaves are green, and there are 10 or more beetles per foot of row.
	Cygon	½		
	Lorsban 4E	½		
	Orthene	½		
	*Penncap-M	½		
	*Pydrin	0.1		
	Sevin	1		
Blister beetles	Sevin	1	On foliage	When defoliation reaches 30% before bloom and 20% between bloom and pod fill.
Corn earworm	*Ambush, *Pounce	0.1	On foliage	Damage occurs when larvae feed on pods. Apply control if populations exceed 1 per foot of row.
	*Lannate, *Nudrin	½		
	Orthene	1		
	*Pydrin	0.1-0.2		
Cutworms	Sevin bait	1-2	Broadcast	Scout as plants are emerging. Treat if 20% of plants are cut and stand has gaps of one foot or more and cutworms are present.
	Lorsban 4E	1	Broadcast	
	*Pydrin	0.1-0.2	Broadcast	
Grasshoppers	Cygon	½	On foliage	When migration into fields begins and defoliation or pod feeding reaches economic levels. When defoliation reaches 30% before bloom and 20% between bloom and pod fill. The higher rates are suggested for control of adult grasshoppers.
	*Furadan 4F	⅛-¼		
	Lorsban 4E	¼-½		
	Orthene	¼-½		
	*Penncap-M	¼-¾		
	*Pydrin	0.1-0.2		
	Sevin	½-1½		
Green cloverworm	*Ambush, *Pounce	0.05-0.1	On foliage	When defoliation occurs during blooming, pod set, and pod fill. Usually requires 12 or more half-grown worms per foot of row and 20% defoliation to justify treatment.
	Dipel, Thuricide, Bactur, SOK (*Bacillus thuringiensis*)	See label		
	Lorsban 4E	¼-½		
	Orthene	½		
	*Penncap-M	½		
	*Pydrin	0.05-0.1		
	Sevin	½		
Japanese beetle	*Penncap-M	¾-1	On foliage	When defoliation reaches 20% during bloom and pod fill.
	*Pounce	0.05-0.1		
	*Pydrin	0.1-0.2		
	Sevin	1		
Loopers	*Ambush, *Pounce	0.05-0.1	On foliage	When defoliation reaches 30% before bloom and 20% between bloom and pod fill.
	Orthene	½-1		
	*Pydrin	0.1-0.2		
	Thuricide, Dipel, Bactur, SOK (*Bacillus thuringiensis*)	See label		
Mexican bean beetle	*Ambush, *Pounce	0.05-0.1	On foliage	When defoliation reaches 30% before bloom and 20% between bloom and pod fill.
	Cygon	½		
	*Furadan 4F	½		
	Lorsban 4E	½		
	Orthene	½		
	*Penncap-M	½		
	*Pydrin	0.05-0.1		
	Sevin	1		
Potato leafhopper	*Ambush, *Pounce	0.05-0.1	On foliage	When leafhoppers are numerous and the edges of the leaves appear burned.
	Cygon	½		
	*Penncap-M	½		
	*Pydrin	0.05-0.1		
	Sevin	1		

Table 6. Soybeans (continued)

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Saltmarsh caterpillar	*Ambush *Lannate, *Nudrin Lorsban 4E *Pydrin	0.05-0.1 ½ ½ 0.05-0.1	On foliage	When defoliation reaches 30% before bloom and 20% between bloom and pod fill.
Seedcorn maggot	diazinon diazinon + lindane	See label See label	On seed On seed	At planting time. Use formulations that are prepared as seed treaters.
Spider mites	Cygon Lorsban 4E *Penncap-M Trithion	½ ½ ½ ½-¾	On foliage	As needed on field margins or entire field.
Stink bugs	Lorsban 4E Orthene *Penncap-M *Pydrin Sevin	1 ¾-1 ½-¾ 0.1-0.2 1-1½	On foliage	When adult bugs or large nymphs reach 1 per foot of row during pod fill.
Thistle caterpillar	Sevin	2	On foliage	When defoliation reaches 30% before bloom and 20% between bloom and pod fill.
Thrips	*Penncap-M Sevin	½-¾ 1	On foliage	If seedlings are being seriously damaged and some plants are being killed.
Webworms	Sevin	1	On foliage	When defoliation reaches 30% before bloom and 20% between bloom and pod fill.
Whitefly	None labeled	..	...	High infestations are occasionally present on double-crop soybeans, but are rarely economic.
Woollybear caterpillars	Lorsban 4E *Pounce *Pydrin	½-1 0.1 0.1		When defoliation reaches 30% before bloom and 20% between bloom and pod fill. Sprays of Ambush or Penncap-M may also be effective.

* Use restricted to certified applicators only. [a] See Table 13 for insecticide restrictions.

Spraying blossoming soybeans can be extremely hazardous to bees. Coordinate with local beekeepers before applying sprays. Beekeepers' names and colony locations may be obtained from your County Extension Office.

Table 7. Alfalfa and Clover

To avoid injury to bees, do not spray alfalfa during bloom or if weeds are blooming.

Insect	Insecticide[a,b]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Alfalfa weevil (spring treatment for larvae)	*Furadan 4F Imidan Lorsban 4E[c] malathion + methoxychlor *Penncap-M *Supracide	¼-½ 1 1 2 qt. per acre ½ ½	On foliage	Refer to Circular 1136. Or when 25% of tips are being skeletonized and if there are 3 or more larvae per stem, treat immediately. Do not apply sprays during bloom. Instead, cut and remove the hay. Two treatments may be necessary on first cutting. Watch regrowth for signs of damage, and treat if feeding damage is apparent.
Alfalfa weevil adults	*Furadan 4F Imidan Lorsban 4E[c] *Penncap-M	½-1 1 1 ¾		As a stubble spray.

Table 7. Alfalfa and Clover (continued)

Insect	Insecticide[a,b]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Aphids	Cygon	¼	On foliage	When aphids average 100 or more per sweep and lady beetle larvae and adults, parasites, and diseases are not abundant.
	*Furadan 4F	¼		
	*Lannate, *Nudrin	½		
	Lorsban 4E[c]	½		
	malathion	1		
	*Penncap-M	½		
	*Supracide	½		Avoid treatments when plants are blooming.
Blister beetles	Sevin	1	On foliage	Although blister beetles rarely cause economic damage to alfalfa, their presence in hay could injure horses if the horses ingest the beetles.
Clover leaf weevil	malathion	1	On foliage	When larvae are numerous (5 or more per crown) and leaf feeding is noticeable, usually in early to mid-April.
Cutworms	Dylox	½-1	On foliage	As needed on regrowth of second cutting.
	Lorsban 4E[c]	1		
	Sevin	1½		
Fall armyworm	Dylox	1	On foliage	Usually in late summer or early fall on new seedlings or established stands.
	*Lannate, *Nudrin	½		
	Lorsban 4E[c]	1		
Grasshoppers	Cygon	¼-½	On foliage	When grasshoppers are small and before damage is severe. The higher rates are suggested for control of adult grasshoppers. Avoid treatments when plants are blooming.
	diazinon	½		
	*Furadan 4F	⅛-¼		
	Lorsban 4E[c]	¼-½		
	*Penncap-M	¼-¾		
	Sevin	1-1½		
Leafhoppers	Cygon	¼-½	On foliage	Treatment is justified at these combinations of alfalfa height and leafhopper numbers:
	*Furadan 4F	½		
	Lorsban 4E[c]	½-1		
	*Penncap-M	½-¾		
	Sevin	1		
	*Supracide	½		

Alfalfa height (inches)	Leafhoppers per sweep
0-3	0.2
3-6	0.5
6-12	1.0
12 or taller	1.5

Avoid treatments when plants are blooming.

Plant bugs	Cygon	¼-½	On foliage	When tip damage is obvious and nymphs and adults are numerous.
	Dylox	1		
	*Furadan 4F	1		
	Lorsban 4E[c]	½-1		
	*Penncap-M	½-¾		
	Sevin	1		Avoid treatments when plants are blooming.
Spittlebug	Imidan	1	On foliage	When spittle masses are found and nymphs average more than 1 per stem.
	Lorsban 4E[c]	½-1		
	malathion + methoxychlor	2 qt. per acre		
	malathion	1		Avoid treatments when plants are blooming.
	*Penncap-M	½-¾		
Webworms	Dylox	1	On foliage	If damage appears.
	malathion + methoxychlor	2 qt. per acre		
	Sevin	1		

* Use restricted to certified applicators only. [a] See Table 13 for insecticide restrictions.

[b] Before applying insecticides, be certain to clean all herbicides out of equipment. During pollination, apply very late in day or, if possible, avoid application during bloom.

[c] Young, tender, rapidly growing alfalfa may show some phytotoxic symptoms when treated with Lorsban 4E.

Spraying blossoming alfalfa can be extremely hazardous to bees. Coordinate with local beekeepers before applying sprays. Beekeepers' names and colony locations may be obtained from your County Extension Office.

Table 8. Grain Sorghum

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Chinch bug	Lorsban 4E[b] Sevin	1 2	At plant base	Use only ground equipment and apply 20 to 40 gallons of finished spray per acre.
Corn earworm	*Lannate, *Nudrin Sevin	½ 1-2	Over row	When there is an average of 2 worms per head.
Corn leaf aphid	Cygon Lorsban 4E[b] malathion	¼-½ ¼-½ 1	Over row	Corn leaf aphids rarely cause economic damage unless populations are heavy and drouth conditions exist.
Cutworms	Lorsban 15G Lorsban 4E[b]	1[c] 1	Band Broadcast	At planting. When seedling plants are being cut.
Fall armyworm	*Lannate, *Nudrin Lorsban 4E[b] Sevin	½ 1 1½	Over row	When there is an average of 2 worms per head. Leaf feeding or whorl damage is seldom economic.
Grasshoppers	Cygon Lorsban 4E[b] Sevin	½ ¼-½ ½-1½	Over row	As needed. The higher rates are suggested for control of adult grasshoppers.
Greenbug	Cygon diazinon spray Lorsban 4E[b] malathion	¼-½ ½ ¼-½ 1	Over row	When greenbug damage is sufficient to cause death of more than 2 normal-sized leaves before the hard-dough stage. CAUTION: Some sorghum varieties are sensitive to organophosphate insecticides.
	Counter 15G Furadan 15G Thimet 20G	1-2[c] 1[c] 1[c]	Band Band, furrow Band	At planting.
Sorghum midge	diazinon spray *Lannate, *Nudrin Lorsban 4E[b]	¼ ¼ ¼	Over row	Apply during bloom when 50% of heads have begun to bloom and there are 1 or more midge adults (flies) per head.
White grubs	*Counter	1-2[c]	Band	At planting.
Wireworms	*Counter	1-2[c]	Band	At planting.
Webworms	*Lannate, *Nudrin Lorsban 4E[b] Sevin	½ 1 1-2	Over row	When 5 or more larvae per head are found.
Yellow sugarcane aphid	Cygon Lorsban 4E[b]	½ ¼-½	Over row	Treatment should be applied at first sign of damage to seedling sorghum; 5 to 10 aphids per leaf.

* Use restricted to certified applicators only.
[a] See Table 13 for insecticide restrictions.
[b] To avoid phytotoxicity, do not treat plants that are under extreme heat and drouth stress.
[c] Based on 40-inch row spacing. Increase rates for narrow rows.

Table 9. Small Grains (Barley, Oats, Rye, Wheat)

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Armyworm	Dylox *Lannate, *Nudrin *Penncap-M Sevin	½-1 ¼-½ ½-¾ 1	On foliage	When there are 6 or more armyworms per linear foot of row and before extensive head cutting occurs. Do not use Dylox or Penncap-M on rye.
Cereal leaf beetle	*Furadan 4F *Lannate malathion Sevin	½ ¼-½ 1 1	On foliage	When there are one or more small larvae per stem or flag leaf. Apply Furadan before heads emerge from the boot.
Fall armyworm	Dylox Sevin	1 1-1½	On foliage	During fall when damage to new growth is apparent. Do not use Dylox on rye.

Table 9. Small Grains (Barley, Oats, Rye, Wheat) (continued)

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Grasshoppers	Cygon	⅜	On foliage	During fall when damage is apparent, treat field borders and noncrop areas to stop migration. The higher rates are suggested for control of adult grasshoppers. Do not apply Penncap-M to rye.
	*Furadan 4F	⅛-¼		
	malathion	1		
	*Penncap-M	¼-¾		
	Sevin	½-1½		
Greenbug, English grain aphid, oat bird-cherry aphid	Cygon	¼-⅜	On foliage	Aphids damage plants indirectly by transmitting disease. Once yellowing is noticeable, it is usually too late to treat. Use Cygon on wheat only. Do not apply Penncap-M to rye.
	malathion	1		
	*Penncap-M	¼-½		
Variegated cutworm	Dylox	½-1		As needed. Do not use Dylox on rye.
Wheat stem maggot	None	..	...	No chemical control. Damage shows as white heads when field is still green.

* Use restricted to certified applicators only.
[a] See Table 13 for insecticide restrictions.

Table 10. Grass Pasture

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Armyworms	Dylox	1	On foliage	As needed. Sevin and Dylox may be applied without removal of grazing livestock.
	malathion	1¼		
	*Penncap-M	½-¾		
	Sevin	1		Do not apply when weeds are blooming.
Grasshoppers	diazinon spray	½	On foliage	As needed. The higher rates are suggested for control of adult grasshoppers.
	malathion	1		
	*Penncap-M	¼-¾		
	Sevin	½-1½		Do not apply when weeds are blooming.

* Use restricted to certified applicators only.
[a] See Table 13 for insecticide restrictions.

Table 11. Noncrop Areas

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Grasshoppers	diazinon	½	On foliage	When grasshopper nymphs average 15 to 20 per square yard along roadsides and fence rows. The higher rates are suggested for control of adult grasshoppers. Do not spray areas adjacent to water or where runoff is likely to occur. Apply treatments while hoppers are small and before they migrate into row crops.
	malathion	1		
	*Penncap-M	¼-¾		
	*Pydrin	0.05-0.1		
	Sevin	½-1½		

To avoid injury to bees, do not apply sprays to noncrop areas if weeds are blooming.

* Use restricted to certified applicators only.
[a] See Table 13 for insecticide restrictions.

Table 12. Sunflowers

Insect	Insecticide[a]	Pounds of active ingredient per acre	Placement	Timing of application, comments
Armyworm	Sevin	1½-2	Over row	When defoliation reaches 25%.
Cutworms	Sevin Lorsban 4E	1½ 1-1½	Over row	When 10% of the seedlings are damaged.
Fall armyworm	Sevin	1½-2	Over row	When defoliation reaches 25%.
Grasshoppers	*Furadan 4F Lorsban 4E *Pydrin Sevin	⅛-½ ½ 0.1-0.2 1-1½	Over row	When defoliation reaches 25%.
Stem weevil	*Furadan 4F Lorsban 4E Sevin *Supracide	½ ½-¾ 1-2 ½	Over row	When there are 2 or more beetles per plant.
Sunflower beetle	*Furadan 4F Lorsban 4E *Pydrin Sevin	⅛-¼ ½-¾ 0.05-0.1 1-2	Over row	When defoliation reaches 25%.
Sunflower moth larvae	*Furadan 4F Lorsban 4E *Pydrin *Supracide	½ ½-¾ 0.1-0.2 ½	Over row	Apply first treatment when a field has reached 20 to 25% bloom and moths are present.

* Use restricted to certified applicators only. [a] See Table 13 for insecticide restrictions.

Spraying blossoming sunflowers can be extremely hazardous to bees. Coordinate with local beekeepers before applying sprays. Beekeepers' names and colony locations may be obtained from your County Extension Office.

Table 13. Limitations in Days Between Application of the Insecticide and Harvest of Crop and Restrictions on Use of Insecticides for Field Crop Insect Control (These are only guidelines — read the label for more detailed information)

(Blanks denote that the product may not be labeled or suggested for that specific use in Illinois)

	Worker re-entry time (days)[a]	Field corn		Grain Sorghum	Forage crops		
		Grain	Ensilage		Alfalfa	Clover	Pasture
*Ambush (permethrin)[a,b]	...	A	A	...	...	...	...
Broot (trimethacarb)	...	90	90	...	...	...	...
*Counter (terbufos)	...	B	30,C	D	...	...	...
Cygon (dimethoate)[b]	...	14,E	14,E	28,E	10,F	...	...
Diazinon	...	B	10	7	7	7	0
Dipel (*Bacillus thuringiensis*)	...	B	B	...	...	...	...
*Di-Syston (disulfoton)[a,b]	...	40	40	...	...	...	...
*Dyfonate (fonofos)[b]	1	30	30	...	...	...	...
Dylox (trichlorfon)	...	G	G	...	0,G	0,G	0,G
Ethion	1	50,H	50,H	...	...	...	...
*Furadan (carbofuran)[a,b]	14[c]	30,I,J	30,I,J	75	K	...	...
Imidan (phosmet)	...	14	14	...	7,F	...	...
**Lannate (methomyl)[a,b]	...	B	3	14	0	...	...
Lorsban (chlorpyrifos)	...	35,L	14,L	60,M	21,N	...	...
Malathion	...	5	5	7	0	0	0
Methoxychlor	...		...	...	7	7	...
*Mocap (ethoprop)	...	B	B	...	...	...	...
**Nudrin (methomyl)[a,b]	...	B	3	14	0	...	...
*Pay-Off (flucythrinate)	...	28,P	28,P	...	...	...	...
*Penncap-M (microencapsulated methyl parathion)[a,b]	...	12	12	...	15	...	15
*Pounce (permethrin)[a,b]	...	A	A	...	...	...	...
*Pydrin (fenvalerate)[a,b]	...	21,Q	21,Q	...	...	...	...
Sevin (carbaryl)	...	0	0	21	3	0	0
*Supracide (methidathion)[a,b]	2	...	...	...	10,R	...	...
*Thimet (phorate)	7	30,S	30,S	...	...	...	...
Trithion (carbophenothion)[a,b]	...	B	21,T	...	...	...	...

Table 13. Limitations (continued)

	Worker re-entry time (days)[a]	Barley	Oats	Rye	Wheat	Soybeans	Sunflowers
*Ambush (permethrin)[a,b]	...	...	...	...	...	60,U	...
Cygon (dimethoate)[b]	...	...	...	...	60	21	...
Dipel, Thuricide, Bactur, SOK (*Bacillus thuringiensis*)	...	...	...	...	...	0	...
Dylox (trichlorfon)	...	21	21	...	21	...	...
*Furadan (carbofuran)[a,b]	14[c]	V	V	...	V	21,W	28,X
**Lannate (methomyl)[a,b]	...	7	7	7	7	14	...
Lorsban (chlorpyrifos)	...	...	...	...	...	28,Y	42,Z
Malathion	...	7	7	7	7	0	...
**Nudrin (methomyl)[a,b]	...	7	7	7	7	14	...
Orthene (acephate)	...	...	...	...	...	14,AA	...
*Penncap-M (microencapsulated methyl parathion)[a,b]	...	15	15	...	15	20,BB	...
*Pounce (permethrin)[a,b]	...	...	...	...	...	60,U	...
*Pydrin (fenvalerate)[a,b]	...	...	...	...	...	21,CC	28,CC
Sevin (carbaryl)	...	...	...	...	21,DD	0	60
*Supracide (methidathion)[a,b]	2	...	...	...	...	...	50,AA
Trithion (carbophenothion)[a,b]	...	...	...	...	...	7,AA	...

Read the label for more detailed information.

A. Apply prior to ear formation. Ear formation occurs when pollination is completed as evidenced by initiation of brown silk.

B. No specific restriction when used as recommended.

C. Only 1 postemergence incorporated treatment or 1 cultivation-time treatment may be used in addition to treatment at planting time.

D. Only one application per year may be used.

E. Make no more than 3 applications per year. Do not apply to sorghum after heading.

F. Apply only once per cutting; do not apply during bloom.

G. Three applications may be made per season on corn, and 3 applications may be made per cutting of alfalfa or grasses. Can be applied up to harvest.

H. Do not make more than 1 application after ear formation. Do not feed treated foliage to livestock.

I. Do not make a foliar application if Furadan 15G was applied at more than 8 ounces per 1,000 linear feet of row (6.7 pounds per acre with 40-inch row spacing) at planting. Do not make more than 2 foliar applications of Furadan 15G per season.

J. Do not make more than 2 applications of Furadan 4F per season at the 1½-2 pint use rate. Do not make more than 4 applications per season at the 1 pint use rate. Do not apply on seed corn less than 14 days prior to detasseling or rogueing. If prolonged, intimate contact will result, do not reenter treated field within 14 days of application without wearing proper clothing.

K. Make no more than 2 applications per season. Do not apply more than once per cutting. Do not use more than 1 pint per acre in the second application. Apply only to fields planted to pure stands of alfalfa. When using no more than ¼ pound per acre, allow 7 days between application and harvest. When using ¼ to ½ pound per acre, allow 14 days between application and harvest. When using ½ to 1 pound per acre, allow 28 days between application and harvest. Do not move bees to alfalfa fields within 7 days of application.

L. For soil insect control, do not exceed the equivalent of 16 ounces of Lorsban 15G per 1,000 feet of row or 13.5 pounds of Lorsban 15G per acre per crop season. For foliar insect control, do not exceed the equivalent of 16 ounces of Lorsban 15G per 1,000 feet of row or 13 pounds of Lorsban 15G per acre per crop season. Do not apply more than a total of 15 pints of Lorsban 4E per acre per season. Do not allow livestock to graze in treated areas nor harvest treated corn silage as feed for meat or dairy animals within 14 days after last treatment. Do not feed treated corn fodder to meat or dairy animals within 35 days after last treatment.

M. The treated crop is not to be used for forage, fodder, hay, or silage within 30 days after application of 1 pint of Lorsban 4E per acre or within 60 days after application of rates above 1 pint per acre. Do not treat sweet varieties of sorghum. Do not apply more than 3 pints of Lorsban 4E per acre per season.

N. Do not apply more than once per cutting. Do not cut or graze treated alfalfa within 14 days after application of 1 pint of Lorsban 4E per acre, nor within 21 days after application of rates above 1 pint per acre. Do not make more than 4 applications per year.

P. Do not apply by air. Do not make more than 2 applications per season.

Q. Do not exceed 1.0 pound of active ingredient per acre per season.

R. Make no more than 1 foliage and 1 stubble application per alfalfa cutting.

S. Do not make more than one application over the plant.

T. Do not make more than one application per season.

U. Do not graze or feed soybean forage or hay. Do not make more than 2 applications per season.

V. Apply before heads emerge from boot. Do not make more than 2 applications per season. Do not feed treated forage to livestock.

Table 13. Limitations (continued)

W. Do not use Furadan 4F as a foliar application if Furadan 10G, Furadan 15G, Furadan 4F was applied to soybeans at planting time. Do not make more than 2 foliar applications per season. Do not graze or feed foliar-treated forage to livestock or cut for silage or hay.

X. No more than 4 applications per season.

Y. Do not apply more than 6 pints of Lorsban 4E per acre or 3 pounds of chlorpyrifos (active ingredient) per acre per season. Do not apply last 2 treatments closer than 14 days apart. Do not allow livestock to graze in treated areas nor otherwise feed treated soybean forage to meat or dairy animals within 14 days after application. Do not feed straw from treated soybeans to meat or dairy animals within 28 days after application. On determinate soybeans do not apply more than one application after pod set.

Z. Do not apply more than 9 pints of Lorsban 4E per acre per season. Do not allow livestock to graze in treated areas.

AA. Do not graze or feed treated crop to livestock.

BB. Do not make more than 2 applications per season.

CC. Do not feed or graze livestock on treated plants. Do not exceed 0.8 pound active ingredient per acre per season.

DD. Do not make more than 2 applications after grain heads emerge from boot.

* Use restricted to certified applicators only.

**Liquid formulations are restricted.

[a] Workers should be warned in advance of treatments. Workers may not enter fields treated with the insecticides without wearing protective clothing for the intervals indicated. They may not enter a field treated with other insecticides without protective clothing until the spray has dried or the dust has settled. Protective clothing includes a hat, long-sleeved shirt, full length pants, and shoes and socks.

[b] Sprays to be applied only by experienced operators wearing proper protective clothing.

[c] Do not apply Furadan 4F on seed corn less than 14 days prior to detasseling or rogueing. If prolonged intimate contact will result, do not reenter field treated with Furadan 4F within 14 days of application without wearing proper protective clothing.

Table 14. Relative Toxicities of Commonly Used Agricultural Insecticides

		Toxicity to mammals[a]		Toxicity to		
Trade name	Chemical name	Acute oral	Acute dermal	Birds	Fish	Bees
*Ambush	permethrin	low	low	low	very high	high
Broot	trimethacarb	moderate	low	. . .	. . .	. . .
*Counter	terbufos	high	high	high	very high	. . .
Cygon	dimethoate	moderate	moderate	moderate	very low	high
Diazinon	diazinon	moderate	moderate	high	high	high
Dipel, Bactur, Topside, Thuricide, SOK	*Bacillus thuringiensis*	very low	very low	very low	very low	very low
*Di-Syston	disulfoton	high	high	moderate	. . .	moderate
*Dyfonate	fonofos	high	moderate	moderate	. . .	. . .
Dylox	trichlorfon	low	low	low	very low	low
Ethion	ethion	high	high	low	. . .	very low
*Furadan	carbofuran	high	moderate	moderate	moderate	high
Imidan	phosmet	moderate	low	low	. . .	high
**Lannate, **Nudrin	methomyl	high	moderate	low	. . .	high
Lorsban	chlorpyrifos	moderate	moderate	moderate	very high	high
Malathion	malathion	low	low	low	moderate	high
Methoxychlor	methoxychlor	low	low	very low	very high	low
*Methyl parathion	methyl parathion	high	high	moderate	very low	high
*Mocap	ethoprop	moderate	high	moderate	. . .	moderate
Orthene	acephate	moderate	moderate	moderate	low	high
*Pay-Off	flucythrinate	moderate	low	low	very high	high
*Penncap-M	microencapsulated methyl parathion	moderate	low	moderate	very low	high
*Pounce	permethrin	low	low	low	very high	high
*Pydrin	fenvalerate	moderate	low	low	very high	very high
Sevin	carbaryl	low	low	very low	very low	high
*Supracide	methidathion	high	moderate	moderate	high	high
*Thimet	phorate	high	high	moderate	very high	moderate
Trithion	carbophenothion	high	high	high	very high	moderate

* Use restricted to certified applicators only.

** Liquid formulations are restricted.

[a] Relative toxicities based on acute oral and acute dermal LD_{50} values of technical insecticide. Toxicities of formulated materials vary.

Always read the label before applying insecticides.

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STORED GRAIN

Grains produced in Illinois may be stored for periods of a few weeks to a few years before feeding or processing. The profitability of such storage depends not only upon marketing concerns, but also upon maintenance of grain quality. It is important to remember that the harvest and storage of grain does not signal an end to the possibility of losses caused by insects and pathogens.

Successful management of stored-grain insects is possible only when proper storage practices are carried out. Insecticides and fumigants should be viewed as supplements to, not replacements for, sound storage methods. Used properly, however, insecticides and fumigants can help to limit insect losses in stored grains without endangering the pesticide applicator or resulting in excessive pesticide residues that threaten the health of consumers (livestock or humans) of treated grain or grain products.

This publication provides recommendations for cultural and chemical control of stored-grain insects. It is revised annually; always use the current year's issue. Registration changes that occur between revisions will be announced to appropriate media sources and county Extension offices.

USING INSECTICIDES AND FUMIGANTS

The U.S. Environmental Protection Agency has designated certain pesticides for "restricted" use. The grain fumigants chloropicrin and aluminum phosphide are restricted-use pesticides. *Private* applicators who wish to purchase or apply restricted-use pesticides "for the purpose of protecting any agricultural commodity on property owned or rented by him or as exchange labor (no compensation) on the property of another" must obtain certification by passing an examination. The Illinois Department of Agriculture administers the certification procedure for private applicators. *Commercial* applicators also must be certified in order to apply restricted-use pesticides. Elevator employees responsible for grain treatment at their place of employment must be certified under the category "Grain Facility Pest Control Applicator." Commercial fumigation professionals who treat stored grain or grain products at farms, elevators, warehouses, etc. must be certified by the Illinois Department of Public Health.

Those who apply pesticides should be aware that the pesticide user is always responsible for the results of pesticide applications. To avoid accidents and maximize the effectiveness of any application, always read the pesticide label and follow all directions and safety precautions. Be sure that the pesticide is specifically labeled for the pest, site, and application method planned. Remember: THE LABEL IS THE LAW.

Poison Resource Centers. The Poison Resource Centers listed below have been established to provide information about the treatment of poisoning cases. Anyone with a poisoning emergency can call the toll-free telephone number for help. Personnel at the Resource Center will provide first-aid information and refer callers to local treatment centers if necessary.

Poison Resource Centers supplement, but do not replace, local emergency medical services. Do not delay calling local emergency medical personnel to request immediate assistance or transportation. If possible, have the pesticide container and label present when you call or reach a treatment center or hospital.

Chicago and northeast Illinois
1753 West Congress Parkway
Chicago, Illinois 60612
Telephone: 800-942-5969

Northern and central Illinois
530 N.E. Glen Oak
Peoria, Illinois 61603
Telephone: 800-322-5330

Central and southern Illinois
800 East Carpenter
Springfield, Illinois 62702
Telephone: 800-252-2022

NOTE: The information that follows is provided for educational purposes only. Reference to commercial products or trade names does not constitute an endorsement by the University of Illinois and does not imply discrimination against similar products. Trade names are presented for reasons of clarity only. The reader is urged to exercise the usual caution in making purchases or evaluating product information.

Prepared by Richard A. Weinzierl, Extension Entomologist
CIRCULAR 1242

INSECTS ATTACKING STORED GRAIN

Several types of insects inhabit stored grain. Exact identification of these insects often is difficult because most stored-grain pests are extremely small (1/16 to 1/4 inch in length), and many separate species are very similar in appearance. Presenting identification information for the many species of stored-grain pests is not the purpose of this publication; materials containing such information are included in the reference listing at the end of this circular. It is important, however, to recognize the different groups of insects that live in stored grains because management considerations may differ according to the insects' characteristics.

Weevils and Other Insects that Feed Inside Kernels

The most damaging insect pests of stored grain are those that develop within grain kernels. These insects are referred to as internal pests or primary pests. Adults deposit eggs on or in whole kernels, and larvae develop hidden within kernels. Damage caused by internal pests makes grain more suitable for infestation by insects that feed externally on grain or grain debris.

The common primary pests of grains in Illinois are the weevils — rice weevil, maize weevil, and granary weevil. The grain weevils are small (between 1/16 and 1/8 inch in length), but recognizable as a group because the head bears a prolonged snout. These insects may be found in any portion of the grain mass within a bin; they are not restricted to portions near the surface.

Beetles that Develop and Feed Outside Grain Kernels

Most insects commonly collected in stored grain in Illinois are beetles that range in size from 1/16 inch to over 1/2 inch in length. Adults of most species are reddish-brown to black in color, and their forewings are hardened to form a "shell" over the body. Larvae of common species are cylindrical and cream-colored; some bear fine hairs. Species frequently collected in Illinois grain bins include the sawtoothed grain beetle, flat grain beetle, rusty grain beetle, foreign grain beetle, hairy fungus beetle, larger black flour beetle, red flour beetle, and confused flour beetle.

Like the weevils, beetles that feed and develop outside grain kernels are not limited in distribution to the grain surface, but instead inhabit any portion of a grain mass. They feed on several different grains, but their buildup in any grain usually results from an abundance of broken kernels (fine material) or fungal growth on moist grain. Their dependence on fines or fungal growth accounts for the description of these insects as "secondary" pests, "bran bugs," or "fungus-feeders." Concentrations of stored-product beetles cause an increase in grain moisture and temperature, and such changes favor continued population growth.

Surface-Feeding Caterpillars

Caterpillars that feed in stored grain inhabit only the outer portions of the grain mass (usually the grain surface, but also the bottom of the grain mass just above perforated drying floors or aeration ducts). These caterpillars reach approximately 3/4 inch in length and are cream-colored. They produce fine, silken webbing as they move about near the grain surface. Mature larvae pupate within a silky cocoon. Adult moths fly and mate in the bin headspace where they may be seen resting on the bin walls and roof.

Although the Mediterranean flour moth and the meal moth can be found in high-moisture conditions, the Indianmeal moth is the most common surface-feeding caterpillar in stored grain in Illinois. The adult Indianmeal moth has a wingspan of about 3/4 inch; the outer half of each front wing is reddish-brown or copper-colored. Malathion resistance appears to be common in Illinois populations of Indianmeal moth.

Other Stored-Grain Insects

Additional pests that sometimes infest stored grains include psocids (booklice) and grain mites. These soft-bodied pests feed on grain-rotting fungi. An abundance of psocids or grain mites often indicates a more important problem of mold-related deterioration of the grain.

Remember that not all insects in grain are pests. Parasitic wasps, larvae of a predaceous fly species, and predaceous Hemipterans (true bugs) attack certain grain pests. In addition, many field insects are inadvertently transported to grain bins where they cause no damage.

PREVENTION OF INSECT INFESTATIONS

Sources of Infestations

Some stored-grain insects can infest maturing grain crops in the field. Although some field infestations probably do occur in Illinois, the extent of field-originated storage problems appears to be negligible.

The most common sources of stored-grain insects are old grain, grain spills, feeds, seed, and grain debris. Insects often move to new grain from carry-over grain, from small amounts of grain not cleaned from "empty" bins, from feed supply buildings, and from grain debris beneath perforated floors of bins. Most pest species can fly at least short distances to reach new grain.

Sanitation

To minimize the migration of stored-product insects from current food sources to new grain, thorough cleanup practices are necessary. At least 2 weeks before storing new grain, clean all grain and grain debris from within and around grain bins. Be thorough; sweep or vacuum bin floors. Also remove and feed or destroy any grain and grain debris in combines, wagons, augers, etc. If grain debris is not removed from the combine,

collect and feed or destroy the first few bushels of grain that pass through the combine.

Bin Sprays and Empty-Bin Fumigation

Insects may remain in certain bin locations even after a thorough cleanup is completed. Hard-to-clean sites that harbor insect pests include cracks and crevices in bin walls and the plenum beneath nonremovable perforated floors. Applying an insecticide or a fumigant in an empty bin can supplement (but not replace) physical cleanup efforts.

Apply an insecticide to the walls, ceiling, roof, and floor of all bins that will be used to store grain for more than a few weeks. Use

- 4 fl oz malathion 57% EC in 2 gal water;

or

- 1 qt methoxychlor 25% EC in 2 gal water;

or

- 12 oz methoxychlor 50% WP in 2 gal water;

or

- 4 fl oz Reldan 4E (chlorpyrifos-methyl) in 3 gal water.

Spray all bin surfaces to the point of runoff, and be sure to thoroughly treat all cracks and crevices and around doors. Directing extra spray to and through perforated flooring will provide some control of insects living in grain debris in the subfloor plenum, but satisfactory control of insects in this space requires fumigation (or removal of the false floor to allow complete cleanup of debris in the plenum).

Fumigating empty bins to control insects in the subfloor plenum may be necessary if summer-harvested grain (wheat, etc.) is to be stored in the bin 1 month or longer or if fall-harvested crops (corn, soybeans, or grain sorghum) will be stored beyond May or June of the year following harvest. The fumigant chloropicrin (trade names are Chlor-o-pic, Larvacide 100, and Quasar) is labeled and effective for empty bin fumigation. Use this fumigant only on relatively calm days when the outside air temperature is 65°F or higher.

Before applying chloropicrin, use tape and polyethylene sheeting to seal the side door and all bin openings below the level of the side door. Be sure to seal fan openings and the unloading auger shaft. Post warning placards according to label directions. Always have a partner present when applying this or any other fumigant.

To fumigate the subfloor plenum of empty bins, pour in chloropicrin from a ventilation door on the bin roof; use 1 quart per 250 square feet of floor area. Chloropicrin forms a pungent tear gas that settles in the lower portion of the bin. This gas will kill all stages of stored-grain insects beneath the subfloor, but chloropicrin will not spread to the upper portions of the bin to kill insects suspended in grain debris remaining on bin walls. Wait 24 hours before airing out the bin.

Chloropicrin is a restricted-use pesticide that is extremely toxic. The U.S. Environmental Protection Agency is reviewing and revising regulations concerning safety equipment (clothing, gloves, and respiratory protection) needed for the application of fumigants. Until updated regulations are published, rely upon the fumigant label directions for necessary safety precautions. If you are uncertain about the safe use of a fumigant, contact the manufacturer for detailed recommendations.

Filling the Bin

Effective insect management in stored grain starts with good grain storage practices. Use a grain cleaner to minimize the amount of fine material that is binned along with the grain. Many species of stored grain insects cannot survive in the absence of broken kernels and grain debris. Use a grain spreader to evenly distribute remaining fine material and to help level the grain surface. Once the bin is full, if fine material is concentrated in a central core beneath the auger spout, remove 1 or 2 loads from the bin in order to extract this core of fines. Do not add new grain on top of old because insects will rapidly move from the infested grain to the new crop. Do not overfill bins; the levelled grain surface should be at least 8 inches below the lip of the bin. Levelling the grain surface is important for uniform airflow and for effective insecticide or fumigant application.

Store only dry grain. Maintaining moisture levels that prevent the growth of storage fungi is sufficient where fall-harvested grain is to be stored only through the winter, but grains that will be stored 1 month or longer between May 1 and September 30 should be dried to 12-13 percent moisture. This moisture content is unfavorable for most grain insects; it also allows prolonged persistence of protectant insecticide residues.

Aerate to cool stored grain as soon as possible. Temperatures below 50°F prevent most insect feeding and reproduction. Cooling grain to just above freezing will kill some stages of many grain insects. Aeration also results in uniform temperatures that prevent moisture migration problems within a bin. Most grain storage references recommend aerating to maintain grain temperatures within 15°F of average outdoor temperatures. These references also usually discourage the use of aeration to cool grain below freezing.

Grain Protectants

Summer-harvested grains that are to be stored 1 month or more and fall-harvested grains that are to remain in storage beyond May and June of the year following harvest should be treated with a protectant insecticide. Where grain protectant insecticides are applied at labeled rates, grain can be processed or fed to livestock with no waiting period.

In order to protect against stored-grain beetles and weevils throughout the entire mass of grain within a bin, a protectant insecticide must be applied uniformly to all grain as it is augered into the bin. Drip-on or spray-on applicators can be mounted on the auger to apply liquid formulations. Dusts can be applied using an auger-mounted applicator, or they can be spread over a truck or wagon just before unloading. Protectant insecticides should not be applied to grain before high-temperature drying. Once grain is in the bin, surface or "cap-off" applications of protectant insecticides are effective only against the insects that are feeding at the grain surface. A surface dressing or "cap-off" treatment may be used to give some control of insects entering the top of the grain mass. Table 1 summarizes uses for registered grain protectants. Dichlorvos resin strips, although not applied directly to grain, also are listed in Table 1.

Crop-specific recommendations for the use of protectant insecticides are:

Corn. Apply malathion at the loading auger using rates listed in Table 1. Reldan is not registered for use on corn. Do not apply malathion before high-temperature drying because extreme heat will result in rapid volatilization and loss of malathion. For malathion residues to persist on corn at effective levels through the summer following harvest, corn must be dried to approximately 12 percent moisture.

Malathion will not control Indianmeal moth. Use *Bacillus thuringiensis* (*B.t.*) or dichlorvos resin strips to prevent Indianmeal moth infestations. Apply *B.t.* or hang dichlorvos strips at harvest or by May of the following year.

Soybeans. Only Indianmeal moth will infest soybeans stored at moisture levels that prevent mold growth. To protect against Indianmeal moth infestation, use dichlorvos resin strips or *B.t.* at harvest or by May of the following year. No other protectant insecticides are registered for application to stored soybeans.

Wheat. Wheat is especially vulnerable to insect infestation because it is harvested in mid-summer when stored-product insects are active within and outside storage facilities. Warm temperatures in summer-harvested wheat also contribute to the rapid development and reproduction of insects within bins.

Apply malathion or chlorpyrifos-methyl (Reldan) at the loading auger to all wheat that is to be stored for 1 month or more. Where malathion is used, also incorporate *B.t.* in the top 4-6 inches of grain or hang dichlorvos resin strips to prevent Indianmeal moth infestations. Chlorpyrifos-methyl controls Indianmeal moth and the weevils and "secondary" beetles that infest grain.

Sorghum. Apply malathion or chlorpyrifos-methyl at the loading auger, but not before high-temperature drying. For malathion residues to persist at effective

Table 1. Insecticides Registered For Use to Protect Stored Grain

Insecticide	Registered for use on:	Rate/1,000 bu	Restrictions; Comments
malathion 57% EC, 6% D, 4% D, and 2% D	corn, wheat, oats, barley, rye, sorghum, sunflower	1 pt 57% EC in 2-5 gal water; 10 lb 6% dust; 15 lb 4% dust; or 30 lb 2% dust. Use the same amount/1,000 sq ft of grain surface as a "cap-off" treatment *if the entire grain mass is not treated.*	Do not apply to soybeans. Malathion will not control Indianmeal moth. Dry grain to 12% moisture in order for malathion to persist for 1 year or more. Do not apply prior to high-temperature drying.
chlorpyrifos-methyl (Reldan 4E)	wheat, oats, barley, rye, sorghum, sunflower	barley — 9.2 fl oz; oats — 6.2 fl oz; rice — 8.6 fl oz; sorghum — 10.7 fl oz; wheat — 11.5 fl oz. Apply in 1-5 gal water.	Do not apply to corn or soybeans. Controls weevils, "bran bugs," and Indianmeal moth. Dry grain to 14% moisture in order for chlorpyrifos-methyl to persist for 1 year or more. Do not apply prior to high-temperature drying.
Bacillus thuringiensis (Bactospeine, Dipel, SOK-Bt, and Thuricide)	corn, soybeans, wheat, oats, barley, rye, sorghum, sunflower	Rate depends on product concentration. Follow label directions.	Use to control Indianmeal moth larvae. Controls only larval stages; must be ingested. Apply to the top 4-6 inches of grain as it is augered into the bin or incorporate by raking once the bin is filled.
pyrethrins plus piperonyl butoxide	corn, wheat, oats, barley, rye, sorghum, sunflower	Rate depends on product concentration. Follow label directions.	Do not apply to soybeans. Short-term residual activity. Useful mainly as a surface spray to control larval and adult Indianmeal moths as well as other pests at the grain surface.
dichlorvos 20% resin strip (Farm Strips, Vapona Strips, etc.)	corn, soybeans, wheat, oats, rye, barley, sorghum, sunflower	1 strip/1,000 cu ft of space above the grain mass.	Install once bin is filled or by May 15. Replace every 6-8 weeks from May to October. Effective only in closed bins; controls adult moths only.

levels through the summer following harvest, grain must be dried to 12 percent moisture content; chlorpyrifos-methyl (Reldan) will persist for 12 months or more on 14 percent moisture sorghum. Where malathion is applied, also use *B.t.* or dichlorvos strips at harvest or by May to control Indianmeal moth.

SAMPLING STORED GRAIN

Stored grain should be monitored regularly to determine grain moisture content and temperature and to detect any insect infestations. Sample stored grain for insects at least monthly from November through April and at least twice monthly from May through October. Pay particular attention to the grain surface and the central core of the grain mass, but also sample additional locations and depths. Be sure to examine grain from any locations where temperature or moisture readings are substantially higher than average. Deep bin probes and sectioned grain triers are most commonly used for withdrawing samples from beneath the grain surface. Probe traps and sticky pheromone traps also are available for monitoring insects within the grain mass and flying moths respectively. Sampling equipment is available from most bin sales and service companies.

CONTROLLING ESTABLISHED INFESTATIONS

When insects are found in stored grains, a logical question is "Are there enough insects present to warrant control?" Unfortunately, this question is hard to answer. The importance of an insect infestation is determined not only by insect numbers, but also by type of grain, insect species, time of year, grain temperature and moisture, the planned duration of storage, market potential, and local elevator quality and dockage guidelines. Federal Grain Inspection Service (FGIS) standards for grain insect infestation are presented in Table 2, but local elevators usually enforce more stringent standards. Insect-damaged kernels also may result in price discounts. Consider too that insect populations and their damage can increase rapidly.

When insects are detected in stored grain, consider several possible management practices. Sometimes the most profitable action can be to clean and sell the grain immediately without any chemical treatment. Immediate sale can be especially appropriate where early stages of insect infestations are detected before insect numbers reach elevator dockage or discount levels. During cool weather, aerating to cool the grain to below 50°F can prevent insect activity and allow an extended period of safe storage.

Table 2. The Number of Live Insects (per Kilogram of Grain) Required for FGIS Designation as "Infested"

Crop	Insect density for designation as "infested"
Wheat	• More than 1 live weevil, or • One live weevil plus any other stored grain insect pest, or • No live weevils, but 5 or more other live pest insects.
Corn, Barley, Oats, Sorghum, and Mixed Grains	• More than 1 live weevil, or • One live weevil plus 5 or more other live pest insects, or • No live weevils, but 15 or more other live pest insects.

Sometimes insect problems may be limited primarily to the surface or central core of stored grain. If Indianmeal moth is the only problem, light infestations can be controlled by using both *B.t.* and dichlorvos resin strips as outlined in Table 1. Where abundant webbing indicates a severe infestation, webbing should be raked from the surface before treating; fumigation may be necessary in these situations. Where bran bugs are confined primarily to a central core of fine material, removing 1 or 2 loads of grain to extract that core can allow safe storage of the remaining grain.

Where infested grain can be moved to a clean bin, transfer and treatment with a protectant insecticide (see Table 1) is recommended. If possible, use a grain cleaner during the transfer process. Protectant insecticides will not immediately kill immature insects within grain kernels, but residues will eventually provide control and protect against re-infestation for a period dependent upon grain moisture and temperature.

Infested grain that cannot be treated successfully in any other way should be fumigated. Before planning any fumigation, consider the following regulations:

- The use of any liquid fumigant containing ethylene dibromide (EDB) is now prohibited.
- As of December 31, 1985, the *sale* of any liquid fumigant containing carbon tetrachloride is prohibited.
- Grain owners may use existing supplies of fumigants containing carbon tetrachloride through June 30, 1986. Application of fumigants containing carbon tetrachloride is prohibited after June 30, 1986.

Suspension of most liquid fumigant registrations, coupled with increased safety concerns and protective equipment requirements for remaining fumigants, signal the fact that fumigation of farm-stored grain is a potentially dangerous and difficult operation. Hiring a professional fumigator is recommended, especially for fumigation of bins with capacities greater than 5 to 10 thousand bushels.

Fumigation Steps

1. Level the surface of the grain, break up any caked or crusted areas, and remove any surface webbing.

2. Use tape and plastic sheeting to thoroughly seal all cracks and holes in the bin; seal the eaves, hatches, side door, unloading auger shaft, and fan openings. Leave only the necessary access openings to seal after fumigant application.

3. Spray the outside surface of the bin with malathion (4 fl oz 57% EC/gal water), chlorpyrifos-methyl (4 fl oz Reldan 4E/3 gal water), or methoxychlor (1 qt 25% EC or 12 oz 50% WP/2 gal water).

4. Learn and follow all safety precautions. Always work in pairs; an observer should be present *outside* of the bin. The U.S. Environmental Protection Agency is reviewing and revising regulations concerning safety equipment (clothing, gloves, respiratory equipment, and gas-detection devices) needed for the safe application of fumigants. Until updated regulations are published, rely on the fumigant label directions for necessary safety precautions. If you are uncertain about the safe use of a fumigant, contact the manufacturer for detailed recommendations.

5. Choose a calm, warm day when the grain temperature is above 60°F. Apply a liquid or solid fumigant. Only those fumigants containing aluminum phosphide are registered for use on soybeans.

Common liquid fumigants containing carbon tetrachloride include carbon bisulfide + carbon tetrachloride (80:20 mixture) and ethylene dichloride + carbon tetrachloride (75:25 mixture). Use 3 to 5 gallons of these products per 1,000 bushels of grain; use the 5-gallon rate in wooden bins and flat storages. Use of fumigants containing carbon tetrachloride is prohibited after June 30, 1986.

Chloropicrin (Chlor-o-pic, Larvacide 100, and Quasar) is a restricted-use liquid fumigant labeled for probe and surface application to stored grain. Protective clothing and respiratory equipment must be worn during application. Use 2.5 lb/1,000 bushels of wheat, barley, or rice; 3.0 lb/1,000 bushels of corn; 3.5 lb/1,000 bushels of oats; or 4.5 lb/1,000 bushels of grain sorghum. Wait at least 72 hours before airing out; fumigated grain must be thoroughly aerated before processing or feeding.

Dry fumigants containing aluminum phosphide include Detia, Fumitoxin, Gastoxin, Phostek, and Phostoxin. Aluminum phosphide is a restricted-use fumigant. A special application probe is required to place aluminum phosphide tablets or pellets in the grain mass. Use 180 tablets or 300 pellets per 1,000 bushels of bin capacity. Do not allow water to come in contact with tablets or pellets; wear neoprene or cotton gloves to prevent perspiration from reaching the dry material. Gas released from pellets or tablets usually does not reach a dangerous concentration above the grain for 1 to 2 hours after application, but this period can be much shorter if grain is very warm or very moist.

6. Seal the access door that served as an exit from the bin. Place warning signs as directed by the fumigant label.

7. Where fumigants containing carbon tetrachloride were used, air out the bin after 24 hours. Wait at least 72 hours before airing out bins following aluminum phosphide or chloropicrin application; follow label directions.

An additional fumigant that is effective and registered for application to stored grain is methyl bromide. Because methyl bromide is a restricted-use fumigant that is applied as a gas, it is available only to professional fumigators.

Once it is aired out, fumigated grain is subject to reinfestation. Surface application of a protectant insecticide and/or placement of dichlorvos resin strips should follow fumigation if storge is to continue.

REFERENCES

Stored Grain Insects. 57 pp. USDA Agricultural Handbook No. 500. Available for $1.50 from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Management of On-Farm Stored Grain. 92 pp. University of Kentucky Cooperative Extension Service. For single copies (free), write Dr. Harley Raney, Entomology Department, Agricultural Science Center, North, Room 5225, University of Kentucky, Lexington, KY 40546.

Fact Sheets available from Agricultural Entomology, University of Illinois, 172 Natural Resources Building, 607 East Peabody Drive, Champaign, IL 61820.

NHE 62 — Angoumois Grain Moth
NHE 63 — Indianmeal Moth
NHE 64 — Granary and Rice Weevil
NHE 65 — Grain and Flour Beetles

1986 Insect Pest Management Guide

HOME, YARD, and GARDEN

MUCH HAS BEEN SAID ABOUT THE EFFECTS of pesticides, particularly insecticides, on the health and well-being of the American people. However, as you are also aware, you are constantly faced with a horde of insects, intent upon destroying your property or making your life uncomfortable. Destruction of crop residues, varietal selection, hand-picking, fertilization, tree pruning, irrigation, screening, and other practices may reduce the number of insects with which you must contend. Occasionally, you can avoid or at least reduce the destruction caused by some pests without using an insecticide. For most insects, though, you must rely on an insecticide to provide the satisfactory management you want.

By using insecticides and other pest-management tools carefully, you can enjoy reasonable freedom from insects without endangering yourself, your family, or your pets. You must recognize, however, that insecticides are designed to destroy one group of animals — insects — and can be harmful to other animals, including man himself, if used without regard for normal safety precautions. It is up to each insecticide user to handle, apply, and store insecticides safely in order to reap their benefits without suffering from their dangers.

This publication lists certain insecticides with which to control insect pests of food, fabrics, structures, man and animals, lawns, shrubs, trees, flowers, and vegetables. We have tried to suggest only the safest materials. Many people prefer to employ the services of a professional exterminator or custom applicator rather than to become involved in the selection and application of insecticides.

The names used in the tables are the common, coined chemical names, not the trade names, and as such may not be familiar to you. For instance, the common name for *Cygon* is *dimethoate.* If there is no coined chemical name, the trade name is used but is capitalized.

Requested label clearances for a few uses of some insecticides, carriers, and solvents are uncertain for 1986, since many requests have not yet been officially cleared. Consequently, labels may be cancelled and the product removed from the market at any time. Anticipating this, we took a conservative attitude a few years ago and began modifying these suggested uses. We have attempted to anticipate any further label changes in 1986, but there still may be an occasional use cancelled. Check with your local county Extension adviser if you are not sure about the insecticide you plan to use. We will make announcements about label changes through the news media and newsletters in an attempt to keep you up to date.

Insecticides are being classified for *general use* or *restricted use* by the U.S. Environmental Protection Agency. Only a few insecticides have been classified for restricted use at this time. No insecticides listed in this circular have a restricted-use classification. A person wishing to use an insecticide classified for restricted use must be certified as a private or commercial pesticide applicator by the State of Illinois. Contact your county Extension adviser in agriculture for details about that program.

Suggestions for the use of insecticides, effective from a practical standpoint, are based on available data. Many factors affect efficiency of control. Please report details of control failures to us.

In using these tables, always read the footnotes before using the insecticides. The footnotes list precautions and other pertinent information.

The suggestions given in this circular are subject to change without notification during the year.

Leaflets describing the life history, habits, and damage of specific insects and nonchemical methods of control can be obtained from your county Extension adviser or by writing to Entomology Extension, 172 Natural Resources Building, 607 E. Peabody Drive, Champaign, Illinois 61820. These leaflets are indicated by an NHE number in the tables.

This circular was prepared by Roscoe Randell and Fredric Miller, Jr., Extension Entomologists, University of Illinois College of Agriculture.

VEGETABLE INSECTS

Insects	Crop	Insecticide	Suggestions
Aphids (NHE-47) Mites (NHE-58) Thrips	Most garden crops	malathion or diazinon	Apply on foliage to control the insects. Aphids and leafhoppers transmit plant diseases; early control is important. Mites web on the underside of leaves; apply insecticide to underside of leaves early before extensive webbing occurs.
Blister beetles (NHE-72) Cutworms (NHE-77) Flea beetles (NHE-36) Grasshoppers (NHE-74) Leafhoppers (NHE-22) Picnic beetles (NHE-40)	Most garden crops	carbaryl	For cutworms, attach collars of paper, aluminum foil, or metal at planting for small numbers of plants, or apply insecticide to base of plants at first sign of cutting. Control grasshoppers in garden borders when hoppers are small. For picnic beetles, pick and destroy overripe or damaged vegetables.
All cabbage worms (NHE-45)	Cabbage and related crops, salad crops, and leafy vegetables	*Bacillus thuringiensis*[1]	Presence of white butterflies signals start of infestation. Control worms when small. It is almost impossible to raise cole crops in Illinois without controlling these pests.
Hornworms (NHE-130) Fruitworms	Tomatoes	carbaryl *Bacillus thuringiensis*[1]	Handpicking usually provides satisfactory control.
Earworms (NHE-33)	Tomatoes and sweet corn	carbaryl	Apply to late-maturing tomatoes 3 to 4 times at 5- to 10-day intervals from small-fruit stage. Apply at fresh-silk stage to early and late corn every 2 days 4 to 5 times.
Colorado potato beetles	Eggplant, potatoes, tomatoes	carbaryl	Apply as needed. Insects usually present only in late May and June.
Potato leafhoppers (NHE-22)	Potatoes, beans	carbaryl or malathion	Apply 3 to 4 times at weekly intervals starting in late May or early June. Late potatoes and beans require additional treatments. Most serious pest of potatoes and beans in Illinois.
Bean leaf beetles (NHE-67)	Beans	carbaryl	Leaves are riddled in early plantings. Apply once or twice as needed.
Mexican bean beetles	Beans	carbaryl	Except for southern Illinois, only a pest of late beans. Apply insecticide to underside of leaves.
Cucumber beetles (NHE-46)	Vine crops	carbaryl	Apply as soon as beetles appear in spring. When blossoming begins, apply insecticide late in the day so as not to interfere with pollination by bees.
Squash vine borers (NHE-8)	Squash	carbaryl	Make weekly applications to crowns and runners when plants begin to vine. Apply late in day.
Corn borers	Sweet corn	carbaryl	Apply 4 times every 3 days to whorl and ear zone of early corn when feeding appears on whorl leaves.
Soil insects (including grubs, wireworms, root maggots)	All crops	diazinon	Mix 6 fluid ounces of 25% diazinon emulsion in enough water to cover 1,000 sq. ft., usually 2 to 3 gallons. Rake into soil.

Days Between Application and Harvest

	Collards, kale, and other leafy crops	Beans	Lettuce	Cabbage and related crops	Sweet corn	Onions	Vine crops[2]	Tomatoes	Pumpkin	Eggplant	Peas	Potatoes
carbaryl	14	0	14	3	0	..	0	0	0	0	0	0
diazinon	..	7	..	7	2	..	7	3	..	..	0	..
malathion	7	1	14	7	5	3	1	1	3	3	3	0

Amount of Insecticide for Volume of Spray for Vegetable Insects

	1 gal.	6 gal.	100 gal.	Commercial dust
carbaryl (Sevin) 50% W.P.	2 tbl.	¾ cup	2 lb.	5%
diazinon 25% E.C.	2 tsp.	4 tbl.	1 qt.	4%
malathion 50-57% E.C.	2 tsp.	4 tbl.	1 qt.	4%

E.C. = emulsion concentrate; W.P. = wettable powder. An emulsion concentrate is a chemical pesticide dissolved in a solvent to which an emulsifier has been added. It can then be mixed with water to the desired strength before being used.

[1] No time limitations. Sold as Dipel, Thuricide, Bactur, SOK-BT, and others. [2] Apply insecticides late in the day after blossoms have closed to avoid bee kill.

FLOWER INSECTS

Insect	Insecticide[1]	Dosage	Suggestions
Ants, soil-nesting wasps, and sowbugs (NHE-17, 79, 93, 111) White grubs	diazinon 25% E.C.	1 cup per 1,000 sq. ft.	Drench into soil.
Aphids, mealybugs, spittlebugs, lacebugs, scales (NHE-7, 114)	malathion 50-57% E.C. acephate 15.6% E.C.	2 tsp. per gal. water 4 tsp. per gal. water	Spray foliage thoroughly. Repeat treatments may be needed.
Blister beetles (NHE-72)	carbaryl 50% W.P.	2 tbl. per gal. water	Spray foliage. Repeat treatments may be needed.
Cutworms (NHE-77)	diazinon 25% E.C. diazinon 2% granules	6 oz. per 2-3 gal. water 5 lb. per 1,000 sq. ft.	Spray 1,000 sq. ft. soil at base of plants. Do not spray on plant foliage. Small numbers of plants can be protected with collars of paper, aluminum foil, or metal.
Grasshoppers (NHE-74)	carbaryl 50% W.P. malathion 50-57% E.C.	2 tbl. per gal. water 2 tsp. per gal. water	Spray foliage and also adjacent grassy or weedy areas.
Iris borer	dimethoate (Cygon 2E)	4 tsp. per gal. water	Apply when irises are in bloom, but not on blooms and make only one application. Add a small amount of liquid detergent to spray mix to improve coverage on leaves.
Leaf-feeding beetles	carbaryl 50% W.P. acephate 15.6% E.C.	2 tbl. per gal. water 4 tbl. per gal. water	Spray foliage. Repeat treatments if needed.
Leaf-feeding caterpillars	Same as for leaf-feeding beetles		
Plant bugs and leafhoppers	Same as for leaf-feeding beetles		
Slugs (NHE-84)	metaldehyde bait Mesurol 2% bait		Apply as a bait to soil. Remove old leaves, stalks, poles, boards, and other debris where slugs like to hide and lay eggs.
Spider mites (NHE-58)	dicofol 18.5% E.C.	2 tsp. per gal. water	Pay particular attention to underside of leaves when spraying. Apply 2 or 3 times at weekly intervals.
Springtails (NHE-70)	malathion 50-57% E.C. malathion 4% dust	2 tsp. per gal. water	Spray foliage and soil. Apply to base of plants.
Stalk borers (NHE-24)	Same as for leaf-feeding beetles		Spray foliage thoroughly and frequently.
Thrips	Same as for leaf-feeding beetles		Spray foliage carefully.
White flies (NHE-136)	pyrethrin 0.1% resmethrin	aerosol spary	Spray foliage thoroughly. Repeat in 5 days.

E.C. = emulsion concentrate; W.P. = wettable powder.

[1] Use only one insecticide from those listed. Do not use oil-base sprays on plants. Do not use malathion on African violets. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns. Repeated use of carbaryl foliage sprays may cause mite or aphid infestations to increase and to become damaging. Do not use insecticides during full bloom. Do not use dimethoate on chrysanthemums.

FOR YOUR PROTECTION

1. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
2. If you use a bait around or in the home, place it after the children have retired and pick it up in the morning before they get up. Furthermore, place it out of their reach. At present we do not encourage the use of baits for insect control.
3. Avoid breathing insecticide sprays and dusts over an extended period. This is particularly true in enclosed areas such as crawl spaces, closets, basements, and attics.
4. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
5. Wear rubber gloves when handling insecticide concentrates.
6. Do not smoke while handling or using insecticides.
7. Leave unused insecticides in their original containers with the labels on them and in locked cabinets.
8. Triple-rinse empty pesticide containers. Wrap each container in several layers of paper. Dispose of the containers one at a time through the municipal solid-waste-disposal system.
9. Do not leave puddles of spray on impervious surfaces.
10. Do not apply insecticides to fish ponds.
11. Do not apply insecticides near dug wells or cisterns.
12. Observe all precautions listed by the manufacturer on the label.

TREE AND SHRUB INSECTS

Insects	Insecticide[1]	Suggestions[2]
Aphids (NHE-7)	acephate diazinon malathion	Spray foliage thoroughly with force. Repeat as needed.
Bagworms (NHE-6)	acephate carbaryl malathion *Bacillus thuringiensis*[3]	Spray foliage thoroughly. Apply June 15. Later sprays are less effective. For late spraying, use *Bacillus thuringiensis.*
Borers Bronze birch (NHE-143)	dimethoate	Spray trunk and limbs thoroughly in late May and early June. Repeat in 3 weeks or apply 6-inch band of concentrate to trunk.
Flatheaded apple tree Oak	chlorpyrifos	Spray trunk and/or limbs in mid-May and repeat 4 weeks later.
Ash (NHE-145) Lilac (NHE-145) Peach tree	chlorpyrifos	Spray trunk and limbs in mid-June and repeat 4 weeks later. Keep the tree healthy and vigorous and avoid wounds or injury to the trunk.
Cankerworms (NHE-95)	acephate carbaryl malathion *Bacillus thuringiensis*[3]	Spray foliage when feeding or worms are first noticed in spring.
Eastern tent caterpillars	Same as for cankerworms	Spray when nests are first noticed.
Elm leaf beetles (NHE-82)	acephate carbaryl	Spray as soon as damage is noticed.
European pine shoot moths and Nantucket pine moths (NHE-83)	dimethoate	Spray ends of branches thoroughly in late June for European species and in mid-May for Nantucket species.
Fall webworms	acephate carbaryl diazinon malathion *Bacillus thuringiensis*[3]	Spray when first webs appear; clip off and destroy infested branches or burn out webs.
Galls (NHE-80, 81) Elm cockscomb Hickory Maple bladder	diazinon malathion	Spray foliage thoroughly when buds are unfolding. Sprays after galls form on leaves are ineffective.
Hackberry blister	acephate diazinon malathion	Spray foliage thoroughly in late May. Kills psyllids in galls. Sprays after galls form on leaves are ineffective.
Cooley spruce Eastern spruce	diazinon malathion	Apply in late September or October or early spring just before buds swell.
Green-striped mapleworms	Same as for cankerworms	Spray as soon as damage is noticed.
Leaf miners Boxwood Hawthorn Oak	diazinon malathion acephate	Spray foliage thoroughly when miners first appear. Repeat treatment in 10 to 12 days. Use acephate only on oak.
Birch Holly	dimethoate	Repeat treatment in 3 weeks.
Mealybugs	acephate malathion	Spray foliage thoroughly and with force. Repeat in two weeks.
Mimosa webworms (NHE-109)	acephate carbaryl malathion *Bacillus thuringiensis*[3]	Spray foliage thoroughly when first nests appear (June, July). A repeat treatment may be needed.
Mites (NHE-58)	dicofol	Pay particular attention to underside of leaves. Apply 2 or 3 times at weekly intervals.
Oak kermes	malathion	Spray foliage thoroughly about July 1 to kill the crawlers.
Periodical cicadas (NHE-113)	carbaryl	Spray all branches thoroughly when adults appear. Repeat in 7 to 10 days.
Sawflies	carbaryl	Spray as soon as worms or damage are evident.
Scales (NHE-100, 114, 146)	diazinon malathion acephate	Spray foliage thoroughly in early April for *Fletcher* and *European elm scale;* in late May for *pine needle* and *sweet gum scale;* in early June for *scurfy, oystershell,* and *euonymous scales;* in early July for *cottony maple, Juniper,* and *dogwood scales;* in mid-July for *spruce bud scale;* and again in August for *oystershell scale.*

[1] Use only one insecticide of those listed. [2] Treatment dates listed are for central Illinois. In southern Illinois, apply 2 weeks earlier; in northern Illinois, 2 weeks later. [3] Trade names: Dipel, Thuricide, Bactur, SOK-BT, and others.

TREE AND SHRUB INSECTS (continued)

Insects	Insecticide[1]	Suggestions[2]
Scales (cont.) Cottony maple (NHE-144), Putnam, San Jose, Tulip tree	dormant oil diluted according to label	Apply when plants are still dormant in late winter. Do not use on evergreens. For tulip tree scale, a malathion spray in late September or in early spring is also effective.
Sycamore lace bugs Plant bugs	acephate carbaryl malathion	Spray when nymphs appear, usually in late May.
Thrips	Same as for aphids	Mainly on privet. Spray foliage thoroughly.
Yellow-necked caterpillars	acephate carbaryl malathion	Spray foliage when worms are small.
Zimmerman pine moths (NHE-83)	chlorpyriphos dimethoate	Spray trunk and branches in mid-April or mid-August.

[1] Use only one insecticide from those listed. [2] Treatment dates listed are for central Illinois. In southern Illinois, apply 2 weeks earlier; in northern Illinois, 2 weeks later.

Amount of Insecticide Needed for Volume of Spray for Tree and Shrub Insects

	1 gal.	6 gal.	100 gal.		1 gal.	6 gal.	100 gal.
acephate (Orthene) 15.6% E.C.[1]	4 tsp.	1 cup	2 qt.	dicofol (Kelthane) 18.5% E.C.	2 tsp.	4 tbl.	1 qt.
carbaryl (Sevin) 50% W.P.[2]	2 tbl.	¾ cup	2 lb.	dimethoate (Cygon 2E)[3]	2 tsp.	4 tbl.	1 qt.
chlorpyrifos (Dursban 2E.)	2 tsp.	4 tbl.	1 qt.	malathion 50-57% E.C.[5]	2 tsp.	4 tbl.	1 qt.
diazinon 25% E.C.[4]	2 tsp.	4 tbl.	1 qt.				

E or E.C. = emulsion concentrate; W.P. = wettable powder.

[1] Do not use on flowering crab, sugar maple, redbud, American elm, Lombardy poplar, or cottonwood. [2] Do not use on Boston ivy. [3] Do not use on chrysanthemums. [4] Do not use on ferns or hibiscus. [5] Do not use on canaert red cedar.

LAWN INSECTS

Insects	Insecticide[1]	Dosage per 1,000 sq. ft.[2]	Suggestions
White grubs (NHE-104, 147)	diazinon 25% E.C. 5% G. Oftanol 1.5% G.	1 cup 2½ lb. 3 lb.	Apply as spray or granules to small area and then water in thoroughly before treating another small area. Grub damage will usually occur in late August and in September.
Ants (NHE-111) Cicada killer and other soil-nesting wasps (NHE-79, 150)	diazinon 25% E.C. 5% G. chlorpyrifos 5 or 6% E.C.	¾ cup 2 lb. 1 cup	Apply as spray or granules and water in thoroughly. For individual nests pour 1% diazinon in nest and cover with soil.
Sod webworms (NHE-115)	carbaryl 50% W.P. diazinon 25% E.C. 5% G. chlorpyrifos 5 or 6% E.C.	½ lb. ¾ cup 2 lb. 8 fl. oz. (1 cup)	As sprays, use at least 2.5 gal. of water per 1,000 sq. ft. Do not water for 72 hours after treatment. As granules, apply from fertilizer spreader. Webworms usually damage lawns in late July and in August.
Millipedes and sowbugs (NHE-93)	carbaryl 50% W.P. diazinon 25% E.C. chlorpyrifos 5 or 6% E.C.	½ lb. ¾ cup 1 cup	Spray around home where millipedes or sowbugs are crawling. If numerous, treat entire lawn.
Armyworms Cutworms	carbaryl 50% W.P. chlorpyrifos 5 or 6% E.C.	2 oz. 1 cup	Apply as sprays or granules. Use 5 to 10 gal. of water per 1,000 sq. ft.
Chinch bugs	chlorpyrifos 5 or 6% E.C. diazinon 25% E.C. 5% G.	1 cup ¾ cup 2 lb.	Spray infested areas where chinch bugs are present.
Aphids (NHE-148)	acephate 15.6% E.C.	4½ fl. oz.	Spray grass thoroughly.
Chiggers	diazinon 25% E.C.	1 tbl.	Spray grass thoroughly.
Slugs (NHE-84)	Mesurol 2% bait		Apply where slugs are numerous. Scatter in grass. For use only in flower gardens and shrubbery beds.

E.C. = emulsion concentrate; W.P. = wettable powder; G. = granules.

[1] Use only one insecticide from those listed. [2] To determine lawn size in square feet, multiply length times width of lawn and subtract non-lawn areas including house, driveway, garden, etc. Do not allow people or pets on the lawn until the spray has dried.

HOUSEHOLD INSECTS

Insects	Insecticide[1]	Dosage	Suggestions
Ants (NHE-111) Carpenter ants (NHE-10) Crickets (NHE-137) Spiders (NHE-17, 116)	diazinon 25% E.C. chlorpyrifos diazinon propoxur	Dilute to 0.5% with water 0.5% R.T.U. 0.5% R.T.U. 0.5% R.T.U.	Use diazinon E.C. to spray completely around outside foundation and the adjacent 1 ft. of soil. Apply an R.T.U. spray to baseboards, cracks, and door thresholds. Do not use diazinon E.C. inside.
Bed bugs	malathion 50-57% E.C. malathion 1% dust	Dilute to 1% with water R.T.U.	Thoroughly spray slats, springs, and bed frame. Apply a light dust to seams, tufts, and folds of mattresses. Use clean bedding.
Boxelder bugs (NHE-9)	diazinon 25% E.C. carbaryl 50% W.P.	Dilute to 0.5% with water Dilute to 0.25% with water	Spray boxelder bugs on tree trunks, foundation walls (diazinon only), under eaves, and other areas where they gather. *Indoors:* Remove with vacuum.
Carpet beetles, clothes moths (NHE-87)	chlorpyrifos diazinon	0.5% R.T.U. 0.5% R.T.U.	Spray storage areas, edges of carpeting, baseboards, etc. Prevent lint and dust from accumulating. Dry cleaning kills these pests. Store cleaned or washed woolens in insect-free chests and plastic bags.
Centipedes, millipedes, sowbugs (NHE-93) Earwigs (NHE-142)	diazinon 25% E.C. chlorpyrifos diazinon propoxur	Dilute to 0.5% with water 0.5% R.T.U. 0.5% R.T.U. 0.5% R.T.U.	Apply diazinon E.C. as an outside foundation spray. If millipedes are abundant, treat entire lawn according to label. Remove debris from around foundation. *Indoors:* Collect insects with vacuum or use R.T.U. spray according to label.
Chiggers (NHE-127)	diazinon 25% E.C.	Dilute to 0.5% with water	Treat lawns, roadsides, and areas not mowed. For personal protection, a repellent such as DEET will prevent attack. Take a warm, soapy shower or bath immediately after returning from an infested area.
Clover mites (NHE-2)	dicofol 18.5% E.C. pyrethrin	Dilute to 0.03% with water 0.1% R.T.U.	Spray outside of house from ground up to windows and adjacent 10 ft. of lawn. Repeat spray in 7-10 days if necessary. Eliminate grass and weeds from 18-inch strip next to foundation. *Indoors:* Remove with vacuum, or spray with pyrethrin.
Cluster flies (NHE-1)	dichlorvos 20% resin strip[2] pyrethrin	1 strip per 1,000 cu. ft. 0.1% R.T.U.	Place resin strips in attic or closets. Fog lightly in rooms with pyrethrin. Repeat spray as needed. Seal cracks around windows, eaves, and siding to prevent entry.
Cockroaches: German (NHE-3) Brown-banded (NHE-4) American, Oriental (NHE-5)	chlorpyrifos diazinon propoxur	0.5% R.T.U. 0.5% R.T.U. 0.5% R.T.U.	Spray roach runways and hiding places. Treat under sink, refrigerator, cabinets, on baseboards, etc. Treatment throughout home may be needed to control brown-banded roaches. May be supplemented with boric acid applied into out-of-sight and out-of-reach voids under cabinets and appliances.
Drain flies (NHE-91)	dichlorvos 20% resin strip[2] pyrethrin	1 strip per 1,000 cu. ft. 0.1% R.T.U.	Use chemicals only after solving sanitation problems. Clean out overflow drains, drain traps, and cellar drains. Pour boiling water or rubbing alcohol into overflow drain to eliminate maggots.
Elm leaf beetles (NHE-82)	carbaryl 50% W.P. pyrethrin	Dilute to 0.25% with water 0.1% R.T.U.	*Outdoors:* Spray with carbaryl on nearby Chinese elm trees to control elm leaf beetle larvae and adults. Seal cracks around windows to prevent entry. *Indoors:* Remove with vacuum, or spray with pyrethrin.
Fleas (NHE-107)	dichlorvos or naled	flea collars	Replace flea collars on pets about every 3 months. Some pets are allergic.
	carbaryl malathion tetrachlorvinphos	5% dust 4% dust 3% dust	Dust pets directly as needed. Dust areas inside and outside the home where pets rest. Vacuum pets and inside areas after 30 minutes.
	pyrethrin	0.1% R.T.U.	For infestations in the home spray edges of carpets and rugs, and floors where fleas are observed according to label directions. Vacuum rugs and upholstered furniture thoroughly.
	diazinon 25% E.C. diazinon 5% G.	¾ cup per 1,000 sq. ft. 2 lb.	Apply to lawn.

E.C. = emulsion concentrate; W.P. = wettable powder; R.T.U. = ready to use; G. = granules.

[1] Use only one insecticide from those listed. [2] To determine lawn size in square feet, multiply length times width of lawn and subtract non-lawn areas including house, driveway, garden, etc. Do not allow people or pets on the lawn until the spray has dried.

HOUSEHOLD INSECTS (continued)

Insects	Insecticide[1]	Dosage	Suggestions
Houseflies (NHE-16) Gnats Midges	*Outdoors:* malathion 50-57% E.C.	Dilute to 1% with water	Spray around garbage cans and other resting sites. Dispose of refuse twice a week and prevent the accumulation of rotting or decaying vegetation or food material.
	Indoors: pyrethrin	0.1% R.T.U.	Apply fine mist or fog of pyrethrin. Use screening and keep in good repair. Fly swatters are also effective.
Mosquitoes (NHE-94, 132) No-see-ums	*Outdoors:* malathion 50-57% E.C.	Dilute to 1% with water	Spray tall grass, around doorways, and other resting sites. Eliminate standing water in eave troughs, tires, toys, tin cans, children's swimming pools, etc. Use a repellent like DEET when entering mosquito-infested areas.
	Indoors: pyrethrin	0.1% R.T.U.	Apply fine mist or fog of pyrethrin. Use screening and keep in good repair. Fly swatters are also effective.
Lice, human (NHE-105)	malathion 1% dust carbaryl 5% dust	1 oz. per adult person	Dust lightly over body hair, and wash clothing and bedding. Repeat in 2 weeks if needed. Do not get in eyes.
Mites, human Human scabies (NHE-135)	Kwell 1% lotion available only by a doctor's prescription		See your physician.
Pantry and cereal pests (NHE-11)	diazinon propoxur pyrethrin	0.5% R.T.U. 0.5% R.T.U. 0.1% R.T.U.	Discard infested packages. Scrub or vacuum food cabinets and shelves. Force spray into cracks and crevices; allow to dry; cover shelves with clean, fresh paper. Do not contaminate food or utensils with insecticide.
Powder-post beetles (NHE-85)	chlorpyrifos 42%	Dilute to 1% with water	Paint or spray infested unfinished wood. Follow label directions. Painting or varnishing wood to seal pores will prevent egg laying and reinfestation.
Silverfish (NHE-86)	diazinon propoxur	0.5% R.T.U. 0.5% R.T.U.	Spray runways, baseboards, closets, and places where pipes go through the walls. Repeat treatments in 2 weeks if needed. Keep books and papers in dry places.
Springtails (NHE-70)	*Outdoors:* diazinon 25% E.C. *Indoors:* pyrethrin	Dilute to 0.5% with water 0.1% R.T.U.	*Outdoors:* Spray soil next to the house, especially grassy moist areas. Eliminate low moist spots around the house. *Indoors:* Use vacuum. Allow soil to dry in potted plants or planter boxes.
Swimming pool insects (NHE-103)	*Do not* add insecticides to pool water		Remove insects from the pool with dip nets. Clean the pool regularly.
Termites (NHE-57)	chlordane 45 or 72% E.C. chlorpyrifos 42% E.C. (Dursban T.C.)	Dilute to 1% with water or oil	For soil injection along the building foundation and under footings, use 1 gal. per 2 cu. ft. of soil. Remove termite mud tubes connecting wood to the soil. Eliminate wood-to-soil contacts. Ventilate to keep unexcavated areas dry. Use only chlorpyrifos on slab-on-ground structures with ducts in floor.
Ticks (NHE-56): Brown dog tick, wood tick	tetrachlorvinphos 50% W.P. malathion 50-57% E.C. carbaryl 50% W.P.	Dilute to 0.5% with water Dilute to 2.5% with water 4 tbl. per 100 sq. ft.	Apply spray to lawns, fence rows, roadsides, and areas not regularly mowed.
	carbaryl malathion tetrachlorvinphos	5% dust 4% dust 3% dust	Dust pets directly as needed, according to label instructions. Dust baseboards, cracks, and crevices around pet bedding.
Wasps (NHE-141) Hornets Bees	carbaryl diazinon dichlorvos dichlorvos 20% resin strip[2] pyrethrin	5% dust 5% G. 0.5% R.T.U. 1 strip per 1,000 cu. ft. 0.1% R.T.U.	Hang dichlorvos resin strips in attic to prevent infestations. For nests below ground, apply diazinon according to label and seal opening with soil. Spray above-ground wasp and hornet nests in partitions with carbaryl. Drill holes through siding to inject insecticide, if necessary. Remove nests and honey and destroy them. Treat nests at dusk or dawn.

E.C. = emulsion concentrate; W.P. = wettable powder; R.T.U. = ready to use; G. = granules.

[1] Whenever possible purchase specially prepared ready-to-use forms of insecticides for indoor use. *Use only one insecticide from those listed.* When preparing a quantity of 1 gallon or more of a spray of a desired percentage, use the dilution table . You need to know only the formulation of the insecticide when using the dilution tble. [2] Do not use in pet shops or if tropical fish are present. Do not use in kitchens, restaurants, or areas where food is present. Do not use in nurseries or rooms where infants, individuals who are ill, or aged persons are confined. Do not use in hospitals or medical clinics.

Pesticide Dilution Table for Household Insects

HOW TO USE: When preparing a spray of a desired percentage you need to know only the formulation of the particular product (examples: Kelthane 18.5% wettable powder; Kelthane 18.5% emulsion concentrate). For instance, if you were preparing a 0.5% diazinon solution for spraying the foundation of the home, you would mix 5 tablespoons of diazinon 25% E.C. into each gallon of water. The formulations of insecticides in the table may be purchased from hardware stores, pest control establishments, lawn and garden centers, and other sources. For some jobs, such as spraying outdoors to control flies or mosquitoes, a gallon or more of properly diluted spray is required. To obtain the percent concentration suggested for controlling a particular insect, add the amount of pesticide suggested in the table to one gallon of water.

For control of household insects. *Do not* use this table for vegetable, flower, tree, shrub, or lawn insects.

Pesticide formulation	Amt. of insecticide needed per gal. of spray Desired concentration				
	0.03%	0.25%	0.5%	1.0%	2.5%
carbaryl (Sevin) 50% W.P.	..	2 tbsp.	4 tbsp.	8 tbsp.	..
chlordane 45% E.C.	..	..	8 tsp.	5 tbsp.	..
chlordane 72% E.C.	..	..	4 tsp.	8 tbsp.	..
chlorpyrifos	..	..	..	5 tbsp.	..
diazinon (Spectracide) 25% E.C.	..	..	5 tbsp.	10 tbsp.	..
dicofol (Kelthane) 18.5% E.C.	1½ tsp.	..	..	..	..
malathion 50-57% E.C.	..	..	7 tsp.	4½ tbsp.	10 tbsp.
tetrachlorvinphos 50% W.P.	..	..	4 tbsp.	..	..

(tbsp. = tablespoon; tsp. = teaspoon)

CONVERSION TABLE FOR SMALL QUANTITIES

1 level tablespoon = 3 level teaspoons	1 pint = 2 cups
1 fluid ounce = 2 tablespoons	1 quart = 2 pints or 32 fluid ounces
1 cup = 8 fluid ounces or 16 tablespoons	1 gallon = 4 quarts or 128 fluid ounces

NAMES OF INSECTICIDES

Below is a list of the common names of insecticides used in the preceding tables, followed by the commercial trade name and the chemical name. Some products may be available under a variety of trade names not listed below. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

Common name	Trade name	Chemical name
acephate	Orthene	O, S-dimethyl acetylphosphoramidothioate
Bacillus thuringiensis	Dipel, Thuricide, Bactur, SOK-BT	
carbaryl	Sevin	1-naphthyl methylcarbamate
chlorpyrifos	Dursban	O, O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate
DEET	Off, Kik	N, N-diethyl-m-toluamide
diazinon	Spectracide	O, O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothioate
dichlorvos	Vapona, DDVP	2,2-dichlorovinyl dimethyl phosphate
dicofol	Kelthane	4,4′-dichloro-a-(tri = chloromethyl) benzhydrol
dimethoate	Cygon	O, O-dimethyl S-(N-methyl carbamoyl methyl) phosphorodithioate
ethyl hexanediol	6-12, Rutgers 612	2-ethyl-1, 3-hexanediol
isofenphos	Oftanol	1-methylethyl 2-[[ethoxy [(1-methylethyl) amino] phosphinothioyl] oxy] benzoate
malathion	Cythion	diethyl mercaptosuccinate, S-ester with O, O-dimethyl phosphorothioate
pirimicarb	Pirimor	2-(dimethylamino)-5,6-dimethyl-4-pyrimidinyl dimethyl carbamate
propoxur	Baygon	O-isopropoxyphenyl methyl carbamate
propyl thiopyrophosphate	Aspon	0,0,0,0-tetrapropyl dithiopyrophosphate
pyrethrin		principally from plant species *Chrysanthemum cinariaefolium*
resmethrin	Chryson, SBP-1382	(5-benzyl-3-furyl) methyl 2,2 dimethyl-3-(2-methylprophenyl) cyclopropanecarboxylate
tetrachlorvinphos	Rabon	2-chloro-1-(2,4,5,-trichlorophenyl) vinyl dimethyl phosphate

1986 Insect Pest Management Guide

LIVESTOCK and LIVESTOCK BUILDINGS

Successful pest management is an essential part of efficient and profitable livestock production. Although pest-related losses are often inconspicuous, flies, lice, mites, and ticks can cause significant reductions in meat, milk, wool, and egg production. Several livestock pests also transmit important diseases.

Effective management of livestock pests should include the use of cultural, mechanical, and biological control tactics as well as the application of chemical insecticides. Insecticides should be viewed as supplements to, not replacements for, sanitation and sound cultural practices. Used properly, insecticides efficiently reduce pest populations without injuring livestock or threatening the safety of the pesticide applicator or the ultimate consumer of animal products.

This publication provides recommendations for safe and effective use of livestock insecticides. It is revised annually; always use the current year's issue. Registration changes that occur between revisions will be announced to appropriate media sources and county extension offices. If you have questions about the use of insecticides for livestock insect management, consult your county extension adviser.

Selection of the insecticides listed on the following pages was based on EPA registrations and on efficacy data reported by entomologists of the University of Illinois College of Agriculture, the Illinois Natural History Survey, and other midwestern universities. If listed insecticides fail to provide pest control, please contact your county extension adviser or the Entomology Extension office at the University of Illinois.

Additional sources of information. In the tables, leaflets outlining the life history, biology, and habits of livestock pests are indicated by the letters "NHE" and the leaflet number. Request these leaflets at your county extension office or from Entomology Extension, 172 Natural Resources Building, 607 East Peabody Drive, Champaign, Illinois 61820. Additional pest management publications available from the Office of Agricultural Publications (47 Mumford Hall, 1301 West Gregory Drive, Urbana, Illinois 61801) include Circular 899, *1986 Insect Pest Management Guide: Field and Forage Crops;* Circular 900, *1986 Insect Pest Management Guide: Home, Yard, and Garden;* Circular 925, *Insect Pests of Cattle;* Circular 897, *1986 Insect Pest Management Guide: Commercial Vegetable Crops and Greenhouse Vegetables;* and Circular 1136, *Alfalfa Weevil Pest Management Program.*

Using livestock insecticides. The pesticide user is always responsible for the results of insecticide applications to his livestock and crops, as well as for problems of pesticide drift and contamination. All users should observe the following rules.

- Read the label and follow directions and safety precautions. Be sure that the insecticide is specifically labeled for the pest and animal in question and the application method planned. THE LABEL IS THE LAW.
- Use face masks or respirators and protective clothing during spraying. Avoid breathing spray mist or dust.
- If pesticides are spilled on the skin or clothing, wash thoroughly with soap and water and change clothes.
- Do not eat, drink, or smoke when handling pesticides.
- Provide adequate ventilation when applying pesticides.
- Do not exceed registered rates of application. Improper or excessive applications can endanger livestock and result in illegal residues in meat and milk.
- Obey the preslaughter interval listed on the label.

Prepared by Richard A. Weinzierl, Extension Entomologist
CIRCULAR 898 (revised annually)

- Avoid drift to adjacent cropland, yards, woodlots, lakes, or ponds. Some materials may injure or kill fish, wildlife, and crops.
- Do not treat animals that are sick, overheated, or stressed from shipping, dehorning, castration, recent weaning, and other causes.
- Avoid contamination of feed, mangers, water, milk, and milking equipment.
- Do not spread treated manure on crops that are not listed on the pesticide label.
- Accurately record all pesticide usage. Include the pesticide's trade name, formulation, dilution, application rate, and date of treatment.
- Store pesticides in their original, labeled containers, safely locked away from children, pets, and livestock.
- Dispose of empty pesticide containers promptly and properly according to specified recommendations. Do not breathe smoke from burning containers.
- Contact a physician at once in all cases of suspected poisoning. Symptoms of organophosphate poisoning include blurred vision, abdominal cramps, and tightness in the chest.

Poison Resource Centers. The Poison Resource Centers listed below have been established to provide information about the treatment of poisoning cases. Anyone with a poisoning emergency can call the toll-free telephone number for help. Personnel at the Resource Center will provide first-aid information and refer callers to local treatment centers if necessary.

Poison Resource Centers supplement, but do not replace, local emergency medical services. Do not delay calling local emergency medical personnel to request immediate assistance or transportation. If possible, have the pesticide container and label present when you call or reach a treatment center or hospital.

Chicago and northeast Illinois
1753 West Congress Parkway
Chicago, Illinois 60612
Telephone: 800-942-5969

Northern and central Illinois
530 N.E. Glen Oak
Peoria, Illinois 61603
Telephone: 800-322-5330

Central and southern Illinois
800 East Carpenter
Springfield, Illinois 62702
Telephone: 800-252-2022

Preventing livestock poisoning. Every year livestock animals die after consuming pesticide granules, wettable powders, or dusts that have been spilled on trucks, wagons, or soil surfaces. Animals consume the pesticide alone or with feed grains or forage placed on the contaminated surface. Prevent livestock poisoning by properly containing and disposing of spilled pesticides and by storing all pesticides in locked facilities that are inaccessible to domestic and wild animals, as well as to children.

NOTE: The information in the following tables is for educational purposes only. Reference to commercial products or trade names does not constitute an endorsement by the University of Illinois and does not imply discrimination against other similar products. Trade names are presented for reasons of clarity only. The reader is urged to exercise the usual caution in making purchases or evaluating product information.

Beef Cattle and Nonlactating Dairy Cattle

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE (NHE 18) 1/16 to 1/8 inch long. Biting lice are reddish, flattened, and active. Sucking lice are gray to blue and sluggish. Heavy populations cause poor growth, general unthriftiness, and anemia. Symptoms are rough, patchy hair coats and a dirty appearance. Lice are most troublesome when cattle are crowded in shelters during winter months.	Self-treatment devices such as back rubbers, face rubbers, and dust bags effectively control lice when used in conjunction with systemic insecticides applied from August through October for grub control. The systemics kill lice that are present on animals during the fall; the self-treating devices then hold louse populations below economic levels throughout the winter. Place rubbing devices and dust bags where cattle will use them. For back rubbers and face rubbers, mix insecticides with No. 2 fuel oil, No. 2 diesel fuel, or an oil recommended on the insecticide label. Mineral oil is less irritating than fuel oil. Do not use waste oil or motor oil. Keep dust bags dry. Service self-treating devices at least once per month.			
	Back rubber or face rubber (oilers)	Co-Ral 11.6% EC (coumaphos)	1 gal/13 gal fuel or mineral oil.	0 days. Do not apply with oral drenches, with other internal medications such as phenothiazine, or with natural or synthetic pyrethroids, synergists, or organophosphates.
		malathion 57% EC	0.5 pt/1.5 gal fuel or mineral oil.	0 days.
	Dust bag	Products listed for use in dust bags can also be applied by hand-dusting. Follow label directions.		
		Co-Ral 1% D (coumaphos)	10 lb dust/bag. Use 1 bag/10-20 head.	0 days.
		Ectiban or Permectrin 0.25% D (permethrin)	10 lb dust/bag. Use 1 bag/10-20 head.	0 days.
		Rabon 3% D (stirofos)	4-8 lb dust/bag. Use 1 bag/10-20 head.	0 days.

Beef Cattle and Nonlactating Dairy Cattle, continued

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE, cont.	Spray	Apply sufficient spray to thoroughly wet each animal. Use up to 1 gallon finished spray per animal. Do not contaminate feed or water.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	2 gal/100 gal water.	0 days. Make a second application 10-14 days after first. Repeat as necessary but not more often than every 7 days. Do not treat Brahman cattle.
		Co-Ral 11.6% EC or 25% WP (coumaphos)	2 qt 11.6% EC or 2 lb 25% WP/100 gal water.	0 days. Do not treat calves less than 3 months old or sick, convalescent, or stressed cattle. Do not spray within 10 days after shipping, weaning, or disease exposure. Do not spray in nonventilated areas. Do not apply in conjunction with other organophosphates, pyrethroids, synergists, or phenothiazine.
		Delnav 15% EC or 30% EC (dioxathion)	1 qt 15% EC or 1 pt 30% EC/25 gal water.	0 days. Do not treat more often than every 14 days. Do not use on dairy cattle or in dairy barns. Restricted-Use.
		Ectiban 5.7% EC (permethrin)	1 qt/100 gal water.	0 days. Repeat treatment 14-21 days after first application. Do not treat more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for control of lice on beef cattle. Check product labels for dilution and application rates.)		
		malathion 57% EC	1 gal/100 gal water.	0 days. Do not apply to lactating dairy cattle or within 14 days of freshening. Do not treat calves less than 1 month old.
		Rabon 50% WP or 24% EC (stirofos)	4 lb 50% WP/75 gal water or 1.5 gal 24% EC/100 gal water.	0 days. Beef cattle only.
		methoxychlor 25% EC or 50% WP	2 qt 25% EC or 2 lb 50% WP/25 gal water.	0 days. Repeat treatment 14-21 days after first application. Do not use on dairy cattle or in dairy barns.
		Ravap 28.7% EC (stirofos plus dichlorvos)	1 gal/75 gal water.	0 days. Beef cattle only. Do not treat more often than once every 10 days.
	Pour-on or spot-on	Fall applications of systemic pour-ons and spot-ons such as Co-Ral (coumaphos), Warbex (famphur), Tiguvon (fenthion), Neguvon (trichlorfon), and Prolate (phosmet) for grub control also reduce louse populations. These treatments may not provide season-long louse control through the winter. Follow label directions concerning reuse after grub treatment cut-off dates. Products listed below effectively control lice, but do not provide grub control.		
		Dursban 44 (chlorpyrifos)	2 cc/100 lb body weight.	14 days. Beef cattle only. Apply as spot treatment. Do not exceed 16 cc/animal. Do not treat calves under 3 months old or bulls over 8 months old. Do not treat purebred continental or exotic breed cattle such as Charolais, Chianina, Simmental, and Gelbveih. Do not retreat within 30 days. Do not use on cows within 21 days prior to calving or 14 days after calving.
		Lysoff 7.6% EC (fenthion)	1 pt/1 gal water. Use 1 fl oz/100 lb body weight.	21 days; 35 days if 2 applications are made. Do not apply within 28 days of freshening of dairy cattle. Pour evenly along back line. Do not treat calves under 3 months old or sick, convalescent, or stressed livestock. Do not use with other cholinesterase-inhibiting insecticides or drugs.
	Injection	Ivomec 1% (ivermectin)	Ready to use. 1 cc/110 lb body weight.	35 days. Inject subcutaneously. Use aseptic procedures. Do not use on dairy cattle of breeding age.

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
CATTLE GRUBS Larvae ("grubs") bore through the skin and migrate within the host to the skin of the back. Grubs ruin hides and reduce weight gain. The hairy, yellow and black adult flies, slightly smaller than honey bees, annoy grazing cattle.	Timing of grub control treatments is important. Systemic insecticides applied as pour-ons, spot-ons, or sprays trave within the animal's bloodstream and should be applied to control grubs 6 to 8 weeks before they migrate to the animal' back. Late treatments may cause host-parasite reactions with symptoms of bloat, hindquarter paralysis, or death. Systemi insecticides should be used on native beef cattle herds in August or September in southern Illinois, and in Septembe or October in the northern half of the state. Treat only pastured cattle in herds with histories of grub problems. Animal in confinement are not attacked by ox warble flies (heel flies). Heel fly season and grub treatment dates are earlier fo cattle grazed in southern states. Cattle feeders should either know the origin of feeder cattle to determine grub treatmen dates or should purchase only cattle that have received grub treatments. Do not apply systemic insecticides in conjunction with or immediately after phenothiazine, with pyrethrins or syntheti pyrethroids or their synergists, or with other organophosphate insecticides. Do not treat cattle under stress from castration, dehorning, weaning, shipping, illness, or overexertion. Do not treat calves less than 3 months old.			
	Pour-on	Apply pour-ons using a long-handled dipper supplied by the manufacturer. Apply to the back lin from the shoulder to the hip.		
		Co-Ral 4% (coumaphos)	Ready to use. Apply 0.5 fl oz/100 lb body weight.	0 days. Do not apply within 14 days of fresh ening of dairy cattle.
		Neguvon 8% (trichlorfon)	Ready to use. Apply 0.5 fl oz/100 lb body weight. Do not exceed 4 fl oz/animal.	21 days. Do not apply within 7 days of fresh ening of dairy cattle.
		Prolate (GX-118) 11.6% E (phosmet)	1 gal/2 gal water. Apply 1 fl oz/100 lb body weight. Do not exceed 8 fl oz/animal.	21 days. Do not apply to dairy animals.
		Tiguvon 3% (fenthion)	Ready to use. Apply 0.5 fl oz/100 lb body weight.	35 days. Do not apply within 28 days o freshening of dairy cattle.
		Warbex 13.2% (famphur)	Ready to use. Apply 0.5 fl oz/100 lb body weight. Do not exceed 4 fl oz/animal.	35 days. Do not apply within 21 days o freshening of dairy cattle. Do not use on Brahmans or Brahman crossbreeds.
	Spot-on	To apply spot-ons, use the applicator system provided by the manufacturer. Apply the material to a single location on the back midline.		
		Spotton 20% (fenthion)	Ready to use. Apply 4 cc/300 lb body weight. Do not exceed 20 cc/animal.	45 days. Do not treat dairy cattle of breeding age.
	Spray	Use high-pressure sprays (250-350 psi) to apply 3 to 4 quarts of finished spray per animal. Because few farm sprayers generate sufficient pressure for proper application, veterinarians and commercial applicators with appropriate livestock spray equipment should be contacted to apply grub sprays. Use a pencil stream of spray directed at right angles to the sides and back. Treat 10 or fewer animals at one time. Do not contaminate feed or water.		
		Co-Ral 25% WP or 11.6% EC (coumaphos)	12-16 lb 25% WP or 8-12 qt 11.6% EC/100 gal water.	0 days. Do not apply within 14 days of fresh ening of dairy cattle.
		Prolate (GX-118) 11.6% EC (phosmet)	2 gal/100 gal water.	21 days. Beef cattle only.
	Injection	Ivomec 1% (ivermectin)	Ready to use. 1 cc/110 lb body weight.	35 days. Inject subcutaneously. Use aseptic procedures. Do not use on dairy cattle of breeding age.
MANGE MITES Microscopic mites live on the skin or burrow into it. Lesions vary with mite species. Infestations are greatest when cattle are crowded in shelters during winter months.	Chorioptic mange is the most prevalent mite-induced disorder of Illinois cattle. Infested cattle may or may not develop lesions; lesions usually occur as localized nodules that exude serum. They are most numerous from the tailhead to the hind heels. Insecticides listed previously for louse control on beef cattle also control chorioptic mange mites. Cattle scabies (psoroptic mange) is a quarantinable disease. Its symptoms are lesions that occur first on the withers, over the back, and at the tailhead. Small wounds cause itching, and rubbing leads to abscesses, especially on the shoulders and rump. Mites move to edges of scabs, causing lesions to enlarge and coalesce. Scabs may cover much of the body. Where cattle scabies is detected, contact the Illinois Department of Agriculture, Bureau of Animal Health, Illinois State Fairgrounds, Springfield, Illinois 62706, 217/782-4944.			

Beef Cattle and Nonlactating Dairy Cattle, continued

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
TICKS 8-legged adults of most species are reddish brown and less than ¼ inch long. Engorged females may exceed ½ inch in length. Ticks are blood feeders and disease vectors.	Ticks rarely pose an economic threat to cattle in Illinois. Problems are most likely where cattle graze in brushy or wooded areas.			
	Spray	Apply sufficient spray to thoroughly wet each animal; use up to 1 gallon finished spray per animal. Do not contaminate feed or water.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	2 gal/100 gal water.	0 days. Repeat application 10-14 days after first spray. Do not use more than once every 7 days.
		Co-Ral 25% WP or 11.6% EC (coumaphos)	4 lb 25% WP or 1 gal 11.6% EC/100 gal water.	0 days. Do not treat calves less than 3 months old or sick, convalescent, or stressed cattle. Do not spray within 10 days after shipping, weaning, or disease exposure. Do not spray in nonventilated areas. Do not apply in conjunction with phenothiazine, pyrethroids, synergists, or systemic organophosphate insecticides.
		Ectiban 5.7% EC (permethrin)	1 qt/100 gal water.	0 days. Do not apply more than once every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for control of ticks on cattle. Check product labels for dilution and application rates.)		
		malathion 57% EC	1-2 gal/100 gal water.	0 days. Do not apply to dairy cattle within 14 days of freshening. Do not treat calves less than 1 month old.
MOSQUITOES Annoyance may cause cattle to bunch in or near buildings and reduce their grazing.	Mosquito populations are greatest near low, wet areas, ponds, or slow-moving streams. Reduction of mosquito breeding sites is necessary for long-term control.			
	Spray (to animals)	Ectiban 5.7%	1 qt/100 gal water.	0 days. Do not apply more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of mosquitoes and horse flies on cattle. Check product labels for dilution and application rates.)		
		Vapona 23.4% EC (dichlorvos)	1 qt/6 gal water. Mist 1-2 fl oz/ animal/day.	1 day. Do not contaminate feed or water. Do not wet skin. Do not apply in conjunction with trichlorfon.
		pyrethrin (0.1%) plus synergist	Mist 1-2 fl oz/ animal.	0 days. Do not contaminate feed or water. Do not wet skin. Repeat as necessary.
HORSE FLIES, DEER FLIES (NHE 60) Large flies that feed on the back, shoulders, neck, and head. Blood feeding annoys cattle and reduces grazing and weight gain. Wounds attract other flies.	Adequate and practical control methods for horse flies and deer flies on pastured beef cattle are not available. Insecticide applications provide some relief but do not provide long-term control. Place cattle in barns or sheds to protect them from horse flies and deer flies.			
	Spray	Ectiban 5.7%	1 qt/100 gal water.	0 days. Do not apply more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of mosquitoes and horse flies on cattle. Check product labels for dilution and application rates.)		
		pyrethrin (0.5-1.0%) plus synergist	0.5% oil is ready to use; apply 2 fl oz/animal 3 times per week. Mix 1 gal 1% EC/10 gal water; apply 1 to 2 pt/ animal every 3 days.	0 days. Apply to head, back, sides, belly, and legs. Do not contaminate feed or water.

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
PASTURE FLIES (HORN FLIES, FACE FLIES, STABLE FLIES) **Horn flies** (NHE 59) are smaller than house flies but are similarly colored and marked. They have piercing mouthparts and are blood feeders. Horn flies congregate about the back, shoulders, and horns; on hot days they are mostly on the shady side of the animal or on the belly. Horn flies seldom follow animals into barns or sheds. **Face flies** (NHE 106) resemble house flies but are slightly larger and darker. Only females frequently visit cattle. They feed on secretions about the eyes, nose, and mouth. Annoyance to cattle reduces feeding. Face flies also transmit pinkeye. Face flies do not attack cattle in barns or sheds. **Stable flies** (NHE 61) resemble house flies but have a bayonetlike proboscis that protrudes from the front of the head. Stable flies are blood feeders that often attack the lower portion of the front legs. Stable flies attack both pastured and feedlot cattle.	Moving cattle into barns or sheds will reduce attacks by horn flies and face flies.			
	Back rubber or face rubber (oilers)	Mix insecticides with No. 2 fuel oil, No. 2 diesel fuel, or a label-recommended mineral oil. Mineral oils are less irritating than fuel oils. Do not use waste oil or motor oil. Service the rubbing device at least once per week. Self-treating devices are effective only if they are used regularly. Place rubbing devices in the entryways to water or mineral feeders to ensure usage. Effective horn fly control can be achieved with forced-use oilers, but only partial control of face flies is provided by these devices. Oilers do not control stable flies.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 qt/4 gal fuel or mineral oil.	0 days.
		Co-Ral 11.6% EC (coumaphos)	1 gal/13 gal fuel or mineral oil.	0 days.
		Delnav 15% EC or 30% EC (dioxathion)	2 qt 15% EC or 1 qt 30% EC/5 gal fuel or mineral oil.	0 days. Beef cattle only.
		Ectiban 5.7% EC (permethrin)	1 qt/10 gal diesel oil.	0 days.
		Permectrin II 10% EC (permethrin)	1 qt/20 gal fuel or mineral oil.	0 days.
		Ravap 28.7% EC (stirofos plus dichlorvos)	1 qt/7 gal fuel or mineral oil.	0 days. Beef cattle only.
	Dust bag	Dust bags are effective only if they are used regularly. Place them in the entryways to water or mineral feeders to ensure use. Keep dust bags dry and well charged; service at least once per week. Forced-use dust bags that contact the animal's face provide effective horn fly control and significant reductions in face flies; dust bags do not effectively control stable flies.		
		Co-Ral 1% D (coumaphos)	10 lb/bag.	0 days.
		Ectiban or Permectrin 0.25% D (permethrin)	10 lb/bag.	0 days.
		malathion 4% plus methoxychlor 5% D	1 10-lb bag/ 10-15 animals.	0 days. Beef cattle only.
		Rabon 3% D (stirofos)	4-8 lb/bag.	0 days.
	Feed additive	Feed additives prevent the development of face fly and horn fly larvae in cattle manure. Stable flies do not develop in fresh manure and are not controlled by feed additives. Face flies migrate considerable distances, so larval control in manure of a single herd will not significantly reduce fly populations if other herds in the area do not also receive feed additives. Animals must consume the recommended dosage for the feed additive to be effective.		
		Altosid 0.02% (methoprene)	0.25-0.5 lb/100 lb body weight/ animal/month.	0 days. Feed mineral mix or block from May to September.
		phenothiazine 17.8%	Mix 1:3 with salt. Use 1 lb mixture/10 head/day.	0 days. Feed no other salt. Use from May to September.
		Rabon 97.3% or 7.76% Oral Larvacide (stirofos)	70 mg a.i./100 lb body weight/day.	0 days. Use from May through September. Mix with complete feeds, concentrates, or protein supplements.
	Ear tag or ear tape	Ear tags impregnated with fenvalerate, flucythrinate, or permethrin and permethrin-impregnated ear tapes effectively control horn flies and provide some control of face flies. They do not control stable flies. One tag or tape per cow will effectively control horn flies on cows and calves for up to 20 weeks. Using 2 tags per cow and 2 tags per calf will improve face fly control. Attach tags in late May or early June after fly populations have begun to increase. Remove tags in September or October. Combination tags containing permethrin plus chlorpyrifos (Dursban) and a synergist (piperonyl-butoxide) also are available; claims regarding their usefulness in controlling pyrethroid-resistant horn flies or delaying resistance development have not been documented. Tags containing the organophosphate Rabon (stirofos) provide fly control for approximately 6 weeks after application.		
		fenvalerate 8% tag (Ectrin, Insecta-Shield, Ear Tag Plus, Starbar, Vet Shack)	1-2 tags per head.	0 days. Apply when fly activity begins in spring; remove in fall or before slaughter.

Beef Cattle and Nonlactating Dairy Cattle, continued

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
PASTURE FLIES, cont.	Ear tag or ear tape, cont.	flucythrinate 7.5% tag (Guardian)	1-2 tags per head.	0 days. Apply when fly activity begins in spring; remove in fall or before slaughter.
		permethrin 10% tag (Atroban, Apollo, Insecta-Gard, Gard Star, Fearing Du-flex, Gen-Sal, Permectrin)	1-2 tags per head.	0 days. Apply when fly activity begins in spring; remove in fall or before slaughter.
		permethrin 0.9 g tape (Ectiban)	1 tape per animal.	0 days. Apply when fly activity begins in spring; remove in fall or before slaughter.
		stirofos 13.7% tag (Rabon)	1-2 tags per head.	0 days. Apply when fly activity begins in spring; remove in fall or before slaughter.
	Spray	Sprays directed to animals should not contaminate feed or water.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 pint/1.5 gal water. Use 1-2 fl oz mist/animal/day. *OR:*	0 days.
			2 gal/50 gal water. Use 1-2 qt/animal.	0 days. Repeat as needed, but not more often than once every 7 days.
		Co-Ral 11.6% EC or 25% WP (coumaphos)	2 qt 11.6% EC or 2 lb 25% WP/ 100 gal water. Completely wet skin to runoff.	0 days. Do not apply to dairy cattle within 14 days of freshening.
		Delnav 15% EC or 30% EC (dioxathion)	1 qt 15% EC or 1 pt 30% EC/25 gal water.	0 days. Do not use more often than every 14 days. Do not use on dairy cattle or in dairy barns. Restricted-Use.
		Ectiban 5.7% EC (permethrin)	1 qt/100 gal water. Thoroughly wet animals.	0 days. Repeat as needed, but not more often than once every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for control of pasture flies on cattle. Check product labels for dilution and application rates.)		
		Ectrin 10% WDL (fenvalerate)	8 oz/2½ gal water. Mist 2-3 fl oz/animal every 4-7 days. Or mix 8 oz/12 gal water. Use 1 qt/ animal every 7 days.	0 days. State-labeled use; applicator must have label in possession.
		methoxychlor 25% EC or 50% WP	2 qt 25% EC or 2 lb 50% WP/25 gal water.	0 days. Do not use on dairy cattle or in dairy barns.
		Rabon 50% WP (stirofos)	4 lb/75 gal water. Use ½ to 1 gal/animal.	0 days. Beef cattle only.
		Ravap 28.7% EC (stirofos plus dichlorvos)	1 gal/75 gal water. Use ½ to 1 gal/animal.	0 days. Beef cattle only. Repeat as needed, but not more often than once every 10 days.

Lactating Dairy Cattle

Insecticides listed in this section are registered for use on lactating dairy cattle. Most insecticides listed for use on beef cattle can be applied to nonlactating dairy cattle if the specified interval between application and freshening is observed. Follow all label directions.

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE (NHE 18) 1/16 to 1/8 inch long. Biting lice are reddish, flattened, and active. Sucking lice are gray to blue and sluggish. Heavy populations cause reduced milk production and anemia. Symptoms are rough, patchy hair coats and a dirty appearance. Most troublesome in winter.	Dust bag	Place dust bags at milkroom exits. Keep bags charged and dry, and service at least once per month. (Co-Ral 1% dust and Ectiban and Permectrin 0.25% dusts can be used for direct hand-dusting; follow label directions.)		
		Co-Ral 1% D (coumaphos)	10 lb dust/bag.	0 days.
		Ectiban or Permectrin 0.25% D (permethrin)	10 lb dust/bag. Self-treating.	0 days.
	Spray	Apply sufficient spray to thoroughly wet each animal; use up to 1 gallon finished spray per animal. Do not contaminate feed, water, milk, or milking equipment.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 qt/12 gal water.	0 days. Make a second application 10-14 days after first. Repeat as needed, but not more than once every 7 days.
		Co-Ral 11.6% EC or 25% WP (coumaphos)	1 qt 11.6% EC or 1 lb 25% WP/100 gal water.	0 days. Do not treat calves less than 3 months old.
		Ectiban 5.7% EC (permethrin)	1 qt/100 gal water.	0 days. Repeat application 14-21 days after first treatment.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of lice on dairy cattle. Check product labels for dilution and application rates.)		
CATTLE GRUBS	No pesticides are currently registered for control of cattle grubs on lactating dairy cattle.			
MANGE MITES Microscopic mites live on or within skin. Lesions vary with mite species. Infestations are greatest when cattle are crowded in shelters during winter.	Mange caused by chorioptic mites (barn itch mites) is the most common mite-induced disorder of Illinois dairy cattle. Infested cattle may or may not develop lesions; lesions usually appear as localized nodules that exude serum. Lesions are most prevalent from the tailhead to the hind heels. Insecticides listed for louse control on dairy cattle also control chorioptic mange. Cattle scabies (psoroptic mange) is a quarantinable disease. Its symptoms are lesions that occur first at the withers, over the back, and at the tailhead. The wounds itch, and rubbing leads to absesses, especially on the shoulders and rump. Mites move to edges of scabs, causing lesions to enlarge and coalesce. Scabs may cover much of the body. Where cattle scabies is detected, contact the Illinois Department of Agriculture, Bureau of Animal Health, Illinois State Fairgrounds, Springfield, Illinois 62706, 217/782-4944.			
TICKS 8-legged adults of most species are reddish brown and less than 1/4 inch long. Engorged females may exceed 1/2 inch in length. Ticks are blood feeders and disease vectors.	Ticks are rarely economically important on Illinois dairy cattle. Problems are most likely where cattle graze in brushy or wooded areas.			
	Spray	Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 qt/12 gal water. Use up to 1 gal/animal.	0 days. Make a second application 10-14 days after first. Do not apply more often than once every 7 days.
		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Do not apply more often than once every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of ticks on dairy cattle. Check product labels for dilution and application rates.		
MOSQUITOES Blood feeding. Annoyance may cause cattle to remain in buildings and reduce their grazing.	Mosquito populations are greatest near low, wet areas, ponds, and slow-moving streams. Reduction of mosquito breeding sites is necessary for long-term control.			
	Spray (to animals)	Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt per animal.	0 days. Do not apply more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of mosquitoes on dairy cattle. Check product labels for dilution and application rates.)		
		Vapona 23.4% EC (dichlorvos)	1 qt/6 gal water. Mist 1-2 fl oz/animal/day.	1 day. Do not wet skin. Do not contaminate feed, water, milk, or milking equipment.
		pyrethrin (0.03-0.10%) plus synergist (0.5-1.0%)	Ready to use. Mist 1-2 fl oz/animal.	0 days. Do not wet skin. Do not contaminate feed, water, milk, or milking equipment. Repeat as necessary.

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
PASTURE FLIES (HORN FLIES, FACE FLIES, STABLE FLIES)	Reduce attacks by horn flies, face flies, deer flies, and horse flies by moving cattle into barns or sheds.			
Horn flies (NHE 59) are smaller than house flies but are similarly colored and marked. They have piercing mouthparts and are blood feeders. Horn flies congregate about the back, shoulders, and horns; on hot days they are mostly on the shady side of the animal or on the belly. Horn flies seldom follow animals into barns or sheds.	Back rubber or face rubber (oilers)	Mix insecticides with No. 2 fuel oil, No. 2 diesel fuel, or a label-recommended mineral oil. Mineral oils are less irritating than fuel oils. Do not use waste oil or motor oil. Service the oiler at least once per week. For self-treating devices to be effective, cattle must use them frequently. Place oilers in the entryways to water or mineral feeders or in the milking room exit. Well-used back rubbers or face rubbers will control horn flies and provide some face fly control. They will not control stable flies.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 gal/16 gal fuel or mineral oil.	0 days.
		Co-Ral 11.6% EC (coumaphos)	1 gal/13 gal fuel or mineral oil.	0 days.
		Ectiban 5.7% EC (permethrin)	1 qt/10 gal oil.	0 days.
		Permectrin II 10% EC (permethrin)	1 qt/20 gal fuel or mineral oil	0 days.
Face flies (NHE 106) resemble house flies but are slightly larger and darker. Only females frequently visit cattle. They feed on secretions about the eyes, nose, and mouth. Annoyance to cattle reduces feeding. Face flies also transmit pinkeye. Face flies do not attack cattle in barns or sheds.	Dust bag	For self-treating devices to be effective, cattle must use them regularly. Place dust bags in the entryways to water or mineral feeders or in the milking room exit. Keep dust bags dry; service at least once per week. Dust bags will control horn flies and provide some reduction in face fly problems. They will not control stable flies. (NOTE: Insecticide dusts listed below can also be used for direct hand-dusting; follow label directions.)		
		Co-Ral 1% D (coumaphos)	10 lb/dust bag.	0 days. Do not treat calves less than 3 months old.
		Ectiban or Permectrin 0.25% D (permethrin)	10 lb/dust bag.	0 days.
		Rabon 3% D (stirofos)	4-8 lb/dust bag.	0 days.
Stable flies (NHE 61) resemble house flies but have a bayonetlike proboscis that protrudes from the front of the head. Stable flies are blood feeders that often attack the lower portion of the front legs. Stable flies attack both pastured and feedlot cattle.	Spray	It is important that the following sprays do not contaminate feed, water, milk, or milking equipment.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 qt/3 gal water. Mist 1-2 fl oz/animal/day.	0 days.
		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Retreat as needed, but not more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for pasture fly control on dairy cattle. Check product labels for dilution and application rates.)		
		Ectrin 10% WDL (fenvalerate)	8 oz/2½ gal water; mist 2-3 oz/animal every 4-7 days. *OR:* 8 oz/12 gal water; use 1 qt/animal every 7 days.	0 days. State-labeled use; applicator must have label in possession.
		Vapona 23.4% EC or 1% EC oil base (dichlorvos)	1 qt 23.4%/6 gal water; use 1-2 fl oz/animal/day. *OR:* 1% EC (oil base), ready to use; mist 1-2 fl oz/animal/day.	0 days. Do not wet skin.
		pyrethrin (0.1%) plus synergist	Ready to use. Apply 1-2 fl oz/animal.	0 days. Repeat as needed.

Lactating Dairy Cattle, continued

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
PASTURE FLIES, cont.	Feed additive	Animals must consume the recommended dosage for the feed additive to be effective. A feed additive reduces fly development only in treated manure; it does not control existing adult flies. Increase control by practicing good sanitation; remove nearby manure, silage, feed, and other fly-breeding materials.		
		Rabon 97.3% or 7.76% Oral Larvicide (stirofos)	70 mg a.i./100 lb body weight/day.	0 days. Feed in complete feeds, concentrates, or protein and mineral supplements from May to September.
	Ear tag or ear tape	Ear tags and ear tapes effectively control horn flies and reduce face fly problems. They do not control stable flies. One fenvalerate, flucythrinate, or permethrin tag or tape per cow will effectively control horn flies on cows and calves for up to 20 weeks. Using 2 tags per cow and 2 tags per calf will improve face fly control. Attach tags in late May or early June after fly populations have begun to increase. Remove tags in September or October. Combination tags containing permethrin plus chlorpyrifos (Dursban) and a synergist (piperonyl-butoxide) also are available; claims regarding their usefulness in controlling pyrethroid-resistant horn flies or delaying resistance development have not been documented. Tags containing the organophosphate Rabon (stirofos) provide fly control for approximately 6 weeks after application.		
		fenvalerate 8% ear tag (Ectrin, Insecta-Shield, Ear Tag Plus, Starbar, Vet Shack)	1-2 tags per head.	0 days. Apply tags when flies first appear in the spring. Remove in fall or before slaughter.
		flucythrinate 7.5% tag (Guardian)	1-2 tags per head.	0 days. Apply when fly activity begins in spring; remove in fall or before slaughter.
		permethrin 10% ear tag (Atroban, Apollo, Insecta-Gard, Gard Star, Fearing, Permectrin, Wellcome Tag)	1-2 tags per head.	0 days. Apply tags when flies first appear in spring. Remove in fall or before slaughter.
		permethrin 0.9 g ear tape (Ectiban)	1 tape per animal.	0 days. Apply tape when flies first emerge in spring. Remove in fall or before slaughter.
		stirofos 13.7% tag (Rabon)	1-2 tags per head.	0 days. Apply when fly activity begins in spring. Remove in fall or before slaughter.

Hogs

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
MANGE MITES (AND LICE) Microscopic mites feed on or within skin and cause mange. **Sarcoptic mange** usually starts at the head and then spreads back; infested skin becomes dry, scurfy, or leathery. Rubbing may lead to raw or scabby areas. **Demodectic mange** is characterized by hard, round swellings on or below the skin surface.	Sarcoptic mange can be controlled effectively with the insecticides listed below. Although these insecticides will aid in controlling demodectic mange, there is no satisfactory chemical control for the hog follicle mites that cause demodectic mange. Prevent sarcoptic mange outbreaks by treating pigs as soon as possible after weaning; treat sows 30-45 days before farrowing; treat boars before the breeding season. Follow label precautions against the use of organophosphate sprays, dusts, or pour-ons simultaneously with medications used for internal parasite control. Do not contaminate feed or water. Isolate hogs with demodectic mange. Kill and destroy severely infested animals; market for slaughter the animals that are less severely attacked. Clean and disinfect pens, sheds, etc., before moving in uninfested animals.			
	Spray	Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Spray animals thoroughly.	5 days. Repeat application after 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for control of hog lice and mange. Check product labels for dilution and application rates.)		
		Ectrin 10% WDL (fenvalerate)	1 qt/50 gal water. Spray each animal thoroughly.	1 day. Repeat application in 14 days if necessary.
		lindane 12.4% EC or 20% EC	3 pt 12.4% EC or 1 qt 20% EC/100 gal water. Spray animals thoroughly.	30 days. Treat twice at a 7-day interval. Do not treat pigs less than 3 months old. Do not treat sows within 2 weeks before farrowing or 3 weeks after farrowing. Restricted-Use.
		malathion 57% EC	1 qt/15 gal water. Treat animals, bedding, and walls thoroughly.	0 days. Do not treat pigs less than 1 month old. Repeat treatment after 10 days.
	Dust	malathion 4-5% D	Thoroughly cover animals over 1 month old. Also treat pens and bedding. Use ¼-½ tbsp/pig for pigs less than 1 month old.	0 days. Repeat as needed. Gives only partial control of mange mites.
LICE Up to ⅛ inch long. Hog lice suck blood and cause irritation and itching of skin. Animals may rub infested areas and cause bleeding. Infested animals appear generally unthrifty.	Insecticides listed for controlling mange mites on hogs will also control lice. Do not contaminate feed or water. Follow label precautions against the use of organophosphate sprays, dusts, or pour-ons simultaneously with medications used for internal parasite control.			
	Spray	Co-Ral 25% WP (coumaphos)	2 lb/100 gal water. Spray each animal thoroughly.	0 days. Do not treat animals less than 90 days old. Apply a second spray 10-14 days after first.
		methoxychlor 50% WP	8 lb/100 gal water. Spray each animal thoroughly.	0 days. Make second application 14 days after first if needed.
	Dust	Co-Ral 1% D (coumaphos)	1 oz/animal.	0 days. Dust especially around shoulders and back. Repeat as needed, but not more than once every 10 days.
		Ectiban or Permectrin 0.25% D (permethrin)	1 oz/animal.	5 days. Make second application 14 days after first.
		Rabon 3% D (stirofos)	3-4 oz/animal; 1 lb/150 sq ft of bedding for severe infestations.	0 days. Do not retreat for 14 days.
	Pour-on	Ectrin 10% WDL (fenvalerate)	1 qt/25 gal water. Pour 4 fl oz/animal on head and back midline.	1 day. Add wetting agent according to label directions. Repeat application in 14 days if necessary.
		Tiguvon 3% Pour-On (fenthion)	0.5 fl oz/100 lb body weight.	14 days. May be used on gestating and lactating sows. Do not retreat within 35 days.

Sheep

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
KEDS, LICE (NHE 53) **Sheep keds** (also called sheep ticks) are flattened, wingless, reddish brown flies about the size of house flies. **Lice** reach 1/16 to 1/8 inch in length. Biting lice are flattened and yellowish to reddish in color. Sucking lice are oval and bluish gray.	Spray	Apply enough spray to thoroughly cover each animal. Do not contaminate feed or water.		
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	2 gal/100 gal water. Use up to 1 gal/animal.	0 days. Make second application 10-14 days later. Do not retreat within 7 days.
		Co-Ral 25% WP (coumaphos)	*Lice:* 2 lb/100 gal water. *Keds:* 4 lb/100 gal water.	15 days. Do not treat lambs less than 3 months old.
		diazinon 50% WP	0.5 lb/100 gal water. Use 1 gal/animal.	14 days. Use high pressure and volume. Do not treat lambs less than 2 weeks old.
		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Repeat application in 14 days. Do not treat more often than every 14 days.
		Ectrin 10% WDL (fenvalerate)	1 qt/100 gal water. Wet each animal with up to 1 qt of spray.	2 days. Repeat application in 30 days if necessary. Do not apply more than twice in the spring and twice in the fall.
		malathion 57% EC	1 gal/100 gal water.	0 days. Do not treat lambs less than 1 month old.
		Marlate 50% WP (methoxychlor)	8 lb/100 gal water. Spray each animal thoroughly.	0 days.
	Dust	Co-Ral 0.5% D	Follow label directions.	15 days. Treat once after shearing. Do not treat lambs less than 3 months old.
		diazinon 2% D	1½ oz/animal.	14 days. Do not treat lambs less than 2 weeks old.
		malathion 4-5% D	1-2 oz/animal.	0 days. Repeat application in 2-3 weeks if needed. Do not treat lambs less than 1 month old.
		Marlate 50% WP (methoxychlor)	1 tbsp/animal.	0 days. Treat only once.
	Pour-on	Ectrin 10% WDL (fenvalerate)	2 qt/25 gal water. Pour 4 fl oz/animal down midline of back.	2 days. Add wetting agent according to label directions. Repeat application in 30 days if necessary. Do not apply more than twice in the spring and twice in the fall.
WOOL MAGGOTS Cream-colored maggots are larvae of blow flies. Maggots live in wet, matted wool near the rear of the animal and in matted wool surrounding wounds.	Spray	Reduce wool maggot attacks by tagging sheep (shearing under the tail and between the hind legs), docking, and castrating before May. Practice good sanitation. Shear around and direct sprays to the infested areas.		
		Co-Ral 25% WP (coumaphos)	4 lb/100 gal water. Use 1 gal/animal.	15 days. Do not treat lambs less than 3 months old.
		diazinon 50% WP	0.5 lb/100 gal water. Use 1 gal/animal.	14 days. Do not treat lambs less than 2 weeks old.
SCAB MITES (SCABIES, WET MANGE)	Sheep scab is a quarantinable disease. Infested animals shed wool; skin becomes roughened and crusted. Where infestations are suspected, contact the Illinois Department of Agriculture, Bureau of Animal Health, Illinois State Fairgrounds, Springfield, Illinois 62706, 217/782-4944.			
HORN FLIES (NHE 59)	Spray	Co-Ral 25% WP (coumaphos)	2 lb/100 gal water.	15 days. Do not treat lambs less than 3 months old.
		Marlate 50% WP (methoxychlor)	2 lb/100 gal water.	0 days. Repeat treatment every 3 weeks as needed.
FACE FLIES (NHE 106)	Spray	pyrethrin (0.05-0.10%) plus synergist (0.5-1.0%)	1-2 fl oz/animal.	0 days. Apply daily to head, neck, and front legs as a fine mist. Do not wet hair or skin.

Goats

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE (NHE 53)	Spray	Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	2 gal/100 gal water. Use 2-4 qt/animal.	0 days. Make second application 14 days after first. Do not apply more often than every 7 days. Do not contaminate feed, water, milk, or milking equipment.
		Ectrin 10% WDL (fenvalerate)	1 qt/100 gal water. Wet each animal with up to 1 qt of spray.	2 days. Do not apply to lactating goats. Repeat application in 30 days if necessary. Do not apply more than twice in the spring and twice in the fall.
	Pour-on	Ectrin 10% WDL (fenvalerate)	1 qt/25 gal water. Pour 4 fl oz/animal down midline of back.	2 days. Do not apply to lactating goats. Add wetting agent according to label directions. Repeat application in 30 days if necessary. Do not apply more than twice in the spring and twice in the fall.
FACE FLIES (NHE 106), **HORN FLIES** (NHE 59), **STABLE FLIES** (NHE 61)	Spray	Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	1 qt/3 gal water. Use 1 pt/animal/ week.	0 days. Do not apply more often than every 7 days. Do not contaminate feed, water, milk, or milking equipment.
HORSE FLIES, DEER FLIES (NHE 60)	Spray	pyrethrin (0.05-0.10%) plus synergist (0.5-1.0%)	1-2 fl oz/animal.	0 days. Apply to head, neck, and front legs as a fine mist. Do not wet hair or skin.

Poultry

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE, NORTHERN FOWL MITES (BIRD TREATMENT) (NHE 54)	Spray	Co-Ral 25% WP (coumaphos)	*Lice:* 6 oz/5 gal water. *Mites:* 3 oz/5 gal water. Use 1 gal/100-125 birds, or 0.5 fl oz/bird.	0 days. Do not treat more than once per week. Do not treat within 10 days of vaccination or stress.
Chicken lice are flat-bodied, straw-colored, 1/16-inch-long lice with chewing mouthparts. They feed on feathers and skin flakes, irritating birds. Severe infestations reduce egg production.		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1 gal/100 birds.	0 days. Treat vent area thoroughly.
		malathion 57% EC	1 fl oz/gal water. Use 1 gal/100-125 birds.	0 days. Repeat treatment in 4-8 weeks or when necessary.
		Permectrin II 10% EC (permethrin)	1 qt/50 gal water. Use 1 gal/100 birds.	0 days. Treat vent area thoroughly.
		Rabon 50% WP (stirofos)	6.5 oz/5 gal water. Use 1 gal/100 birds or 1 fl oz/bird using at least 100-125 psi.	0 days. Do not treat more than once every 14 days.
Northern fowl mites are dark red to black blood feeders that build up in the vent area. Mature mites are roughly 1/25 inch long. Feathers around the vent appear grayish or black from accumulation of mites, mite eggs, and excrement. Severe infestations reduce egg production and can cause death. Northern fowl mites are most troublesome in winter.		Ravap 28.7% EC Poultry Spray and Larvicide (stirofos + dichlorvos)	1 pt/6 gal water. Use 1 gal/100 birds or 1 fl oz/bird using at least 100-125 psi.	0 days. Do not treat more than once every 14 days.
		Sevin 50% WP or 80% SP (carbaryl)	6 oz 50% WP or 4 oz 80% SP/5 gal water. Use 1 gal/ 100 birds.	7 days. Repeat treatment in 4 weeks if necessary.
	Dust	Ectiban or Permectrin 0.25% D (permethrin)	Use 1 lb/100 birds.	0 days. Apply with shaker or hand duster. Treat vent area thoroughly.
		malathion 4-5% D	Use 1 lb/100 birds.	0 days. Apply with shaker or hand duster.
		Rabon 3% D (stirofos)	Use 1 lb/300 birds.	0 days. Apply with hand or power duster. Do not treat more than once every 14 days.
		Sevin 5% D (carbaryl)	Use 1 lb/100 birds.	7 days. Apply with shaker or hand duster. Do not treat more than once every 4 weeks.
	Strip	Permectrin 10% strip (permethrin)	1 or 2 strips per cage of up to 9 hens.	0 days. For northern fowl mite control.

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE, CHICKEN MITES, NORTHERN FOWL MITES (POULTRY HOUSE AND LITTER TREATMENT) (NHE 54) **Chicken mites** (or roost mites) are bright to dark red and 1/25 inch long. They hide in cracks and crevices during the day and feed on birds at night. They are most prevalent in spring, summer, and fall, not in winter.	Spray	Co-Ral 25% WP (coumaphos)	6 oz/5 gal water. Use 1 gal/1,000 sq ft.	0 days. Apply thoroughly to litter, walls, ceilings, floors, roosts, nests, and adjacent areas. Force spray into all cracks and crevices.
		malathion 57% EC	2 fl oz/gal water. Use 1 gal/1,000 sq ft.	0 days. Apply liberally to litter, walls, ceilings, floors, roosts, nests, and adjacent areas. Force spray into cracks and crevices.
		Rabon 50% WP (stirofos)	0.5 lb/6 gal water. Use 1-2 gal/1,000 sq ft.	0 days. Apply thoroughly to litter, walls, roosts, cracks, crevices, and interiors.
		Ravap 28.7% EC Poultry Spray and Larvicide (stirofos + dichlorvos)	1 pt/6 gal water. Use 1-2 gal/1,000 sq ft.	0 days. Apply thoroughly to litter, walls, roosts, cracks, and crevices.
		Sevin 50% WP or 80% SP (carbaryl)	2 lb 50% WP or 1.5 lb 80% SP/5 gal water. Use 1-2 gal/1,000 sq ft.	7 days. Apply spray to walls, bedding, litter, and roosts. Force spray into cracks and crevices. Repeat as needed. Avoid contamination of nests, eggs, feed, and water.
	Dust	malathion 4-5% D	1 lb/50-60 sq ft.	0 days. Apply liberally to litter, walls, ceilings, roosts, nests, and adjacent areas.
		Rabon 3% D or 50% WP (stirofos)	1 lb 3% D or 2.5 oz 50% WP/100 sq ft.	0 days. Treat litter evenly and thoroughly.
		Sevin 5% D (carbaryl)	1 lb/40 sq ft.	7 days. Apply to litter, roosts, and adjacent areas. Do not apply to eggs or nests. Do not treat more than once every 4 weeks.
DARKLING BEETLES (LESSER MEALWORMS) Cream-colored larvae infest decaying organic matter or moldy feeds. They are ingested and survive long enough to bite and damage the alimentary canal.	Spray	Rabon 50% WP (stirofos)	2 lb/25 gal water. Use 1-2 gal/1,000 sq ft.	0 days. Apply evenly and thoroughly to litter, walls, center posts, and foundation walls.
		Sevin 80% SP or 40% or 43.4% suspensions (carbaryl)	62.5 lb 80% SP or 50 qt 40% or 43.4% suspensions/ 100 gal water. Use 2 gal/1,000 sq ft.	7 days. Apply evenly and thoroughly to litter or floor surface. Do not apply directly to poultry, nests, or eggs. Repeat as needed.
	Dust	Sevin 5% D (carbaryl)	1 lb/40 sq ft.	7 days. Do not apply to eggs or nest litter. Do not treat more than once every 4 weeks.
BED BUGS Flat, reddish brown, blood-sucking insects that feed at night. Rarely seen on birds during daylight.	Spray	Sevin 50% WP, 80% SP, or 40% or 43.4% suspensions (carbaryl)	8 lb 50% WP, 5 lb 80% SP, or 4 qt 40% or 43.4% suspensions/ 100 gal water. Use 1-2 gal/1,000 sq ft.	7 days. Apply thoroughly to walls, litter, and roost surfaces. Force spray into cracks and crevices. Do not apply directly to poultry, nests, or eggs. Repeat as needed.
	Dust	Sevin 5% D (carbaryl)	1 lb/40 sq ft.	7 days. Apply evenly to litter. Do not treat more than once every 4 weeks. Do not apply to eggs or nest.

Horses

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
MANGE MITES Burrowing in skin causes pain and itching. Most prevalent in winter.	Spray	Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Repeat application in 14 days. Do not treat more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of mites on horses. Check product labels for dilution and application rates.)		

Horses, continued

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
LICE 1/16 to 1/8 inch in length. Biting lice are yellow to red. Sucking lice are brownish to blue-gray. Head and neck, withers, and tailhead develop a scurfy appearance. Rubbing may create raw areas.	Spray	Co-Ral 25% WP or 11.6% EC (coumaphos)	0.5 lb 25% WP or 1 pt 11.6% EC/25 gal water. Treat animal thoroughly.	0 days.
		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Repeat application in 14 days. Do not treat more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of lice on horses. Check product labels for dilution and application rates.)		
		malathion 57% EC or 25% WP	6.5-10 fl oz 57% EC or 0.75 lb 25% WP/ 5 gal water. Treat animal thoroughly.	0 days.
TICKS Seldom a problem unless horses graze in brushy or wooded areas.	Spray	Co-Ral 25% WP or 11.6% EC (coumaphos)	1 lb 25% WP or 1 qt 11.6% EC/25 gal water. Treat animal thoroughly.	0 days. Repeat as necessary.
		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Do not treat more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of ticks on horses. Check product labels for dilution and application rates.)		
		malathion 57% EC or 25% WP	6.5-10 fl oz 57% EC or 0.75 lb 25% WP/ 5 gal water. Treat animal thoroughly.	0 days.
HORSE BOTS Flies are nearly as large as honey bees. They deposit eggs on the forelegs, throat, or muzzle area; fly activity severely annoys horses. Eggs are ingested; larvae (bots) develop within the horse's alimentary canal.	Feed additive	Anthon 90% Powder (trichlorfon)	5 g/250 lb body weight mixed with feed. Treat from mid-October to mid-December.	Nonfood use. Repeat after 3 to 4 months. Withdraw all feed 12-18 hours prior to and 3 hours after treatment. Do not treat colts under 4 months of age, mares in the last month of gestation, or horses to be used for food.
		Horse Wormer (dichlorvos)	19.5 g/300 lb body weight mixed with feed. Give to individual horse in half its normal grain ration.	Nonfood use. Treat 30 days after killing frost. Withhold water 4-6 hours before and 3 hours after consumption of the medicine. Do not treat sick animals or animals that have received tranquilizing drugs or other worm medicines within 1 week of application.
	Oral paste	Eqvalan 1.87% (ivermectin)	Ready to use. Follow directions on prefilled syringe.	Nonfood use.
	Injection	Consult with a veterinarian for treatment with carbon disulfide, dichlorvos (Equigard), or piperazine + carbon disulfide (Parvex Plus).		
	Preventive spray	malathion 57% EC	During fall months, sponge legs, under jaw, and chest of animal with a warm 0.5% malathion solution.	0 days. Eggs will be stimulated to hatch and the larvae will be prevented from burrowing into the animal. Retreat when more eggs accumulate. Do not use bare hands; use specially prepared gloves or rubber gloves.
SCREWWORMS, BLOW FLIES Maggots develop in wounds.	Spray	Co-Ral 25% WP (coumaphos)	1.3 oz/gal water. Treat wound lightly but thoroughly.	0 days.
		Coral 3% Spray Foam (coumaphos)	Ready to use. Spray thoroughly so that foam completely covers wound.	0 days.
	Dust	Co-Ral 5% D (coumaphos)	Ready to use. Treat wound lightly but thoroughly.	0 days.

Horses, continued

Pest	Treatment method	Insecticide and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
HORN FLIES, FACE FLIES, STABLE FLIES, HORSE FLIES, DEER FLIES, BLACK FLIES, MOSQUITOES	Spray	Co-Ral 25% WP or 11.6% EC (coumaphos)	0.5 lb 25% WP or 1 pt 11.6% EC/25 gal water. Treat animal thoroughly.	0 days.
		malathion 57% EC or 25% WP	6.5-10 fl oz 57% EC or 0.75-1.25 lb 25% WP/5 gal water. Treat animal thoroughly.	0 days.
		Ectiban 5.7% EC (permethrin)	1 qt/25 gal water. Use 1-2 qt/animal.	0 days. Do not treat more often than every 14 days.
		(Additional permethrin formulations including emulsifiable concentrates of Insectrin, Permaban, and Permectrin II are registered for the control of biting flies on horses. Check product labels for dilution and application rates.)		
		Ectrin 10% WDL (fenvalerate)	4 fl oz/3 gal water. Mist 8 fl oz spray per animal. Direct at face, head, shoulders, and legs.	Do not treat animals intended for slaughter.
		pyrethrin plus synergist	Ready to use.	0 days. Apply as a mist spray. Do not wet the hide. Repeat as needed.
		Rabon 1% Spray-n-Wipe (stirofos)	Apply 1-2 fl oz to flanks, belly, and back.	0 days.
	Dust	Co-Ral 1% D (coumaphos)	2 oz/animal.	0 days. Apply to the head, neck, shoulders, back, and tailhead. Repeat as needed.
		malathion 4% D	4 tbsp/animal.	0 days. Apply evenly along back line. Repeat at 10-14 day intervals.
	Wipe-on	Rabon 2% Gel Wipe-on (stirofos)	1-2 fl oz/animal.	0 days. Apply as directed every 2-3 days if needed.

FLY CONTROL IN LIVESTOCK BUILDINGS AND FEEDLOTS

Filth fly species that commonly inhabit livestock dwellings, feedlots, and nearby buildings include the house fly, stable fly, little house fly, and several blow fly species. These flies develop in a variety of moist, organic wastes including manure, spilled feed, decaying vegetation, and garbage. Common breeding sites are around feed bunks, at the edges of feeding floors, under fences, along stacks of hay or straw, and in accumulations of manure.

Although stable flies are biting flies that take blood meals from cattle, horses, and hogs, most other flies associated with confined livestock are nuisance pests, not blood-feeders. Neither stable flies nor nonbiting nuisance flies spend much time on their animal hosts, so successful fly control around confined livestock does not center on animal treatments. The use of dust bags, oilers, or ear tags provides little or no control of flies in or around buildings. Sprays directed to the legs and belly of cattle, horses, and hogs (apply as recommended in preceding sections for horn fly control on individual livestock species) may provide short-term relief from stable fly attack, but such applications are not likely to significantly reduce the overall fly problem.

Thorough sanitation practices are almost always necessary for successful fly control. Weekly removal of manure, decaying hay and straw, and spilled feeds disrupts fly breeding sites frequently enough to prevent the development of fly larvae. Removing wastes beneath feeders and along fences is especially important. If manure is temporarily piled before spreading, cover it with black plastic to prevent fly development. If manure is not removed weekly, leaving an 8-inch-thick manure residue at each cleanup may help to maintain populations of insect predators and parasites that limit fly populations. Poultry producers who do not remove manure weekly can maintain predator and parasite populations by removing manure from beneath only one row of cages at each cleanup.

Insecticide applications may be necessary in addition to good sanitation. Unless otherwise indicated, premise treatments listed below can be used in beef, dairy (other than milking rooms), swine, sheep, goat, poultry, and horse facilities. Separate recommendations for fly control in milking rooms are provided.

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
HOUSE FLIES, STABLE FLIES, BLOW FLIES, ETC.	Space spray from mist blower or fogger	Space sprays (aerosols) provide rapid control of adult flies present at the time of application. Close doors and windows to reduce air movement during treatment. Daily to twice-weekly applications may be necessary where space sprays are the only treatments used. Animals may be present during application, but space sprays should not be applied directly to livestock. Do not apply space sprays in areas where animals have been treated directly with an insecticide during the previous 24 hours. Do not contaminate feed or water or use in milking rooms.		
		Dibrom 36% EC or 1% Ready-to-use Spray (naled)	1 qt 36% EC/40 gal water. Apply throughout building. Use 1 fl oz of 1% Ready-to-use Spray/ 3,000 cu ft.	0 days.
		Ectiban 5.7% EC (permethrin)	*Misting:* Use 4 fl oz/1,000 cu ft. *Overhead system:* 1 qt/12.5 gal fuel or mineral oil; use 4 fl oz/1,000 cu ft.	0 days.
		Permectrin II 10% EC (permethrin)	*Misting:* Use 4 fl oz/1,000 sq ft. *Overhead system:* 1 qt/12.5 gal fuel or mineral oil; use 4 fl oz/1,000 cu ft.	0 days.
		pyrethrins plus synergist	Follow label directions.	0 days.
		Vapona 23.4% EC (dichlorvos)	*Misting:* 1 pt/6 gal water; use 1 qt/8,000 cu ft. *Fogging:* 1 pt/3.5 gal diesel oil; use 1 pt/8,000 cu ft.	0 days.
		Vapona Feedlot 43.2% EC (dichlorvos)	1 gal/100 gal water. Use 5 gal/acre.	0 days. For cattle feedlots only.
	Surface residual spray	Surface sprays applied to walls, ceilings, partitions, posts, etc. kill flies at their resting sites and provide residual activity for 1-7 weeks. Products (or the listed concentrations of these products) recommended for use as residual sprays should not be applied directly to animals. Thoroughly spray surfaces to the point of run-off. Do not contaminate feed or water, and do not use residual sprays in milking rooms.		
		Baytex 45% EC (fenthion)	3 qt/25 gal water. Use 1 gal/500 sq ft.	0 days. Residue persists 3-5 weeks.
		Ciovap 12.5% EC (crotoxyphos plus dichlorvos)	2 gal/25 gal water. Use 1 gal/500 sq ft.	0 days. Do not use in poultry houses. Residue persists 1 week.
		Cygon 23.4% EC (dimethoate)	1 gal/25 gal water. Use 1-2 gal/1,000 sq ft.	0 days. Remove all animals before spraying. Keep them out for at least 4 hours. Do not use in dairy barns or poultry houses. Residue persists 2-4 weeks.
		Ectiban 25% WP or 5.7% EC (permethrin) (Atroban, Insectrin, Overtime, Permaban, and Permectrin II are other permethrin products registered for use as surface residual sprays.)	6 oz 25% WP/11 gal water or 1 qt 5.7% EC/12.5 gal water. Use 1 gal/750 sq ft.	0 days. Residue persists 3-7 weeks.
		Ectrin 10% WDL (fenvalerate)	1 qt/10 gal water. Use 1 gal/750 sq ft.	0 days for swine buildings. Use only in swine buildings and in horse barns where horses are not to be slaughtered. Residue persists 3-7 weeks.
		Rabon 50% WP (stirofos)	4-8 lb/25 gal water. Use 1-2 gal/1,000 sq ft.	0 days. Residue persists 2-4 weeks.

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
HOUSE FLIES, STABLE FLIES, BLOW FLIES, ETC., cont.	Bait	Baits may enhance house fly control; they do not attract stable flies. Bait applications of insecticides used in surface residual sprays can be prepared by adding sugar or corn syrup to the spray tank mixture. Follow directions on individual product labels. Dry baits can be sprinkled in areas where flies congregate. Do not place dry baits in areas where birds or animals will contact the bait. Do not contaminate feed or water.		
		Dipterex 1% Dry Bait (trichlorfon)	4 oz/1,000 sq ft.	0 days.
		Golden Malrin 1% Dry Bait (methomyl)	4 oz/1,000 sq ft.	0 days.
		Vapona 0.5% Dry Bait (dichlorvos)	4 oz/1,000 sq ft.	0 days.
	Resin strip	Farm Strip 20% resin strip (dichlorvos)	Suspend 1 strip/ 1,000 cu ft.	0 days. Close doors and windows so that vapor concentrations reach recommended levels. Do not hang near light bulbs or within reach of animals.
	Manure spray	Manure sprays control fly larvae that are developing in treated feces. Migration of adult flies from nearby areas can occur if any breeding sites remain untreated. Manure sprays are recommended only where manure cannot be removed on a weekly basis. Apply sprays at rates that wet the manure surface; soaking is not necessary. Repeat applications as necessary, but not more often than every 7 days. Do not apply where mammals or birds will come in contact with the manure. Do not apply treated manure to crops not listed on the insecticide label.		
		Cygon 23.4% EC (dimethoate)	0.5 pt/5 qt water. Apply as a coarse spray.	0 days.
		Rabon 50% WP or 24% EC (stirofos)	4 lb 50% WP or 1 gal 24% EC/25 gal water. Use 1 gal/ 100 sq ft. manure.	0 days.
		Ravap 28.7% EC (stirofos plus dichlorvos)	1 gal/25 gal water. Use 1 gal/100 sq ft manure.	0 days.
		Vapona 23.4% EC (dichlorvos)	1 gal/25 gal water. Use 1-2 qt/100 sq ft manure.	0 days.
	Feed additive	Feed additives used to prevent the development of fly larvae in feces provide minimal control of flies in livestock buildings. Feed additives do not reach house fly and stable fly larvae that develop in sites other than fresh manure. Good sanitation more effectively prohibits larval development. Animals must consistently consume recommended dosages for feed additives to be effective against fly larvae in manure.		
		Moorman's 0.02% IGR (methoprene)	0.25-0.5 lb/100 lb body weight/animal/ month.	0 days. Feed mineral mix or block from May through September. Beef cattle and dairy cattle only.
		Rabon 7.76% or 97.3% Oral Larvacide (stirofos)	70 mg a.i./100 lb body weight/day.	0 days. Use from May through September. Mix with complete feeds, concentrates, or protein supplements. For beef cattle, dairy cattle, and hogs only.
	Biological agents	Several companies sell parasitic wasps for use in controlling flies around livestock buildings and feedlots. These predaceous wasps attack only flies; they do not sting (or bite) other insects, animals, or humans. Adult wasps (less than 1/10-inch long) deposit eggs on or inside fly larvae or pupae. Developing wasps kill the immature flies. Suppliers usually recommend wasp releases (several thousand wasps per release) before and during the fly season. For biological control programs to effectively manage flies around livestock facilities, frequent and thorough sanitation practices (including manure removal, water management, and weed control) must be practiced. Some suppliers also recommend certain insecticide applications to supplement the control provided by biological agents. In many instances it is difficult to assess the separate impacts of parasitic wasps, sanitation practices, and insecticide applications. Although wasp releases have been shown to be effective for fly control in certain poultry housing, research data do not support other uses of currently available biological controls for flies. If biological control agents are to significantly contribute to fly control programs, integration with sanitation and chemical control practices is essential.		

1986 Insect Pest Management Guide

COMMERCIAL VEGETABLE CROPS AND GREENHOUSE VEGETABLES

Restricted-use insecticides are identified with an asterisk (*).
You must be certified as a pesticide applicator to use restricted-use pesticides.
See your county Extension adviser in agriculture for information.

COMMERCIAL VEGETABLE GARDENERS find it impossible to produce vegetables profitably unless they control insects at maximum efficiency and minimum cost. The housewife of today will not accept unsightly wormy vegetables; not only are wormy fruits and vegetables unappetizing but the waste from trimming increases food costs. Thus the commercial vegetable gardener must produce a quality product that is acceptable and safe to the consumer. Careful use of the right insecticides will enable him to do this.

Insect pest-management programs, which include the wise selection of cultural, mechanical, biological, and chemical methods, are suggested for the major insect pests of vegetable crops. Insecticides, though, are still the most efficient means of managing most insects.

This suggested insecticide guide has been prepared for use by Illinois commercial vegetable farmers; it is not for home gardeners, who should use only those insecticides that are extremely safe to handle, apply, and store. Furthermore, the commercial vegetable gardener must use a wider variety of insecticides than the home gardener in order to obtain maximum insect control at the least cost.

In using insecticides, read the label and carefully follow the instructions. Do not exceed maximum rates suggested; observe carefully the interval between application and harvest, and apply only to crops for which use has been approved. Make a record of the product used, the trade name, the percentage content of the insecticide, the dilution, the rate of application per acre, and the dates of application.

Some of the insecticides suggested here can be poisonous to the applicator. In using them, the commercial grower is expected to use precautions to protect himself, his workers, and his family from undue or needless exposure.

In using this guide, always refer to the table on the next page, which lists the limitations and restrictions on use. These limitations apply to the vegetables as human food. If you use any portion of a vegetable for livestock food (tops, stalks, etc.), refer to the label for instructions as to the interval required between application and feeding.

The chemical names used in these tables may be unfamiliar to you. These names are the common coined chemical names and as such are not capitalized. Trade names are capitalized. In the table of limitations the common names are listed first. If the trade name is more commonly used, it is listed in parentheses following the common name. Throughout the tables of suggestions, however, the common name is used if there is one. In case you have a question, refer to the table of limitations.

These suggestions are subject to change without notification during the growing season.

Requested label clearances for a few uses of insecticides, carriers, and solvents are uncertain for 1986, since many requests have not been officially cleared. Anticipating needed changes in labeling, we began modifying these suggested uses a few years ago.

Check with your county Extension adviser if you are in doubt about the insecticide you plan to use. We will make announcements of label changes through newsletters and the news media to keep you up to date.

Insecticides are being classified for *general use* or *restricted use* by the U.S. Environmental Protection Agency. A person wishing to use an insecticide classified for restricted use must be certified as a private or commercial pesticide applicator by the Illinois Department of Agriculture. Contact your county Extension adviser in agriculture for details on this program.

A few insecticides have been classified at this time. More will be classified later.

Suggestions for the effective use of insecticides from a practical standpoint are based on available data. Soil textures, pH of the soil, rainfall, slope of the field, wind velocity at planting, method and accuracy of application, and other unpredictable factors affect efficiency.

Prepared by Roscoe Randell, Extension Entomologist

CIRCULAR 897

Fly Control, continued

Pest	Treatment method	Material and formulation	Dilution and rate	Preslaughter interval, restrictions, comments
CONTROL OF FLIES IN MILKING ROOMS	Although effective fly control is essential in dairy barns and milkrooms, small amounts of pesticides can be detected in milk, and their presence is often illegal. To control flies and avoid residue problems, the following steps are recommended: 1. Use good sanitation and recommended insecticides in dairy barns to reduce the number of flies entering the milkroom. 2. Use sticky fly strips where appropriate. 3. Use tight screens (14-16 mesh) on milkroom doors and windows. Copper, aluminum, bronze, plastic, or rust-resisting screens are best. 4. Dichlorvos resin strips will give excellent control if windows and doors are kept closed when one strip per 1,000 cubic feet of space is used. Replace strips when they become ineffective. 5. Use a mist or aerosol spray of 0.06-0.1% pyrethrin plus piperonyl butoxide oil-based fly sprays in the milkroom when resin strips do not give adequate fly control. To prevent milk contamination, cover all milking utensils, cans, bulk tanks, and containers before spraying.			
RATTAILED MAGGOTS	The rattailed maggot is the larval stage of a syrphid fly. The 1¼-inch long maggot has a cylindrical body about ¾-inch long and a tail-like breathing tube that extends ½-inch from the posterior of the body. The adult fly is a bee-like hover fly that is not a pest on or around livestock or humans. Rattailed maggots live in highly polluted water such as that in livestock lagoons and manure pits. When larvae are ready to pupate, they migrate from lagoons and pits to adjacent, drier areas. They become pests when they enter feed, egg cartons, and milking rooms. To limit rattailed maggot development, eliminate floating solids within pits and keep pit sidewalls clean. Agitate the pit contents or pump the pit weekly. Although insecticides are of limited value in managing rattailed maggots, application of Ravap to the pit surface provides some control. Use 1 pint Ravap 28.7% EC per 3½ gallons fuel oil and apply 1 gallon of the spray mixture per 100 square feet of pit surface. (Do not agitate the pit contents after application.) Repeat applications as needed, but not more often than every 7 days. Limit rattailed maggot migration by constructing a soil barrier between the pit and the milking room. Migrating larvae will burrow into the loose soil to pupate instead of continuing their migration into milking rooms, etc.			

LIMITATIONS FOR FIELD VEGETABLES IN DAYS BETWEEN APPLICATION AND HARVEST AND OTHER RESTRICTIONS ON USE OF INSECTICIDES IN ILLINOIS

(Blank spaces indicate that the material is not suggested for the specific use in Illinois)

Insecticide	Beans	Peas	Broccoli	Brussels sprouts	Cabbage	Cauliflower	Horseradish	Radish	Turnip	Onions	Eggplant	Peppers	Tomatoes
acephate (Orthene)	14	...	..	..	..	..	..	..	...	....	..	7	..
*azinphosmethyl (Guthion)[2]	..	...	15	7	21	15	..	..	....	....	..	..	..
Bacillus thuringiensis[3]	..	...	0	0	0	0	..	..	....	....	..	..	0
carbaryl (Sevin)	0	...	3	3	3	3	3	3	3, 14A	....	0	0	0
carbofuran (Furadan)	..	...	..	..	..	..	..	..	....	....	..	21B	..
chlorpyrifos (Lorsban)	..	...	C	C	C	C	..	C	....	C, D	..	..	..
Dasanit	..	...	..	..	..	..	..	..	....	C, D	..	..	..
*demeton (Systox)	..	...	..	..	..	..	..	..	....	....	..	3	..
diazinon	..	...	5	..	7	5	..	10	10	10	..	..	1
dicofol (Kelthane)	7E	...	..	..	..	..	..	..	....	....	2	2	2
dimethoate (Cygon)	0E	0E	7	..	3	7	..	..	14	....	..	0	7
Dyfonate	..	...	C	..	C	C	..	..	....	C, D	..	..	..
ethion	..	...	..	..	..	..	..	..	....	C	..	..	..
*fenvalerate (Pydrin)[4]	..	3E,N	3	..	3	3	..	..	....	....	..	..	1K
malathion	1	...	3	7	7	7	7	7	3	3	3	3	1
*methomyl (Lannate)	1	1, 5A	3	3	1	3	..	..	....	....	..	10	2
*mevinphos (Phosdrin)[2]	..	...	1	3	1	3	..	..	3	....	..	..	..
*Monitor	..	...	21	21	35	28	..	..	....	....	..	..	..
naled (Dibrom)	..	...	1	1	1	1	..	..	4	....	..	..	..
oxydemetonmethyl (Meta-Systox R)	..	...	..	..	..	..	..	..	....	....	7F	0B	..
*parathion[2]	..	...	7	7	10	7	..	15	10	....	..	..	..
*permethrin (Ambush, Pounce)	..	...	1H	1H	1H	1H	22	..	....	....	..	..	..
phorate (Thimet)[2]	C	...	..	..	..	..	..	..	....	....	..	..	..
rotenone	..	...	..	..	..	..	..	..	....	....	1	1	1
trichlorfon (Dylox)	..	...	..	21	21	21	..	..	28E	....	..	21	21

Insecticide	Potatoes	Collards	Kale	Lettuce	Spinach	Swiss chard	Sweet corn	Cucumbers[1]	Melons[1]	Pumpkins[1]	Squash[1] Winter	Squash[1] Summer
Bacillus thuringiensis[3]	..	0	0	0	0	..	..	..	..	..	..	..
carbaryl (Sevin)	0	14	14	14	14	14	0	0	0	0	0	0
carbofuran (Furadan)	14H	..	..	..	..	..	7L, 21A	C	C	C	C	C
chlorpyrifos (Lorsban)	..	..	..	..	..	..	35A, J	..	..	.	..	..
diazinon	..	10	10	10	10	12	C	7	3	..	3	7
dicofol (Kelthane)	..	..	..	..	..	..	..	2	2	2	2	2
dimethoate (Cygon)	0	14	14	14	14	14	..	..	3	..	..	..
Dyfonate	..	..	..	..	..	..	C	..	..	..	..	..
*fenvalerate (Pydrin)[4]	7E	..	..	..	..	..	1K	..	3	3	3	3
isofenphos (Amaze)	..	..	..	..	..	..	I	..	..	..	..	..
malathion	0	7	7	14	7	7	5	1	1	3	1	1
*methomyl (Lannate)	6	..	..	10	7	..	0, 3A	3	3	..	..	3
*mevinphos (Phosdrin)[2]	..	3	3	2	4	..	..	..	..	..	..	..
Mocap	..	..	..	..	..	..	C	..	..	..	..	..
naled (Dibrom)	..	4	4	1	1	1	..	..	..	..	..	..
*parathion[2]	5	10	10	21	14	21	12	15	7	10	15	15
*permethrin (Ambush, Pounce)	7E	..	..	..	..	..	1M	..	..	..	..	..
phorate (Thimet)[2]	C	..	..	..	..	..	C	..	..	..	..	..
rotenone	..	1	1	1	1	1	..	..	..	..	..	..
terbufos (Counter)	..	..	..	..	..	..	C	..	..	..	..	..
trichlorfon (Dylox)	..	28G	21	28G	..	..	..	..	..	3F	..	..

* Use restricted to certified applicators only.

[1] Apply insecticides late in the day after the blossoms have closed to reduce bee kill.
[2] For use only by professional applicators or commercial gardeners.
[3] The trade names are Bactur, Dipel, Thuricide, and Sok Bt.
[4] Only root crops indicated on label can be planted following application. For all other root crops, wait 12 months before planting.

A. If tops or stover are to be used for feed.
B. Not more than twice per season.
C. Soil applications at planting time only.
D. Do not use on green onion crop.
E. Do not use tops for feed or food.
F. Not more than 3 times per season.
G. Not after edible portions or heads begin to form.
H. Not more than 8 times per season.
I. Crops other than corn and soybeans may be planted 10 months after application.
J. Not more than once per season.
K. Do not exceed 2 lb. a.i. per acre.
L. Not more than 4 applications per season.
M. Not more than 6 applications per season.
N. Do not exceed 0.4 lb. a.i. per acre.

REENTRY INTERVALS FOR WORKER PROTECTION

Insecticide	Hours
azinphosmethyl (Guthion)	24
demeton (Systox)	48
ethion	24
parathion	48

Workers must wear protective clothing if they enter treated fields before the time intervals shown at the left. They must also wear protective clothing for all other insecticides applied if the spray has not dried or the dust has not settled.

CABBAGE AND RELATED COLE CROPS

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Cabbage maggots[1] (NHE-44)	All season	diazinon	3	Broadcast	Disk in just before planting. Use only for cabbage, cauliflower, and broccoli.
		Dyfonate	2		
		diazinon granules	1	Furrow	At time of planting; on turnips a drenching spray of 1 lb. diazinon should be applied 30 days following treatment.
		*azinphosmethyl	3 oz. W.P. or 2 oz. E.C. per 50 gal. transplant water		6 fluid oz. transplant water per plant.
		diazinon	4 oz. per 50 gal. transplant water		
		Lorsban	3 oz. 4E per 1,000 ft. of row		Transplant drench to cabbage, broccoli, and cauliflower.
		Lorsban	1 oz. 4E per 1,000 ft. of row	Furrow	Radishes only.
Aphids (NHE-47) Thrips (NHE-48)	All season	*azinphosmethyl	¾	Foliage	When aphids appear, but before leaves begin to curl.
		dimethoate	0.3		
		malathion	1		
		*mevinphos	¼		
		*parathion	0.4		
Cabbage loopers (NHE-45); diamond-back moth larvae; imported cabbage worms	All season	*Bacillus thuringiensis*	See rates on label	Foliage	When small worms first appear, and about every 5 to 7 days thereafter. Thorough spray coverage of foliage is important.
		*fenvalerate	0.1-0.2		
		*methomyl	0.45-0.9		
		*Monitor	1		
		*permethrin	0.1-0.2		
Cutworms	At planting	*fenvalerate	0.1-0.2	Base of plants	As needed.
		trichlorfon	1		
Flea beetles and leafhoppers	All season	carbaryl	1½	Foliage	As needed.
		*fenvalerate	0.1-0.2		

E.C. = Emulsion concentrate; W.P. = wettable powder.

* Use restricted to certified applicators only. [1] Maggots are resistant to diazinon in some areas of Illinois.

COLLARDS, KALE, LETTUCE, SPINACH, SWISS CHARD

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Aphids (NHE-47)	All season	diazinon	½	Foliage	As needed.
		dimethoate	0.3		
		*mevinphos	¼		
		naled	1		
		*parathion	0.4		
Cutworms	On seedling plants	trichlorfon[1]	1	Base of plant and soil	When first damage appears.
Leafhoppers	All season	carbaryl	1½	Foliage	When first leafhoppers appear, and as needed.
		dimethoate	0.3		
		malathion	1		
Caterpillars (NHE-45)	All season	*Bacillus thuringiensis*	See rates on label	Foliage	When small worms first appear and every 5 to 7 days thereafter.
		*methomyl[2]	0.45		
		naled	1		
Leaf miners	All season	diazinon	½	Foliage	When first miners are observed.
		dimethoate	0.3		
		*parathion	0.4		
Flea beetles	All season	carbaryl	1	Foliage	As needed.
		rotenone	¼		

* Use restricted to certified applicators only.

[1] Do not use on spinach or Swiss chard.
[2] Use limited to lettuce and spinach only.

BEANS

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Seed maggots (NHE-27)	All season	diazinon 50% W.P.[1]	3/5 oz./bu.	Seed	Treat seed no longer than 3 months before planting.
		Lorsban 25% W.P.[1]	2 oz./bu.	Seed	
		phorate granules	1½	Soilband	Place on either or both sides of row at planting but not in contact with seed.
Bean leaf beetles (NHE-67)	Early and late season	carbaryl	1	Foliage	When feeding first appears and weekly for 2 or 3 applications as needed.
		malathion	1		
Leafhoppers (NHE-22) and plant bugs (NHE-68)	All season	carbaryl	1	Foliage	Before plants become yellow and stunted. Repeat applications at weekly intervals as necessary.
		dimethoate	0.3		
		malathion	1		
		*methomyl	0.45		
		phorate granules	1½	Soilband	As for seed maggot.
Mexican bean beetles	Midseason and late season	carbaryl	½	Foliage	When occasional leaves show lacework feeding.
		malathion	1		
		phorate granules	1½	Soilband	As for seed maggot.
Aphids (NHE-47)	All season	dimethoate	0.3	Foliage	Usually applied when a few aphids can be found on each plant, but before leaves begin to curl and deform.
		malathion	1		
		phorate granules	1½	Soilband	As for seed maggot.
Blister beetles (NHE-72)	Midseason and late season	carbaryl	1½	Foliage	As needed.
Corn earworms (NHE-33) Corn borers	Late season	acephate	⅔	Foliage	As needed, but usually after August 20. Worms may be present before bloom.
		carbaryl	1½		
		*methomyl	0.45		
Mites	Midseason and late season	dicofol	0.4	Foliage	As needed, but especially during drouthy periods particularly if carbaryl has been used on crops.
		dimethoate	0.3		
		phorate granules	1½	Soilband	As for seed maggot.

* Use restricted to certified applicators only. [1] No restrictions when used as recommended.

CUCUMBERS AND OTHER VINE CROPS[1]

Insect	Time of attack	Insecticide[2]	Pounds of active ingredient per acre	Placement	Timing of application[1]
Striped and spotted cucumber beetles (NHE-46)	Seedling to mature plants	carbaryl	1	Foliage	When beetles first appear; as often as necessary thereafter.
		carbofuran	2	Soil	
		*parathion	½	Foliage	
Aphids (NHE-47)	All season	diazinon	½	Foliage	When aphids become noticeable.
		dimethoate[3]	0.3		
		malathion	1		
		*parathion	½		
Squash bugs (NHE-51)	All season	*fenvalerate	0.2	Foliage	Do not apply until first eggs are found hatching (about June 15 to July 15); controls only nymphs.
		*parathion	½		
		trichlorfon[3]	1		
Leafhoppers	July-August	*fenvalerate	0.1-0.2	Foliage	As needed.
		malathion	1		
		dimethoate[3]	0.3		
Squash vine borers	June-September	carbaryl	1	Base of stem for 3 ft.	Weekly applications when vines begin to run—usually 5 applications.
		*fenvalerate	0.1-0.2		
Pickle worms	August-September	carbaryl	1	Foliage	Weekly applications, beginning in late August.
		*fenvalerate	0.1-0.2		
Mites	July-September	dicofol	½	Foliage	As needed.
		*parathion	½		
Cutworms (NHE-77)	April-June	carbaryl	2	Base of plants	As needed.
		*fenvalerate	0.2		

* Use restricted to certified applicators only.
[1] Spray vine crops with insecticide only late in the day after blossoms have closed to reduce bee kill. [2] Do not use dimethoate on cucumbers.
[3] Pumpkin is the only vine crop for which trichlorfon can be used for squash bug control.

TOMATOES AND EGGPLANT

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Cutworms (NHE-77)	Early and midseason	carbaryl	2	Base of plants or foliage	As needed.
		fenvalerate	0.1-0.2		
		trichlorfon	1		
Flea beetles	May-June	carbaryl	2	Foliage	Apply every week as long as needed.
		rotenone	0.2-0.4		
Aphids (NHE-47)	May-July	diazinon	½	Foliage	As needed, but before leaves curl.
		dimethoate[1]	0.3		
		malathion	1		
Cabbage loopers	July-September	*Bacillus thuringiensis*	See rates on label	Foliage	When loopers are present.
		*fenvalerate[1]	0.1-0.2		
		*methomyl	0.45-0.9		
Corn earworms Corn borers Hornworms	July-September	carbaryl	2	Foliage	Add to weekly applications of fungicide sprays beginning at first fruit set when first small worms appear.
		*fenvalerate[1]	0.1-0.2		
		*methomyl[1]	0.45-0.9		
Mites	July-September	carbophenothion	1	Foliage	As needed.
		dicofol	½		
		malathion	1		
Russet mites	July-September	*parathion	0.4	Foliage	As needed.
		sulfur dust[2]	10		
		sulfur spray[2]	10		
Blister beetles (NHE-72)	June-September	carbaryl	1½	Foliage	As needed.
Fruit flies and picnic beetles	August-October	carbaryl	2	Foliage	When flies or beetles first appear.
		diazinon	½		

* Use restricted to certified applicators only. [1] Use cleared only on tomatoes. [2] No limitations on use.

PEPPERS

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Aphids (NHE-47)	May-July	dimethoate	0.3	Foliage	Only when aphids are present. Add to borer spray when it is being used.
		demeton	⅜		
		*methomyl	0.45		
		oxydemetonmethyl	½		
		acephate	½		
Corn borers	Late season	carbaryl	2	Foliage and fruit	When fruit is present on plant. Apply every 5 days when borers are present.
		acephate	1		
		carbofuran	2-3	Soilband to transplant	Make 2 applications; first, 3 weeks after transplant, second, 5 weeks later.

* Use restricted to certified applicators only.

ASPARAGUS

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Asparagus beetles (NHE-49)	Early and mid-season on spears and ferns	carbaryl[1]	1½	Spears and ferns	As needed, not more often than every 3 days.
		malathion[1]	1		
		rotenone[1]	0.2-0.4	Spears	As needed.

[1] One-day restriction between last application and harvest.

SWEET CORN

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Soil insects (NHE-26, 27, 43)	April-August	Counter	1	Row	Apply on soil surface behind planter shoe and ahead of press wheel. Rootworm control may be needed if the corn was not sprayed the previous year.
		Dyfonate	1		
		Furadan	1		
		Lorsban	1		
		Mocap	1		
		phorate	1		
Cutworms (NHE-38)	April-June	carbaryl[1]	2-3	Base of plants	When first damage appears.
		Lorsban 4E	1½	Broadcast	
Flea beetles (NHE-36)	April-July	carbaryl[1]	1½	Foliage	As necessary.
		carbofuran 15G	1	Soilband	
Japanese beetles (NHE-32)	July-September	carbaryl[1]	1	Ear zone	As necessary.
First-generation corn borers	June	carbaryl[1]	2	Foliage	If needed, make first application when tassel ratio is 30 to 40. Repeat in 4 to 5 days.
Second-generation corn borers and corn earworms[2] (NHE-33)	June-September	carbaryl[1]	2	Ear zone	*Fresh market corn:* At first silk and every 2 to 4 days for 5 to 8 applications. *Canning corn:* Observe light traps for earworm and borer adults, or keep a record of the heat units. When 1,500 or more heat units have accumulated, begin a spray program. As an alternative, begin at 30 to 50% silk and every 3 to 5 days thereafter until the corn is within 8 to 12 days of harvest.
		carbofuran 4F[3]	½		
		*fenvalerate	0.1-0.2		
		*methomyl	0.45		
		*permethrin	0.1-0.2		
Sap beetles (NHE-10) Picnic beetles	July-September	carbaryl[1]	2	Foliage	When adults first appear in field; usually between pollen-shedding and silk-drying.
		diazinon	1		
		malathion	1		
		*parathion	½		
Corn leaf aphids (NHE-29)	July-September	malathion	1	Foliage	As needed to produce attractive ears for fresh market.
		*parathion	½		
Fall armyworms	July-September	*methomyl	0.45	Foliage	Apply to ear zone when whorl feeding is evident.
		*parathion	½		

* Use restricted to certified applicators only.

[1] During pollen shed, apply carbaryl as late in the day as possible (preferably after 4 p.m.) to reduce bee kill. [2] Adding 0.5 to 0.75 pound of parathion or 0.25 to 0.45 pound of methomyl to carbaryl improves earworm control. [3] Corn borer control only.

ONIONS

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Onion maggots (NHE-50)	All season	diazinon W.P.	½-1 for 40-50 lb. of seed	Seed	Seed treatment for set onions only. Use lighter dosage of diazinon on sandy, highly mineral soils.
		ethion W.P.	1 for 40-50 lb. of seed		
		Dasanit granules	1	Furrow	Use 1 lb. active ingredient per acre for rows 12″ apart; ¾ lb. for rows 18″ apart; ½ lb. for rows 24″ apart. Up to twice these amounts are needed for ethion on muck soils. Do not use Dasanit, Dyfonate, or Lorsban on green onions.
		diazinon granules	½-1		
		Dyfonate	1		
		ethion granules	½-2		
		Lorsban granules	1		
		diazinon	2	Broadcast	Preplanting; disk into upper 1 to 2 inches of soil. Supplement with foliage spray below.
		diazinon	⅓	Foliage	Supplemental to soil treatment. Make first application when first adult flies are seen; make another 1 week later. From then on only as necessary.
		malathion	1		
Thrips (NHE-48)	Midseason and late season	diazinon	½	Foliage	When injury first appears and every 10 days as necessary.
		malathion	1		
		*azinphosmethyl	½		

* Use restricted to certified applicators only.

POTATOES

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Flea beetles	May-July	carbaryl	1	Foliage	When damage first appears on the leaves. Repeat as needed.
		carbofuran granules	3	In furrow	Planting time.
		carbofuran spray	1	Foliage	As needed.
		fenvalerate	0.1	Foliage	As needed.
		*methomyl	0.45	Foliage	As needed.
		*permethrin	0.1	Foliage	As needed.
Colorado potato beetles; cutworms; potato leafhoppers (NHE-22)	May-July	carbaryl	2	Foliage	As needed.
		carbofuran granules	3	In furrow	Planting time.
		carbofuran spray	1	Foliage	As needed.
		dimethoate	0.3	Foliage	As needed.
		*fenvalerate	0.1	Foliage	As needed.
		*permethrin	0.1	Foliage	As needed.
		phorate granules	2-3	Soilband	Place on either or both sides of row at planting, but not in contact with seed. Use the lower rate on sandy soils, the heavier rate on heavy soils. Do not use on muck soils.
Aphids (NHE-47)	All season	dimethoate	0.3	Foliage	As needed.
		*methomyl	0.45		
		*parathion	¼		
		phorate granules	2-3	Soilband	Same as for leafhoppers.
Blister beetles (NHE-72)	All season	carbaryl	1½	Foliage	As needed.
Wireworms (NHE-43) White grubs (NHE-23)	All season	phorate granules	2-3	Soil	Preplanting, disk in; or use as soilband at planting.
Grasshoppers (NHE-74)	July-September	carbaryl	¾	Foliage	As needed, control in fence rows, roadsides, ditch banks, etc., before migration.
		dimethoate	0.3		

* Use restricted to certified applicators only.

PEAS

Insect	Time of attack	Insecticide	Pounds of active ingredient per acre	Placement	Timing of application
Caterpillars, including loopers	June	*methomyl	½-1	Foliage	Before harvest if worms are present.
		fenvalerate	0.1		
Aphids	May-June	dimethoate	⅓	Foliage	As needed.

* Use restricted to certified applicators only.

FOR ADDITIONAL INFORMATION

Obtain the following circulars on insect control from the Office of Agricultural Publications, University of Illinois, 47 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois 61801.

Circular 899, 1986 Insect Pest Management Guide — Field and Forage Crops

Circular 900, 1986 Insect Pest Management Guide — Home, Yard, and Garden

Circular 1076, 1986 Turfgrass Pest Control

Leaflets describing the life history, biology, and habits of some of the insects mentioned can be obtained from the offices of county Extension advisers or by writing to Entomology Extension, 172 Natural Resources Building, 607 E. Peabody Drive, Champaign, Illinois 61820. These are indicated by an NHE number in the tables.

FOR YOUR PROTECTION

Always handle insecticides with respect. The persons most likely to suffer ill effects from insecticides are the applicator and his family. Accidents and careless, needless overexposure can be avoided. Here are a few easy rules that if followed will prevent most insecticide accidents:

1. Wear rubber gloves when handling insecticide concentrates.
2. Do not smoke while handling or using insecticides.
3. Keep your face turned to one side when opening insecticide containers.
4. Leave unused insecticides in their original containers with the labels on them.
5. Store insecticides out of reach of children, irresponsible persons, or animals; store preferably in a locked cabinet.
6. Triple-rinse and bury or burn all empty insecticide containers or take to an approved sanitary landfill.
7. Do not put the water-supply hose directly into the spray tank.
8. Do not blow out clogged nozzles or spray lines with your mouth.
9. Wash with soap and water exposed parts of body and clothes contaminated with insecticide.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply to fish-bearing or other water supplies.
12. Do not apply insecticides, except in an emergency, to areas with abundant wildlife or to blossoming crops visited by bees. Avoid drift onto blossoming crops or onto bee hives.
13. Do not apply insecticides near dug wells or cisterns.
14. Do not spray when weather conditions favor drift.
15. Observe all precautions listed on the label.
16. To avoid bee kill, apply insecticides after bee activity has been completed for the day; use the least toxic materials. *Warn beekeepers that you are applying insecticides.*

1986 Insect Pest Management Guide for Commercial Applicators for Trees, Shrubs, and Turfgrass

Tree and Shrub Insects

Insect	Insecticide	Lb. of active ingredient per 100 gal. of water	Timing of application[a]
Aphids	acephate	1/2	When aphids are numerous.
	malathion	1	
	diazinon	1	
Ash borer	chlorpyrifos	1	Apply in early June and repeat 4 weeks later.
	endosulfan	1	
	acephate	1/2	
Bagworm	malathion	1	Spray foliage thoroughly about June 15 while worms are still small.
	carbaryl	1	
	chlorpyrifos	1/2	
	Bacillus thuringiensis	follow label directions	
	dimethoate	1/2	
	acephate	1/2	
Birch leaf miner	acephate	1 1/3	Spray foliage thoroughly when miners first appear. Repeat 10 to 12 days later.
	malathion	1	
	diazinon	1	
	dimethoate	1/4	
	chlorpyrifos	1	
Black vine weevil	endosulfan	1	Spray foliage thoroughly in mid-May when adults are on needles. Allow spray to run off onto soil under shrubs. Repeat twice at two-week intervals.
	acephate	1	
Bronze birch borer	dimethoate	1/2	Spray bark of trunk and limbs in late May and repeat 3 weeks later. Apply a 6-inch band of concentrate on trunk.
Cankerworms	acephate	1/2	Spray when worms are still small as leaf buds are opening in spring.
	malathion	1	
	diazinon	1	
	carbaryl	1	
	Bacillus thuringiensis	follow label directions	
Cicada	carbaryl	1	Spray foliage when egglaying begins. Repeat every 5 days while adult cicadas are present.

[a]Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Insect	Insecticide	Lb. of active ingredient per 100 gal. of water	Timing of application[a]
Cooley spruce gall aphid	malathion diazinon endosulfan	1 1 1	Apply in late September or in early spring just before buds swell.
Cottony maple scale	acephate malathion diazinon	2/3 1 1	Spray in July after crawlers have hatched and repeat 10 days later.
	superior oil	2 gallons	Apply in spring before leaf emergence. Do not use on Japanese or sugar maple.
Dogwood borer	endosulfan	1	Apply in mid-May and repeat 4 weeks later.
Eastern spruce gall aphid	malathion diazinon endosulfan chlorpyrifos	1 1 1 1	Apply in late September or in early spring just before buds swell.
Eastern tent caterpillar	acephate malathion diazinon *Bacillus thuringiensis* chlorpyrifos	1/2 1 1 follow label directions 1	Spray areas of tree where nests first appear in early spring.
Elm bark beetles	methoxychlor	...	Contact Section of Applied Botany and Plant Pathology, Illinois Natural History Survey, Urbana, Illinois 61801, for information on Dutch elm disease control.
Elm cockscomb gall	diazinon malathion	1 1	Usually no control is necessary.
Elm leaf beetle	carbaryl acephate diazinon	1 1/2 1	Apply when damage first appears, usually late May.
Eriophyid mites	dicofol	1/2	Spray only when injury is observed. Usually control is not necessary.
Euonymous scale	acephate dimethoate malathion diazinon	2/3 1 1 1	Spray in early June. Make four applications 10 to 12 days apart.

[a]Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Insect	Insecticide	Lb. of active ingredient per 100 gal. of water	Timing of application[a]
European elm scale	malathion	1	Apply in early spring when first leaves appear.
European pine sawfly	carbaryl chlorpyrifos diazinon	1 1 1	Spray when worms are present and feeding on the needles.
European pine shoot moth	dimethoate	1	Spray ends of branches thoroughly in late June.
Fall webworm	acephate carbaryl malathion diazinon *Bacillus thuringiensis* chlorpyrifos	1/2 1 1 1 follow label directions 1	Spray nests on webbed areas in trees in late summer. Do not apply acephate to crabapple.
Flat-headed apple tree borer	dimethoate	1/2	Spray in late May and repeat twice at 3-week intervals. Keep trees in vigorous growing condition. Wrap trunks of new set trees with paper or burlap.
Fletcher scale	malathion	1	Apply in early April and repeat in early June.
Forest tent caterpillar	acephate carbaryl malathion diazinon	1/3 1 1 1	Spray when caterpillars are present.
Gouty oak gall	...	...	Prune out infested branches and destroy.
Hackberry psyllids	malathion diazinon	1 1	Apply in late May. This insect rarely damages trees.
Hawthorn leaf miner	acephate malathion diazinon	2/3 1 1	Treat in early May or when first sign of leaf-browning appears.
Hawthorn mealy bug	malathion diazinon dimethoate	1 1 1/2	Apply when insects are numerous.
Holly leaf miner	dimethoate acephate	1/2 1/2	Spray foliage in late May or early June when leaf miners first appear.
Honeysuckle aphid	acephate dimethoate oxydemetonmethyl	1/2 1/2 3/4	Spray at time of first damage. Repeat 4 weeks later.

[a]Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Insect	Insecticide	Lb. of active ingredient per 100 gal. of water	Timing of application[a]
Lacebug	acephate	1/2	Spray when bugs are numerous.
	carbaryl	1	
	malathion	1	
Leaf crumpler	malathion	1	Spray in late May and again in late August.
	diazinon	1	
Leafhoppers	carbaryl	1	Spray when hoppers are numerous on foliage.
Lecanium scale	acephate	2/3	Apply to infested trees in mid-June and repeat 2 weeks later.
	diazinon	1	
	malathion	1	
Lilac borer	endosulfan	1	Apply in mid-May and repeat 4 weeks later.
	chlorpyrifos	1	
Locust borer	carbaryl	1	Apply in late August and again in mid-September.
	chlorpyrifos	1	
Locust mite	dicofol	1/2	Apply in early spring just before leaves appear. Repeat spray 2 weeks later.
Magnolia scale	malathion	1	Treat in late September or early spring when buds are opening.
	diazinon	1	
Maple bladder gall	dicofol	1/2	Chemical control usually is not necessary. If infestation has been severe, spray tree as leaf buds are opening in spring.
Mimosa webworm	acephate	1/2	Spray in early July or when webs first appear. Repeat in August for second generation.
	malathion	1	
	diazinon	1	
	Bacillus thuringiensis	follow label directions	
	carbaryl	1	
	chlorpyrifos	1	
Mountain ash borer	chlorpyrifos	1	Treat in early June and repeat 4 weeks later.
	endosulfan	1	
Nantucket pine moth	acephate	1/2	Spray ends of branches in mid-April and late June.
	dimethoate	1	
Oak kermes	malathion	1	Apply when crawlers appear on foliage in early July.
	diazinon	1	
Obscure scale	superior oil	2 gallons	Apply in late October or in early spring just prior to leaf emergence.

[a]Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Insect	Insecticide	Lb. of active ingredient per 100 gal. of water	Timing of application[a]
Oystershell scale	malathion dimethoate chlorpyrifos	1 1/2 1	Apply in early June and repeat 10 to 12 days later. Repeat sprays again in early August in central and southern Illinois.
Peach tree borer	endosulfan chlorpyrifos	1 1	Spray thoroughly bark of trunk and limbs in mid-June and repeat 4 weeks later.
Periodical cicada	carbaryl	1	Spray when adults are laying eggs in June.
Pine bark aphid	malathion diazinon acephate	1 1 1/3	Spray when aphids are present, usually in May and later. Add spreader.
Pine needle scale	acephate malathion diazinon chlorpyrifos	1/2 1 1 1	Apply spray in late May if trees are infested.
San Jose scale	superior oil	2 gallons	Apply to bark of trunk and limbs in spring prior to leaf emergence.
Spider mites	dicofol Vendex	1/2 1/2	Spray when mites are numerous. Especially serious on juniper.
Spittle bug			No chemical control is necessary.
Taxus mealy bug	acephate malathion diazinon	1/2 1 1	Spray foliage with force when insects are present. Repeat 2 weeks later.
Thrips	malathion acephate	1 1/2	Spray privet when thrips are numerous.
Tuliptree scale	superior oil malathion	2 gallons 1	Apply oil in late spring before leaves emerge. Apply malathion in mid-August.
Twig pruner			No known chemical control.
White-marked tussock moth	malathion carbaryl diazinon	1 1 1	Treat when worms are present in June.
Yellow-necked caterpillar	malathion diazinon acephate chlorpyrifos	1 1 1/2 1	Spray foliage on which caterpillars are feeding, usually in late July.
Zimmerman pine moth	dimethoate chlorpyrifos	1 1	Spray bark and foliage either in April or mid-August.

[a]Treatment dates are listed for central Illinois. In southern Illinois apply 2 weeks earlier and in northern Illinois 2 weeks later.

Turfgrass Insects

Insects	Insecticide	Lb. of active ingredient per acre	Timing of application
Ants and soil-nesting wasps	diazinon spray	4	Apply when insects are present.
Aphids (greenbug)	acephate	2	Apply only when aphids are present.
	malathion spray	1	
	diazinon spray	1	
	chlorpyrifos spray	1	
Armyworms and cutworms	carbaryl spray or granules	8	Treat when worms are present.
	trichlorfon spray or granules	5	
	chlorpyrifos spray or granules	1	
Chiggers	diazinon	1	Apply to grass area where chiggers have been a problem.
	malathion	1	
Chinch bugs	chlorpyrifos spray	1	Spray when bugs are numerous.
	trichlorfon spray	5	
	diazinon spray	4	
Grubs, including true white, annual white, Japanese beetle, green June beetle	diazinon spray or granules	5	Treat damaged areas and where grubs are present in soil. Water-in very thoroughly immediately after spray application and soon after granular application.
	trichlorfon spray or granules	8	
	isofenphos granules	2	
	bendiocarb spray	2	
Leafhoppers and grasshoppers	carbaryl spray	4	Treatment usually is not necessary unless hoppers are numerous.
Millipedes	carbaryl spray	8	Apply to turf where millipedes are migrating across area.
	diazinon spray	4	
Slugs	Mesurol bait		Apply by scattering in grass.
Sod webworms	carbaryl spray or granules	8	Apply in late July or August when worms are present. Use 120 gallons of water per acre.
	diazinon spray or granules	4	
	chlorpyrifos spray or granules	1	
	trichlorfon spray or granules	5	

Insecticides: Names and Some Commercial Formulations

Common name	Trade names	Formulations
acephate[a]	Orthene	75% S.
azinphosmethyl	Guthion	50% W.
Bacillus thuringiensis	Bactur, Dipel, Thuricide, SOK-BT	
bendiocarb	Turcam, Dicarb	76% W.
carbaryl[b]	Sevin	80% S. 50% W.
chlorpyrifos	Dursban	2 lb./gal. 4 lb./gal. 50% W.
diazinon[c]	Spectracide, Diazinon	4 lb./gal. 25% E.C. 50% W. 14% G., 5% G.
dicofol	Kelthane	18.5% E.C. 18.5% W.
dimethoate[d]	Cygon, De-Fend	2 lb./gal. 25% W.
endosulfan	Thiodan	2 lb./gal. E.C. 50% W.
isofenphos	Oftanol	5% G., 1.5% G., 2 lb./gal.
malathion[e]	Cythion	50-57% E.C. 25% W.
oxydemetonmethyl	Metasystox-R	25% E.C.
superior oil[f]	many brands	...
trichlorfon	Dylox, Proxol	80% W. 4 lb./gal.
	Imidan	50% W.
	Vendex	50% W.

[a]Do not use on sugar or Japanese maple, American elm, flowering crab, redbud, cottonwood, or Lombardy poplar.
[b]Do not use on Boston ivy.
[c]Do not use on ferns or hibiscus.
[d]Do not use on chrysanthemums.
[e]Do not use on canaert red cedar.
[f]Do not use on conifers, ferns, sugar maple, or Japanese maple.
Note: E.C. = emulsion concentrate; W. = wettable powder; G. = granules; S. = sprayable powder.

The above-named insecticides (except Guthion) are *not* in the restricted-use category, which would require an applicator to be certified before purchasing or using the insecticide.

Insecticide Formulations and Toxicities

The following list of insecticides is intended for use as a quick reference of insecticide names, toxicities, and formulations. In addition to the insecticides recommended in the Insect Pest Management Guides, we have included some that have label approval but are not in the Illinois recommendations and some that are still experimental compounds.

The index of trade names of insecticides, listed alphabetically, will allow you to quickly find the appropriate common name. Within the body of the reference, the approved common names are also listed alphabetically in the left-hand column. Trade names, formulations, toxicities, and signal words are listed for each product.

Acute oral toxicity ratings are usually obtained by feeding white rats; acute dermal ratings are determined by skin absorption tests on rats or rabbits. These figures are expressed as LD_{50}. This term indicates the size of the dose that is lethal to 50 percent of the test animals. LD_{50} is expressed as milligrams (mg) of actual insecticide per kilogram (kg) of body weight of the test animal--mg/kg. Because test results vary, an LD_{50} may be expressed as a range of values rather than a single value.

By multiplying the LD_{50} value times 0.003, you can approximate the ounces of actual insecticide required to be lethal to one of every two 187-pound men or other warm-blooded animals. As an example, an oral LD_{50} value for malathion is 1,200 mg/kg; thus, if a group of men each weighing 187 pounds ate 3.6 ounces (1,200 times 0.003) of actual malathion per man, half of them would probably succumb. The dermal-toxicity-LD_{50} value of malathion is approximately 4,000 mg/kg, or, for a 187-pound man, 12 ounces. If you check the list of insecticides, you will find some highly toxic chemicals with LD_{50} values from 1 to 10 mg/kg. For the average man, fatal doses of those chemicals would be in the range of 0.003 to 0.03 ounce.

By comparison, the oral LD_{50} value of aspirin is 1,200 mg/kg, or 3.6 ounces per 187-pound man, the equivalent of malathion. The oral LD_{50} value of ethyl alcohol is 4,500 mg/kg. If a group of 187-pound men each consumed somewhat more than 1 quart of 80 proof whiskey in 45 minutes, they would not only be intoxicated; 50 percent of them might die.

These toxicity ratings are approximate and pertain to white rats and sometimes rabbits. Such ratings, however, do serve as a guide for comparing the toxicities of insecticides as well as an indication of their comparative acute toxicities to other warm-blooded animals and man. Acute toxicity ratings expressed as LD_{50} are classified as to their relative danger when being used. An acute oral LD_{50} of 500 mg/kg or higher is rated as low toxicity; an LD_{50} rating of 50 to 500 is moderate; and 50 or less is high.

When available, toxicity ratings of insecticides to fish, birds, and honey bees are also given. Those for bees can be interpreted readily as follows: (1) high--kills bees on contact and by residues; bees should be removed from area of application; (2) moderate--kills bees if applied over them; limited damage with correct dosage, timing, and method of application; (3) low--can be used around bees with few precautions and a minimum of injury.

Remember, this is NOT a list of recommended insecticides, nor is it to be used in determining what insecticide to use to control a particular insect. This list is a quick insecticide reference to compare common chemical names with trade names and to determine their toxicity ratings and general use.

INDEX: INSECTICIDE TRADE NAMES

Trade Name	Common Name
Aastar	combination of phorate and flucythrinate
Abate	temephos
Actellic	pirimiphos-methyl
Alfa-tox	combination of diazinon and methoxychlor
Alleviate	allethrin
Altosid	methoprene
Ambush	permethrin
Ammo	cypermethrin
Atroban	permethrin
Attac	toxaphene
Azodrin	monocrotophos
Bactur	Bacillus thuringiensis
Baygon	propoxur
Baytex	fenthion
Baythroid	cyfluthrin
Bidrin	dicrotophos
Black Leaf 40	nicotine
Broot	trimethacarb
Ciodrin	crotoxyphos
Ciovap	combination of crotoxyphos and dichlorvos
Co-Ral	coumaphos
Comite	propargite
Counter	terbufos
Cygon	dimethoate
Cymbush	cypermethrin
Cythion	malathion
Dasanit	fenulfothion
DBP	dibutyl phthalate
DDVP	dichlovos
De-Fend	dimethoate
Delnav	dioxathion
Derris	rotenone
Detia	aluminimum phosphide
Dibrom	naled
Dimecron	phosphamidon
Dimilin	diflubenzuron
Dipel	Bacillus thuringiensis
Di-Syston	disulfoton
DNOC	dinitro compounds
Doom	Bacillus thuringiensis
Dowfume	methyl bromide
Dursban	chlorpyrifos
Dycarb	bendiocarb
Dyfonate	fonofos
Dylox	trichlorfon
D'Z'N	diazinon
Ecopro	temephos
Ectiban	permethrin
Ectrin	fenvalerate
EDC	ethylene dichloride
Elgetol	dinitro compounds
Entex	fenthion
Famphos	famphur
Ficam	bendiocarb
Fumitoxin	aluminum phosphide
Furadan	carbofuran
Gardona	tetrachlorvinphos
Gastoxin	aluminum phosphide
Grasshopper spore	Nosema locustae
Guardian	flucythrinate
Guthion	azinphosmethyl
HCN	hydrocyanic acid
Imidan	phosmet
Karathane	dinocap
Kelthane	dicofol
Knox Out	diazinon
Korlan	ronnel
Lance	cloethocarb
Lannate	methomyl
Larvin	thiodicarb
Larvadex	cyromazine
Lorsban	chlorpyrifos
Marlate	methoxychlor
Mavrik	fluvalinate
Mesurol	methiocarb

Trade Name	Common Name
Metasystox-R	oxydemetonmethyl
Mocap	ethoprop
Monitor	methamidophos
Morestan	oxythioquinox
Morocide	binapacryl
Neo Pynamin	tetramethrin
Nudrin	methomyl
Off	deet
Oftanol	isofenphos
Omite	propargiet
Orthene	acephate
Pay-Off	flucythrinate
PDB	paradichlorobenzene
Penncap-M	methyl parathion (encapsulated
Pentac	dienochlor
Phosdrin	mevinphos
Phostoxin	aluminum phosphide
Phthalthrin	tetramethrin
Plictran	cyhexatin
Pounce	permethrin
Premgard	resmethrin
Prolate	phosmet
Proxol	trichlorfon
Pydrin	fenvalerate
Pynamin	allethrin
Pyretherm	resmethrin
Rabon	tetrachlorvinphos
Ravap	combination of dichlorvos and tetrachlorvinphos
Reldan	chlorpyrifos-methyl
Savit	carbaryl
Scout	tralomethrin
Sevin	carbaryl
SOK-BT	Bacillus thuringiensis
Spectracide	diazinon
Spur	fluvalinate
Stirofos	tetrachlorvinphos
Supracide	methidathion
Synthrin	resmethrin
Systox	demeton
Tedion	tetradifon
Temik	aldicarb
Tetralate	combination of tetramethrin and resmethrin
Thimet	phorate
Thiodan	endosulfan
Thuricide	Bacillus thuringiensis
Tiguvon	fenthion
Tiovel	endosulfan
Trigard	cyromazine
Trithion	carbophenothion
Turcam	bendiocarb
Vapona	dichlorvos
Vendex	fenbutatin-oxide
Vydate	oxamyl
Warbex	famphur
Zectran	mexacarbate
Zolone	phosalone

INSECTICIDE FORMULATIONS AND TOXICITIES

Generic name	Trade name	Formulations[a]	Toxicity to[b]			Acute LD_{50}[c]		Signal word
			Fish	Bee	Bird	Oral	Dermal	
acephate	Orthene	75 SP	L	H	M	866-945	2,000	caution
aldicarb	Temik	10G, 15G	-	H	M	1	2.5-3	danger
allethrin	Alleviate, Pynamin	many	H	L	L	680-1,000	11,200	caution
aluminum phosphide	Detia, Fumitoxin, Gastoxin, Phostoxin	55% tablets, pellets	-	-	-	AV[d] 2,000 ppm		danger
aspon	Aspon	2E, 6E, 5G	-	-	VL	2,710-5,010	...	caution
azinphosmethyl	Guthion	2S, 2L, 50WP	VH	H	M	11-16	220	danger
Bacillus popilliae	Doom	WP	EL	EL	EL	...	...	caution
Bacillus thuringiensis	Bactur, Dipel, SOK-BT, Thuricide, others	suspension, WP, bait	EL	EL	EL	>20,000	>20,000	caution
bendiocarb	Dycarb, Ficam Turcam	29 and 76WP, 1D, 25% oil suspension	-	-	-	179	1,000	warning
benzyl benzoate	...	30L	-	-	-	500-5,000	...	caution
binapacryl	Morocide, others	25 and 50WP, 40EC, 4D, 50WD	H	L	-	161	1,350	warning
carbaryl	Savit, Sevin	XLR, 4-oil, 80S, 50W, 4F, Bait	VL	H	VL	307-986	500-4,000	caution
carbofuran	Furadan	3G, 5G, 10G, 15G, 4F	M	H	M	8-44	>1,000	warning danger
carbon disulfide	...	liquid fumigant	-	-	-	AV 200 ppm CV[d] 20 ppm		warning
carbon tetrachloride	...	liquid fumigant	-	-	-	5,730-9,770 AV 300 ppm CV 10 ppm	5,070-8,780	warning
carbophenothion	Trithion	8E	VH	H	-	6-100	22-66	warning
chlordane	...	G, D, WP, EC, oil	VH	M	M	283-590	580-1,600+	warning
chloropicrin	several	liquid fumigant	-	-	-	AV 20 ppm CV 0.1 ppm		danger
chlorpyrifos	Dursban, Lorsban	2E, 4E, 15G, 50W, 50SL, others	VH	H	H	82-245	2,000	caution warning
chlorpyrifos-methyl	Reldan	4E	-	-	-	2,000-3,000	3,700	warning
cloethocarb	Lance	15G	-	-	-	35	>2,500	warning
coumaphos	Co-Ral	25WP, pour-on, EC, D, F	M	M	H	13-963	860-1,000+	warning danger
crotoxyphos	Ciodrin	EC, D, oils	H	H	-	74-125	302-375	danger
cyfluthrin	Baythroid	0.05G, 2E	VH	H	L	590	5,000	caution
cyhexatin	Plictran	50W	VH	L	-	540	>2,000	warning
cypermethrin	Ammo, Cymbush	EC	VH	H	L	4,123	>1,000	warning
cyromazine	Larvadex, Trigard	0.3% feed premix, 75WP (insect growth regulator)	-	-	-	3,387	>3,100	caution

INSECTICIDE FORMULATIONS AND TOXICITIES

Generic name	Trade name	Formulations[a]	Toxicity to[b] Fish	Bee	Bird	Acute LD_{50}[c] Oral	Dermal	Signal word
deet	Off	in alcohol	-	-	-	1,950-2,000	10,000	caution
demeton	Systox	2E, 6E	M	M	M	2-12	8-14	danger
diazinon	D·Z·N, Knox Out, Spectracide	4E, 14G, 50W, AG500, 2F	H	H	H	66-600	379-1,200	caution warning
dibutyl phthalate	DBP	liquid repellent	-	-	VL	8,000	...	caution
dichlorvos	DDVP, Vapona, others	many	M	H	M	25-170	59-900	danger
dicofol	Kelthane	1.6EC, 35WP	M	L	L	575-1,331	1,000-1,230	caution
dicrotophos	Bidrin	8M	-	H	H	16-75	42-43	danger
dienochlor	Pentac	4F, 50WP	-	-	L	3,160	>3,160	warning
diflubenzuron	Dimilin	25W, 4G	VL	-	VL	>4,640	>2,000	caution
dimethoate	Cygon, De-Fend	400(4E), 2.67E	VL	H	M	28-500	150-1,150	warning
dinitro compounds	DNOC, Elgetol, others	WP, F, flakes, salts	-	-	-	37-50	80-200	danger
dinocap	Karathane	WP, LC, D	-	-	L	980-1,190	>4,700	caution
dioxathion	Delnav	EC	H	M	VL	19-176	53-350	danger
disulfoton	Di-Syston	8E, 15G	M	M	M	2-12	6-15	danger
endosulfan	Thiodan, Tiovel	2EC, 3EC, 50WP	VH	M	M	18-43	74-130	warning danger
endrin	Endrin	1.6E, WP, D	VH	M	VH	3-45	12-19	danger
EPN	EPN	2G, 4G, 4E, 5E	H	H	M	7-65	22-262	warning danger
ethion	Ethion	8E, 5G, 4M, superior 70 oil, 25WP	H	M	VL	27-119	62-245	warning
ethoprop	Mocap	10G, 15G, 6E	-	M	M	61	26	warning danger
ethylene dichloride	EDC	liquid fumigant	-	-	-	670-890	... AV 1,000 ppm CV 50 ppm	danger
eugenol	...	attractant	-	-	-	500-5,000	...	...
famphur	Famphos, Warbex	pour-on	-	H	H	35-62	1,460-5,093	danger
fenbutatin-oxide	Vendex	50WP, 4L	-	-	-	2,631	>2,000	danger
fensulfothion	Dasanit	15G, spray concentrate	-	H	H	2-10	3-30	danger
fenthion	Baytex, Entex, Tiguvon	pour-on, spray concentratte	L	H	VH	255-740	300-400	warning
fenvalerate	Ectrin, Pydrin	2.4EC, 10L	H	H	L	451	>5,000	caution warning
flucythrinate	Guardian, Pay-Off	2.5EC	VH	H	L	67	>1,000	danger
fluvalinate	Mavrik, Spur	2E, 23.3F	-	-	-	260-280	20,000	danger
fonofos	Dyfonate	4E, 10G, 20G	-	M	M	8-16	147	danger warning

INSECTICIDE FORMULATIONS AND TOXICITIES

Generic name	Trade name	Formulations[a]	Toxicity to[b]			Acute LD_{50}[c]		Signal word
			Fish	Bee	Bird	Oral	Dermal	
geraniol	...	attractant	-	-	-	...	...	...
gyplure	...	attractant	-	-	-	...	...	...
hydrocyanic acid	HCN	liquid fumigant	-	-	-	4 AV 40 ppm CV 10 ppm	...	danger
isofenphos	Oftanol	G, EC	-	-	-	28-38	162-315	danger
lead arsenate	...	...	-	H	L	1,050	>2,400	danger
lindane	several	many	H	H	M	76-200	500-1,200	warning
malathion	Cythion, Malathion, others	57EC, ULV, others	M	H	L	885-2,800	4,000-4,444+	caution
metaldehyde	several	bait	-	-	-	630	...	caution warning
methamidophos	Monitor, others	4L	-	H	-	13-30	110	danger
methidathion	Supracide	2E	H	H	M	25-48	375	danger
methiocarb	Mesurol	75WP, bait, powder	-	H	L	130-135	>2,000	warning
methomyl	Lannate, Nudrin	90SP, 1.8L, 2.4LV	M	H	L	17-24	1,500	danger
methoprene	Altosid, others	EC, bait	VL	L	VL	34,600	3,038-3,500+	caution
methoxychlor	Marlate	many	VL	M	VL	5,000-7,000	2,820	caution
methyl bromide	Dowfume, others	liquid fumigant	-	-	-	AV 200 ppm CV 20 ppm		danger
methyl parathion	...	EC, WP, D	VL	H	H	9-42	63-72	danger
methyl parathion (encapsulated)	Penncap-M	2F	VL	H	H	270-480	5,400	warning
mevinphos	Phosdrin	4EC, 10.3WS	VH	H	-	3-7	3-90	danger
mexacarbate	Zectran	2E, 25W	-	-	-	24	...	warning danger
MGK-R11	...	repellent	-	-	-	2,500	...	caution
MGK-R326	...	repellent	-	-	-	5,230-7,230	...	caution
monocrotophos	Azodrin	5M	-	-	-	8-23	354	danger
naled	Dibrom	8E, oil	H	H	L	250-430	800	danger
nicotine	Black Leaf 40, others	40S	-	-	L	50-91	140-285	danger
Nosema locustae	Grasshopper spore	WP, bait	EL	EL	EL	>5,000	...	caution
oxamyl	Vydate	2L	-	-	-	5-6	740-2,960	danger
oxydemeton methyl	Metasystox-R	2E	VH	M	M	47-75	100-250	warning
oxythioquinox	Morestan	25WP	-	L	-	1,100-3,000	>2,000	caution
paradichlorobenzene	PDB	fumigant (crystals, liquid)	-	-	-	500-5,000	2,000	warning
parathion	several	EC, WP, D, oils	H	H	H	3-30	4-200	danger

INSECTICIDE FORMULATIONS AND TOXICITIES

Generic name	Trade name	Formulations[a]	Toxicity to[b]			Acute LD_{50}[c]		Signal word
			Fish	Bee	Bird	Oral	Dermal	
permethrin	Ambush, Atroban, Ectiban, Pounce	2E, 3.2EC, 5.7EC, 25WP	VH	H	L	2,000-4,000+	4,000	warning danger
phorate	Thimet	20G	VH	H	M	1-5	2-300	danger
phosalone	Zolone	3EC, 25WP	H	M	-	125-180	1,500	warning
phosmet	Imidan, Prolate	50WP	H	H	L	113-299	1,550	warning
phosphamidon	Dimecron	8L, soluble concentrates	L	H	VH	15-33	107-150	danger
piperonyl butoxide	...	synergist	VH	-	-	>6,150	>7,950	caution
pirimiphos-methyl	Actellic	EC, ULV, D, aerosols, RTU	-	-	-	2,000	>4,592	caution
propargite	Comite, Omite	6.55EC, 6E, 30W	-	L	-	1,480-2,200	250-680	danger
propoxur	Baygon, others	1.5E, 2% bait, 70WP	-	H	L	83-104	>1,000	warning
pyrethrum	...	flower extract	H	L	VL	200-2,600	>1,800	caution
resmethrin	Premgard, Pyretherm, Synthrin	many	VH	H	VL	1,500	2,500-3,040+	caution
ronnel	Korlan	2E, 5G	M	M	-	906-3,025	>5,000	caution
rotenone	Derris, others	many	VL	L	L	60-1,500	1,000-3,000+	caution
temephos	Abate, Ecopro	4E, G	L	M	M	1,000-1,300	>4,000	caution
terbuphos	Counter	15G	H	M	H	4-9	25	danger
tetrachlorvinphos	Gardona, Rabon, Stirofos	50WP, 75WP, 3D, EC	-	H	VL	4,000-5,000	>5,000	caution
tetradifon	Tedion	EC, WP, smokes	M	L	VL	>5,000	>10,000	caution
tetramethrin	Neo Pynamin, Phthalthrin	25EC	-	-	-	4,640	...	caution
thiodicarb	Larvin	3.2F	-	M	-	66	>2,000	warning
toxaphene	Attac	4E, 6E, 8E	VH	M	M	40-283	600-1,613	warning danger
tralomethrin	Scout	EC	VH	-	-	1,070	>2,000	caution
trichlorfon	Dylox, Proxol, others	many	L	M	M	450-630	>2,000	warning
trimethacarb	Broot	15GX	-	-	-	178-232	>2,000	caution

[a]Formulations: D, dust; E, EC, emulsifiable concentrate; F, flowable; G, granules; L, liquid solution; LC, liquid concentrate; LV, low volume; M, miscible; RTU, ready to use; S, solution; SL, slurry; SP, soluble powder; ULV, ultra low volume; W, WP, wettable powder; WD, water dispersion; WS, water soluble; XLR, extra long residual.
[b]Toxicity to fish, bees, and birds: L, low; M, moderate; H, high; EL, extremely low; VH, very high; VL, very low.
[c]LD_{50} - based on technical grade.
[d]AV - acute vapor (1 hr); CV - chronic vapor (40 hr)

1986 Row Crop Weed Control Guide

This guide is based on the results of research conducted by the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture. Consideration has been given to the soils, crops, and weed problems of Illinois.

The effectiveness of herbicides is influenced by rainfall, soil factors, weed spectrum, method of application, and formulation. Under certain conditions some herbicides may damage the crops to which they are applied. In some cases, herbicide residues in the soil may damage crops that are grown later.

Precautions

When selecting a herbicide, consider both the risk involved in using the herbicide and the yield losses caused by weeds. You can reduce risks by taking the following precautions:

- Apply herbicides only to those crops for which use has been approved.
- Clean tanks thoroughly when changing herbicides, especially when using a postemergence herbicide. Use a 1 percent ammonia wash to clean out traces of 2,4-D or dicamba from the tank before spraying soybeans.
- Correctly calibrate the sprayer and check the nozzle output and adjustment before adding herbicide to a tank.
- Use recommended rates. Applying too much herbicide is costly and in addition may damage crops and cause illegal residues. Using too little herbicide can result in poor weed control.
- Apply herbicides only at times specified on the label. Observe the recommended intervals between treatment and pasturing or harvesting of crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label.
- Guard against drift injury to nearby susceptible plants, such as soybeans, grapes, and tomatoes. Mist or vapors from 2,4-D and dicamba sprays may drift several hundred yards. When possible, operate sprayers at low pressure with tips that deliver large droplets. Spray only on calm days or make sure that wind is not moving toward susceptible crop plants and ornamentals.
- Apply herbicides only when all animals and persons not directly involved in the application have been removed from the area. Avoid unnecessary exposure.
- Check the label for the proper method of container disposal. Triple rinse, puncture, and haul metal containers to an approved sanitary landfill. Haul paper containers to a sanitary landfill or burn them in an approved manner.
- Return unused herbicides to a safe storage place promptly. Store them in the original containers away from unauthorized persons, particularly children.
- Since formulations and labels are sometimes changed and government regulations modified, always refer to the most recent product label.

This guide has been developed to help you use herbicides as effectively and safely as possible. However, since no guide can remove all the risk involved, the University of Illinois and its employees assume no responsibility for the results of using herbicides, even if they have been used according to the suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Cultural and Mechanical Control

Good cultural practices that aid in weed control include adequate seedbed preparation, adequate fertilization, crop rotation, planting on the proper date, use of the optimum row width, and seeding at the rate required for optimum stands.

Planting in relatively warm soils helps crops compete better with weeds. Good weed control during the first 3 to 5 weeks is extremely important for both corn and soybeans. If weed control is adequate during that period, corn and soybeans will usually compete quite well with most of the weeds that begin growing later.

Narrow rows will shade the centers faster and help the crop compete better with the weeds. However, if herbicides alone cannot give adequate weed control, then keep rows wide enough to allow for cultivation. Some of the newer herbicides are improving the chances of achieving adequate control without cultivation.

If a preemergence or preplant herbicide does not ap-

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pear to be controlling weeds adequately, use the rotary hoe while weeds are still small enough to be controlled.

Use the rotary hoe after weed seeds have germinated but before most weeds have emerged. Operate it at 8 to 12 miles per hour and weight it enough to stir the soil and kill the tiny weeds. Rotary hoeing also aids crop emergence if the soil is crusted.

Row cultivators also should be used while weeds are small. Throwing soil into the row can help smother small weeds. Cultivate shallow to prevent injury to crop roots.

Herbicides can provide a convenient and economical means of early weed control and allow for delayed and faster cultivation. Furthermore, unless the soil is crusted, it is usually not necessary to cultivate at all when herbicides are controlling weeds adequately.

Herbicide Incorporation

Soil-applied herbicides are incorporated to minimize surface loss, reduce dependence upon rainfall, and provide appropriate placement of the herbicide. Sutan+ and Eradicane are incorporated soon after application to minimize surface loss from volatilization. Treflan and Sonolan are incorporated within a few hours to minimize loss due to photodecomposition and volatilization. Triazine herbicides such as atrazine and Bladex and acetamide herbicides such as Lasso and Dual may be incorporated to minimize dependence upon timely rainfall, but since these herbicides are not lost as quickly from the soil surface, the time of incorporation is less critical.

Incorporation should place the herbicide uniformly in the top 1 or 2 inches of soil for best control of small-seeded annual weeds that germinate from shallow depths. Slightly deeper placement may improve the control of certain weeds from deep-germinating seed under relatively dry conditions. The field cultivator and tandem disk place most of the herbicide at about one-half the depth of operation. Thus for most herbicides the suggested depth of operation is 3 to 4 inches.

Thorough incorporation with ground-drive implements may require two passes. Single-pass incorporation may result in streaked weed control, especially in wet soils. Single-pass incorporation may be adequate with some equipment, especially if rotary hoeing, cultivation, or subsequent herbicide treatments are used to improve weed control. If the herbicide is sufficiently covered to prevent surface loss with the first pass, the second pass can be delayed until immediately before planting.

The depth and thoroughness of incorporation depend upon the type of equipment used, the depth and speed of the operation, soil texture, and soil moisture. Field cultivators and tandem disks are commonly used for incorporation. However, disk-chisels and other combination tools are being used in some areas.

Field Cultivators

Field cultivators are frequently used for herbicide incorporation. They should have three or more rows of shanks with an effective shank spacing of no more than 8 to 9 inches (a spacing of 24 to 27 inches on each of three rows). The shanks can be equipped with points or sweeps. Sweeps usually give better incorporation, especially when soil conditions are a little too wet or dry for optimal soil flow and mixing. Sweeps for "C" shank cultivators should be at least as wide as the effective shank spacing.

The recommended operating depth for the field cultivator is 3 to 4 inches. It is usually necessary to operate it only deep enough to remove tractor tire depressions. The ground speed should be at least 6 miles per hour. The field cultivator must be operated in a level position so that the back shanks are not operating in untreated soil, which would result in streaked weed control. Two passes are recommended to obtain uniform weed control. If single-pass incorporation is preferred, the use of wider sweeps or narrower spacing with a 3- to 5-bar harrow or rolling baskets pulled behind will increase the probability of obtaining adequate weed control.

Tandem Disks

Tandem disk harrows invert the soil and usually place the herbicide deeper in the soil than most other incorporation tools. Tandem disks used for herbicide incorporation should have disk blade diameters of 20 inches or less and blade spacings of 7 to 9 inches. Larger disks are considered primary tillage tools and should not be used for incorporating herbicides. Spherical disk blades give better herbicide mixing than conical disk blades.

Tandem disks usually place most of the herbicide in the top 50 to 60 percent of the operating depth. For most herbicides, the suggested operating depth is from 3 to 4 inches. Two passes are recommended to obtain uniform mixing with a double disk. A leveling device (harrow or rolling baskets) should be used behind the disk to obtain proper mixing. Recommended ground speeds are usually between 4 and 6 miles per hour. The speed should be sufficient to move the soil the full width of the blade spacing. Lower speeds can result in herbicide streaking.

Combination Tools

Several new tillage tools combine disk gangs, field cultivator shanks, and leveling devices. Many of these combination tools can handle large amounts of surface residue without clogging and yet leave considerable crop residue on the soil surface for erosion control. Results indicate that these combination tools may provide more uniform one-pass incorporation than does a disk or field cultivator, but one pass with them is generally no better than two passes with the disk or field cultivator.

Chemical Weed Control

Plan your weed-control program to fit your soils, tillage program, crops, weed problems, and farming operations. Herbicide performance depends on the weather and on wise selection and application. Your decisions on herbicide use should be based on the nature and serious-

ness of your weed problems. The herbicide selectivity table at the end of this guide indicates the susceptibility of our most common weed species to herbicides.

Corn or soybeans may occasionally be injured by some of the herbicides registered for use on those crops. To reduce crop injury, apply the herbicide at the time specified on the label and at the correct rate (see section entitled "Herbicide Rates"). Crop tolerance ratings for various herbicides are also given in the table at the end of this guide. Unfavorable conditions such as cool, wet weather, delayed crop emergence, deep planting, seedling diseases, poor soil physical conditions, and poor-quality seed may contribute to crop stress and herbicide injury. Hybrids and varieties also vary in their tolerance to herbicides and environmental stress factors. Once injured by a herbicide, plants are prone to disease.

Crop planting intentions for the next season must also be considered. Where atrazine or simazine are used, you should not plant spring-seeded small grains, small-seeded legumes and grasses, or vegetables the following year. Be sure that the application of Treflan or similar herbicides for soybeans is uniform and sufficiently early to reduce the risk of injury to wheat or corn following soybeans. Refer to the herbicide label for information on cropping sequence.

Names of Some Herbicides

Trade	Common (generic)
AAtrex, Atrazine	atrazine
Amiben	chloramben
Banvel	dicamba
Basagran	bentazon
Bicep	metolachlor + atrazine
Bladex	cyanazine
Blazer	acifluorfen
Bronco	alachlor + glyphosate
Buctril, Brominal	bromoxynil
Butoxone, Butyrac	2,4-DB
Dowpon M	dalapon
Dual	metolachlor
Dyanap, Kleen Krop, Premerge Plus	naptalam plus dinoseb
Eradicane	EPTC plus safener
Eradicane Extra	EPTC plus safener and extender
Evik	ametryn
Furloe Chloro IPC	chlorpropham
Fusilade 2000	fluazifop
Hoelon	diclofop
Lasso	alachlor
Lorox, Linex	linuron
Marksman	dicamba plus atrazine
Modown	bifenox
Paraquat Plus, Gramoxone	paraquat
Poast	sethoxydim
Princep, Simazine, Caliber 90	simazine
Prowl	pendimethalin
Ramrod	propachlor
Rescue	naptalam plus 2,4-DB
Reward	vernolate plus extender
Roundup	glyphosate
Sencor, Lexone	metribuzin
(several)	2,4-D
Sonalan	ethalfluralin
Surflan	oryzalin
Sutan+, Genate Plus	butylate plus safener
Sutazine	butylate plus safener plus atrazine
Treflan	trifluralin
Vernam	vernolate

Some herbicides have different formulations and concentrations under the same trade name. *No endorsement of any trade name is implied, nor is discrimination against similar products intended.*

Herbicide Combinations

Herbicides are often combined to control more weed species, reduce carryover, or reduce crop injury. Some combinations are sold as a "package mix," while others are tank mixed. Tank mixing allows you to adjust the ratio to fit local weed and soil conditions. If you use a tank mix, you must follow restrictions on all products used in the combination.

Problems sometimes occur when mixing emulsifiable concentrate (EC) formulations with wettable powder (WP), water dispersible liquid (WDL), or water dispersible granule (WDG) formulations. These problems can sometimes be prevented by using proper mixing procedures. Fill tanks at least one-third full with water or liquid fertilizer before adding herbicides that are suspended. If using liquid fertilizers, check compatibility in a small lot before mixing a tankful. The addition of compatibility agents may be necessary. Wettable powders, WDGs, or WDLs should be added to the tank before ECs. Emulsify ECs by mixing with equal volumes of water before adding them to the tank. Empty and clean spray tanks often enough to prevent accumulation of material on the sides and the bottom of the tank.

The user can apply two treatments of the same herbicide (split application), or he can use two different ones, provided such uses are registered. The use of one herbicide after another is referred to as a sequential or overlay treatment. Sequential treatment can be done in a number of ways. For example, a preplant application might be followed by a preemergence application, or a soil-applied treatment might be followed by a postemergence treatment. One herbicide may be broadcast while the other is banded or directed.

Herbicide Rates

Herbicide rates vary according to the time of application, soil conditions, the tillage system used, and the seriousness of the weed infestation. Sometimes lower rates are specified for preemergence application than for pre-

plant incorporated application. Postemergence rates may be lower than preemergence rates if the herbicides can be applied at either time. Postemergence rates often vary depending on the size and species of the weeds and on whether an adjuvant is specified. Rates for combinations are usually lower than rates for herbicides used alone.

The rates for soil-applied herbicides usually vary with the texture of the soil and the amount of organic matter it contains. For instance, light-colored, medium-textured soils with little organic matter require relatively lower rates of most herbicides than do dark-colored, fine-textured soils with medium to high organic matter. For sandy soils the herbicide label may specify "do not use," "use a reduced rate," or "use a postemergence rather than soil-applied herbicide," depending on the herbicide and its adaptation and on crop tolerance.

The rates given in this publication are, unless otherwise specified, broadcast rates for the amount of formulated product. If you plan to band or direct herbicides, adjust the amount per crop acre according to the percentage of the area actually treated. Many herbicides have several formulations with different concentrations of active ingredient. Be sure to read the label and make the necessary adjustments when changing formulations.

Postemergence Herbicide Principles

Postemergence herbicides applied to growing weeds generally have foliar rather than soil action; however, some may have both. The rates and timing of applications are based on weed size and climatic conditions. Weeds can usually be controlled with a lower application rate when they are small and tender. Larger weeds often require a higher herbicide rate or the addition of a spray additive, especially if the weeds have developed under drouth conditions. Herbicide penetration and action are usually greater when the temperature and relative humidity are high. Rainfall occurring too soon after application (1 to 8 hours, depending on the herbicide) can cause poor weed control.

Translocated (hormone) herbicides can be effective with partial foliar coverage, whereas contact herbicides require more complete coverage. Foliar coverage increases as water volume and spray pressure are increased. Spray nozzles that produce small droplets also improve coverage. For contact herbicides, 20 to 40 gallons of water per acre are often recommended for ground application and a minimum of 5 gallons per acre for aerial application. Spray pressures of 30 to 50 psi are often suggested with flat-fan or hollow-cone nozzles to produce small droplets and improve canopy penetration. These small droplets are quite subject to drift.

The use of a surfactant or crop oil concentrate may be recommended to improve spray coverage. These spray additives will usually improve weed control but may increase crop injury. Spray additives may be needed only under drouth conditions or on larger weeds.

Crop size limitations may be specified on the label to minimize crop injury and maximize weed control. If weeds are smaller than the crop, basal-directed sprays may minimize crop injury because they place more herbicide on the weeds than on the crop. If the weeds are taller than the crop, rope-wick applicators or recirculating sprayers can be used to place the herbicides on the top of the weeds and minimize contact with the crop. *Follow the label directions and precautions for each herbicide.*

Conservation Tillage and Weed Control

Conservation tillage refers to tillage methods that provide efficient crop production along with adequate control of soil erosion caused by wind and water. Erosion is controlled by protecting the soil surface with plant residue. The amount of tillage is less than that used in conventional moldboard plowing. Chisel plowing, ridge tilling, or no tillage can be used; several other systems are also available.

With reduced tillage systems, there is often a greater reliance on herbicides for weed control. With these systems, herbicides cannot be incorporated without covering much of the residue that is necessary for effective erosion control. The early application of preplant, preemergence, and postemergence herbicides is an alternative to incorporation.

Early preplant herbicides may be applied several weeks before planting. Early application may reduce the need for a contact herbicide at planting. However, early preplant application may require additional herbicides (preemergence or postemergence) or cultivation for satisfactory weed control.

Compared with preplant incorporated herbicides, preemergence herbicides require less tillage, but their performance is more dependent upon timely rainfall. However, they have performed better than herbicides that are poorly incorporated. With conservation tillage, a higher application rate of surface-applied herbicides may be required for satisfactory weed control, especially in fields with considerable weed infestation or crop residue. Do not, however, use a higher rate than that stated on the label. Use great care when selecting herbicides and choosing application rates.

The use of effective postemergence herbicides, which depend upon foliar rather than soil action, may be a logical choice with some conservation tillage systems.

No-Till and Double-Crop

Corn, sorghum, and soybeans can be planted without seedbed preparation, either in last year's crop residue (no-till) or as a second crop after a small grain harvest or forage removal (double-crop). Because it conserves soil, soil moisture, and time, no-till planting has greatly improved the probability of success with double-cropping.

Several precautions should be observed in no-till cropping systems. Crop seed should be planted to the proper depth and adequately covered to avoid possible contact with herbicide sprays. (Several herbicide labels give the planting depths that are necessary to avoid possible injury.) Preemergence applications may give better weed

control than preplant applications because the planting process may expose untreated soil that contains viable weed seed. The total reliance on chemical weed control and the large amounts of crop residue present under no-till cropping systems may require that the higher labeled herbicide rates be used to obtain acceptable weed control.

Existing Vegetation Control in Reduced Tillage Program

Existing vegetation may be a perennial grass sod, a legume or legume-grass sod, an annual cover crop, or weeds. Perennial legume sods can often be controlled prior to planting corn or sorghum by preplant applications of 2,4-D or Banvel. Perennial grass sods can sometimes be controlled with preplant applications of Roundup. If a cutting of forages such as alfalfa or clover is removed before no-till planting, control of sod may be poor if herbicides are applied before there is sufficient regrowth.

Existing vegetation which consists of small annual weeds less than 2 inches may not require the necessity of utilizing paraquat or Roundup as knockdown herbicides. Residual herbicides which also have postemergence activity may often control existing vegetation. Bladex, atrazine, Sencor or Lexone, and Lorox or Linex have both preemergence and postemergence activity. Postemergence herbicides can also often be used to control existing vegetation. Poast is labeled to control existing grass weeds prior to planting soybeans.

Early preplant application of labeled residual herbicides can often prevent existing vegetation from being a problem before planting. The earlier applications are made before planting, the shorter the length of control after planting. To strengthen or lengthen control, an additional application of the same or another herbicide can be considered.

Paraquat Plus or Gramoxone (1 or 2 pints per acre) plus a *nonionic* surfactant at ½ pint per 100 gallons of diluted spray can be used to "knock down" existing foliage before crop emergence. Smartweed, giant ragweed, and fall panicum may not be controlled if they are over 4 to 6 inches high. A minimum of 40 gallons or more of spray per acre is suggested to ensure adequate coverage of the foliage. Paraquat can be applied with certain liquid fertilizers. *Do not* apply with suspension or high phosphate liquid fertilizers. *Paraquat and Gramoxone are restricted-use pesticides.*

Roundup (3 to 8 pints per acre) is another alternative for control of existing vegetation prior to crop emergence in situations where fall panicum, smartweed, or certain perennial weeds are a problem. Roundup can translocate to the roots to give better control of perennials. Use 10 to 40 gallons of spray volume per acre. Roundup + 2,4-D can be used in some situations to improve broadleaf control.

Bronco is a formulated mixture of glyphosate (Roundup) plus alachlor (Lasso). Application rates are 4 to 5 quarts per acre. Bronco may be applied in 10 to 30 gallons of water or in 10 to 50 gallons of 28 percent or 32 percent liquid nitrogen solutions. Application with a nitrogen solution should only be made for control of annual weeds that are less than 6 inches tall.

Roundup, paraquat, and Bronco are registered for use in combination with the preemergence herbicides indicated in Table 1. See the sections entitled "Herbicides for Corn" and "Herbicides for Soybeans" for more information on these products.

Herbicides for Corn

All herbicides mentioned in this section are registered for use on field corn and also on silage corn unless otherwise specified. See Table 2 for registered combinations. Herbicide suggestions for sweet corn and popcorn may be found in Circular 907, *1986 Weed Management Guide for Commercial Vegetable Growers.* Growers producing hybrid seed corn should check with the contracting company or inbred-seed producer about tolerance of the parent lines.

Preplant Not Incorporated

Interest in early preplant application is increasing, especially with the trend toward reduced tillage. Bladex and atrazine have postemergence as well as residual activity. Early weeds such as smartweed can be controlled while they are small, and emergence of others can be curtailed.

With AAtrex, Dual, or Bicep, preplant surface application may be made using a ⅔ rate up to 45 days before planting, followed by a ⅓ rate at planting. A single application can be made within 30 days before planting.

Bladex may be applied early preplant at labeled rates, but if applied earlier than 15 days before planting, a split application or use of another herbicide at or after planting is suggested. Banvel or 2,4-D are labeled in mixture with Bladex, Bladex plus atrazine, and Bicep for minimum or no-till corn.

Table 1. — Registered No-Till Herbicide Combinations

	Alone	Combination			
		Dual	Lasso	Surflan	Prowl
Soybeans					
Amiben	PR	PR	PR	PR	PR
Lorox	PBR	PR	PBR	PR	P
Lexone	PBR	PR	PBR	PR	P
Sencor	PBR	PR	PBR	PR	P
Corn					
Atrazine	PBR	PR	PBR	—	—
Bladex	PBR	P	PBR	—	—
Princep	BR	PR	PBR	—	—
Atrazine + Bladex	B	P	PB	—	—
Atrazine + Princep	PBR	PR	PBR	—	—
Bicep	PR	—	—	—	—

Knockdown herbicides:
P = Paraquat, Gramoxone (paraquat).
R = Roundup (glyphosate).
B = Bronco = Roundup + Lasso.
— = Not registered.

Table 2. — Registered Herbicide Combinations for Preplant Incorporated (PPI), Preemergence (Pre), or Early Postemergence (EPoE) Application in Corn

	Atrazine	Bladex	Princep	Atrazine + Bladex	Atrazine + Princep
PPI only					
Eradicane, Eradicane Extra	1	1	1	1	—
Genate Plus..	1	1	—	1	—
Sutan+	1	1	1	1	—
PPI or Pre or EPoE					
Used alone...	1,2,3	1,2,3	1,2	1,2,3	1,2
Dual	1,2,3	1,2	1,2	1,2	1,2
Lasso	1,2,3	1,2	2	1,2	—

1 = Preplant incorporated; 2 = preemergence; 3 = early postemergence.
— = Not registered.

Banvel (dicamba) can be used as a preplant herbicide prior to planting corn or sorghum. The rate is 1 to 2 pints per acre. It is suggested that you delay planting corn 1 week and sorghum 1 to 2 weeks after application.

Roundup can be used preplant to corn or sorghum at ¾ to 1 pint (12 to 16 fluid ounces) per acre to control small annual weeds. Use 5 to 10 gallons of water per acre plus a surfactant. Roundup may be mixed with Banvel or 2,4-D.

Preplant Incorporation

Some herbicides may be applied prior to planting and incorporated. The time of application will depend on the label directions and field conditions. Herbicides with sufficient residual activity, such as AAtrex, Bicep, and Dual, may be applied early preplant up to 45 days before planting. However, if applied too early, weed control may not last as long as desired after planting. Incorporation should distribute the herbicide uniformly in about the top 2 inches of soil. Do not apply herbicides too early or incorporate them too deeply.

Sutan+, Genate Plus (butylate), Eradicane, and Eradicane Extra (EPTC) contain crop safening agents. Crop injury is unlikely, but may occur when growing conditions are unfavorable or when certain hybrids are used. Eradicane Extra also contains an extender to lengthen weed control. These herbicides control annual grass weeds and can control or suppress shattercane and johnsongrass at higher rates. The rate for Sutan+ and Genate Plus is 4¾ to 7⅓ pints per acre. The rate for Eradicane 6.7E is 4¾ to 7⅓ pints per acre. The rate for Eradicane Extra 6E is 5⅓ to 8 pints per acre. Use the higher rates for heavy infestations of shattercane and yellow nutsedge and for johnsongrass.

These herbicides should be incorporated into the soil soon after application. Although some labels allow application up to 4 weeks prior to planting, application close to planting time is generally preferable.

Sutan+, Genate Plus, Eradicane, or Eradicane Extra can be tank-mixed with atrazine or Bladex to improve broadleaf control. Sutan+ or Eradicane can be tank-mixed with Princep. The atrazine rate is 2 to 3 pints of 4L or equivalent amounts of 80W or 90WDG per acre. The Bladex rate is 3 to 4 pints of 4L or 2 to 2½ pounds of 80W per acre. Three-way combinations with atrazine plus Bladex are also registered.

Sutazine+ 6-ME is a 4:1 mixture of Sutan+ and atrazine. The application rate is 5¼ to 10½ pints per acre. Sutazine+ and Sutan+ are available as granular formulations.

Preplant or Preemergence Herbicides

Incorporation of the following herbicides is optional, depending upon the weeds to be controlled and the likelihood of rainfall. Incorporation of these herbicides should be shallow but thorough.

AAtrex, Atrazine (atrazine), or Princep (simazine) can be applied anytime during the 2 weeks prior to planting or soon after planting. If rainfall is limited, incorporation may aid performance. Corn tolerance of atrazine and simazine is good, but carryover to subsequent crops can occur.

Princep controls fall panicum and crabgrass better than atrazine but is less effective in controlling cocklebur, velvetleaf, and yellow nutsedge. Princep is less soluble and more persistent than atrazine. Thus, Princep is usually applied preplant. Princep plus atrazine can be used in 1:1 or 2:1 combinations; the total rate is the same as for atrazine used alone.

The rate for atrazine used alone is 2½ to 3¾ pounds of atrazine 80W, 4 to 6 pints of 4L, or 2.2 to 3.3 pounds of AAtrex 90WDG. Atrazine controls annual broadleaf weeds better than it does grasses, and it is often used at reduced rates in tank mix combinations to improve broadleaf weed control. The rate for atrazine in combinations is 1½ to 2 pounds of atrazine 80W, 2 to 3 pints of atrazine 4L, or 1.1 to 1.8 pounds of AAtrex 90WDG. These rates may not provide adequate control of cocklebur, morningglory, and velvetleaf but can reduce the risk of carryover.

You can minimize carryover injury by mixing and applying the herbicides accurately, by applying them early, by using the lowest rates consistent with good weed control, and by tilling the soil to dilute the herbicide. The risk of carryover is greater after a cool, dry season and on soils with a pH over 7.3.

If you use atrazine at more than 3 pounds of active ingredient per acre or if you apply after June 10, plant only corn or sorghum the next year. If you use atrazine in the spring and must replant, then plant only corn or sorghum that year. Do not plant small grains, small seeded legumes, or vegetables in the fall or the following spring. Soybeans planted the year after an application of atrazine can also be affected from carryover, especially if you use Sencor or Lexone.

Bladex (cyanazine) does not persist in the soil as long as atrazine, but atrazine does have the advantage of better corn tolerance. Bladex provides better control than

atrazine of fall panicum, giant foxtail, and some other grass weeds, but not all broadleaf weeds. Bladex can be combined with atrazine at 3:1, 2:1, or 1:1 ratios of Bladex to atrazine (see label for rates). The higher ratios will provide better grass control, while the 1:1 ratio will provide better broadleaf weed control.

Rates of Bladex must be selected accurately on the basis of soil texture and organic matter to reduce the possibility of corn injury. Bladex rates are 1½ to 6 pounds of 80W, 1.35 to 5.3 pounds of Bladex 90DF, or 1¼ to 4¾ quarts of 4L. You can lessen the risk of corn injury by using reduced rates of Bladex in combinations.

Bladex can be tank-mixed with Lasso, Dual, Ramrod, or Prowl to improve grass control. The Lasso or Dual combination can be applied immediately before planting or after planting. Do not incorporate the Prowl or Ramrod combinations.

Three-way combinations of Bladex plus atrazine plus Lasso, Dual, Sutan+, or Eradicane are registered. The addition of a limited amount of atrazine should improve broadleaf control without increasing concern about carryover.

Lasso (alachlor) or Dual (metolachlor) can be preplant incorporated or applied at the preemergence stage. Preplant incorporation can improve control of yellow nutsedge and can lessen dependence upon rainfall. Incorporation should distribute the herbicide evenly in the top 2 inches of soil.

Lasso and Dual control annual grasses and help control yellow nutsedge. You can improve broadleaf weed control by using atrazine or Bladex or both in either a preplant or in a preemergence combination.

Lasso can be applied anytime during the week before planting corn and shallowly incorporated, or it can be used after planting but before the crop and weeds emerge and within 5 days after the last tillage operation. The rate is 2 to 4 quarts of Lasso 4E or 16 to 26 pounds of Lasso 15G. Use the higher rate for the soil if you plan to incorporate Lasso.

Dual can be applied anytime during the 2 weeks prior to planting corn and shallowly incorporated, or it can be used soon after planting. The rates are 1½ to 4 pints of Dual 8E or 6 to 16 pounds of Dual 25G per acre.

Lasso or Dual plus atrazine can be preplant incorporated or applied after planting until corn is 5 inches tall and grass weeds have not passed the two-leaf stage. *Do not apply with liquid fertilizer after the crop emerges.* The suggested rate is 1½ to 4 quarts of Lasso or 1¼ to 2½ pints of Dual 8E plus 1½ to 2½ pounds of atrazine 80W, 1 to 2 quarts of atrazine 4L, or 1.1 to 2.2 pounds of AAtrex 90WDG. Dual is also cleared in a combination with atrazine plus Princep.

Dual and Lasso are both formulated as packaged mixes with atrazine. **Bicep** contains a 5:4 ratio of metolachlor (Dual): atrazine per gallon. The rate is 2 to 4 quarts of Bicep 4.5L or 1½ to 3 quarts of Bicep 6L per acre. **Lasso/atrazine** (flowable) contains 2½ pounds of alachlor (Lasso) and 1½ pounds of atrazine per gallon. The rate is 3½ to 4½ quarts per acre.

Dual or Lasso plus Bladex can be applied prior to planting and incorporated, or they can be applied during the preemergence stage after planting. The rate is 2 to 4 quarts of Lasso 4E or 1¼ to 2½ pints of Dual 8E plus 1 to 3¾ pounds of Bladex 80W or 1 to 3 quarts of Bladex 4L. Adjust the rate carefully according to soil texture and organic matter.

Preemergence Herbicides

Ramrod (propachlor) can be applied alone or with atrazine after the corn is planted but before grasses reach the two-leaf stage. Granular formulations should be applied before crop or weeds emerge. Ramrod performs well on soils with over 3 percent organic matter.

Ramrod is irritating to the skin and eyes, so observe label precautions. Corn tolerance is good. It controls annual grasses and pigweed. The rate is 4 to 6 quarts of Ramrod 4L or 20 to 30 pounds of 20G per acre.

Banvel (dicamba) can be applied alone after planting until corn is no more than 5 inches tall. Banvel is approved for use in combinations with Lasso, Dual, atrazine, or Bladex. Banvel may injure corn, especially if recommended rates are exceeded, applications are not accurate and uniform, or if corn is planted too shallow (less than 1½ inches). Do not use this treatment on coarse-textured soils or soils that are low in organic matter. The rate on fine-textured soils with over 2½ percent organic matter is 1 pint of Banvel.

Prowl (pendimethalin) is registered for use only on corn after planting. Incorporation of Prowl may result in serious corn injury. Use only where it is possible to cover seed adequately with soil. Prowl can control annual grasses and pigweed and provides some control of smartweed and velvetleaf. You can improve broadleaf weed control by combining Prowl with atrazine, Bladex, or Banvel. Prowl plus atrazine or Bladex may be applied in the early postemergence period before grasses are in the two-leaf stage. These combinations may also help reduce the competition from wild proso millet. However, avoid postemergence application when corn is under stress from cool, wet weather; otherwise, corn injury may result. The rate for such combinations is 1 to 1½ quarts of Prowl 4E. Do not use Prowl plus Banvel on sandy soils or soils with less than 1½ percent organic matter.

Postemergence Herbicides

Lasso, Dual, Ramrod, or Prowl plus atrazine, or Lasso or Dual plus Banvel can be used on corn between the preemergence and very early postemergence stages (see preemergence section). To obtain satisfactory control, apply before grasses reach the two-leaf stage. For more information on postemergence principles, see section entitled "Postemergence Herbicide Principles."

Atrazine can be applied before grass weeds are more than 1½ inches high. Many annual broadleaf seedlings

are more susceptible than grass weeds and may be treated until they are up to 4 inches tall. For control of some broadleaf weeds, 1.2 pounds active ingredient of atrazine may be sufficient. This rate will generally need to be increased to 2 pounds for control of annual grass weeds.

The addition of oil-surfactant mixes or surfactants has generally increased the effectiveness of postemergence atrazine. Crop oil concentrates (80 percent oil and 20 percent surfactant) are used at the rate of 1 quart per acre. Surfactants are usually added at 0.5 percent of the total spray volume or at a rate of about 1 pint per acre. Results with the oil-surfactant mixes have generally been better than those with surfactants.

Applications of atrazine and oil sometimes damage corn that has been under stress from prolonged cold, wet weather or other factors. Do not use more than 2½ pounds of atrazine 80W, 2 quarts of atrazine 4L, or 2.2 pounds AAtrex Nine-O per acre if you mix with oil or oil concentrate. *Do not* add 2,4-D to the atrazine-oil treatment or severe injury may result. Mix the atrazine with water first and add the oil last. If atrazine is applied after June 10, do not plant any crop except corn or sorghum the next year.

Bladex (**cyanazine**) can be applied through the four-leaf stage of corn growth but before weeds exceed 1½ inches in height. The Bladex rate is 1½ to 2½ pounds of 80W or 1.1 to 2.2 pounds of 90DF per acre. *Do not use Bladex 4L* because it contains oil and can increase the potential for injury. Injury to corn may occur under cold, adverse growing conditions. The injury may only be temporary yellowing but can be more severe. Under drouthy conditions certain agricultural surfactants or vegetable oils may be added to Bladex 80W to improve weed control. Do not use petroleum crop oils or apply with liquid fertilizers for postemergence application. Do not apply Bladex postemergence on corn that is under severe stress.

One may combine Bladex 80W with atrazine 80W, substituting atrazine for 30 percent of the Bladex. A Bladex plus Banvel combination is also registered that allows for the addition of ½ to ⅔ pint per acre of Banvel; no surfactant or any type of oil should be added with this combination.

Banvel (**dicamba**) can be applied from emergence until corn is 36 inches tall or 15 days before tassel emergence, whichever comes first. Best results can be expected when using ½ to 1 pint of Banvel per acre when the corn is in the spike to 5-inch stage. Application at this time can offer several weeks of soil (residual) activity when the 1-pint rate is used. With this timing, crop tolerance is better than with preemergence treatments of Banvel. In addition, application rates can be higher than in the later postemergence treatment, and the likelihood of injury to nearby soybeans is diminished. For applications on corn from 5 to 36 inches tall, the rate is ½ pint per acre. Banvel is labeled as an overlay (sequential) treatment following Sutan+, Eradicane, Lasso, Dual, Bicep, Ramrod, atrazine, Bladex, Princep, Roundup, Bronco, or paraquat.

Banvel is also labeled for postemergence use as a tank mix with atrazine, Bladex 80W, or 2,4-D. The postemergence rate for Banvel is ½ pint (¼ pound active ingredient per acre) after corn is 5 inches tall. The label allows for the addition of ⅛ to ¼ pound of 2,4-D acid equivalent per treated acre. With Banvel or Banvel plus 2,4-D, drop pipes should be used on the nozzles if corn is taller than 8 inches to help keep the spray off the corn leaves and out of the whorl.

For best results, use Banvel before June 20 with a spray volume of 20 gallons per acre and a spray pressure of no more than 20 psi to help reduce the risk to plants outside the target area.

To aid in the control of hemp dogbane, Banvel is approved for use at ½ pint with 1 pound acid equivalent per acre of 2,4-D LV ester or amine after corn is in the brown silk stage but at least 7 days before harvest.

Marksman (**dicamba + atrazine**) is a formulated mixture of 1.1 pound dicamba (active ingredient in Banvel) and 2.1 pounds of atrazine per gallon. The rate is 2 to 3.5 pints per acre depending on the soil texture and organic matter. On most Illinois soils, the rate is 3.5 pints per acre or 0.48 pound of dicamba and 0.92 pound of atrazine per acre. Marksman is cleared as a tank-mix and in sequential combinations with many other herbicides.

Marksman may be applied to actively growing weeds prior to, during, or after planting but before corn exceeds the 5-leaf stage. In most conventional tillage applications the recommended timing would be emergence to the 5-leaf stage of corn. Most annual broadleaf weeds should be controlled, and some perennial broadleaf weeds should be suppressed. This formulated mixture will be targeted at the velvetleaf market in Illinois where Banvel has needed some help.

2,4-D is effective in controlling many broadleaf weeds in corn. Use drop nozzles if corn is more than 8 inches high to decrease the possibility of injury. If you direct the nozzles toward the row, adjust the spray concentration so that excessive amounts are not applied to the corn.

Do not apply 2,4-D to corn from the tasseling to dough stage. After the hard dough to dent stage, you can apply 1 to 2 pints of certain 2,4-Ds by air or high clearance equipment to control some broadleaf weeds that may interfere with harvest or to suppress certain perennial weeds. Do not forage or feed fodder for 7 days after treatment.

The suggested broadcast rate is ⅓ to ½ pint of ester or 1 pint of amine for formulations with 3.8 pounds of 2,4-D acid equivalent per gallon. Use equivalent rates with other formulation concentrations. Use proportionately less when using directed nozzles.

The ester forms of 2,4-D can vaporize and injure nearby susceptible plants. This vapor movement is more likely with high-volatile than with low-volatile esters. Spray particles of either the ester or the amine form can drift and cause injury.

Corn is often brittle for 7 to 10 days after application of 2,4-D and thus is susceptible to stalk breakage from

high winds or cultivation. Other symptoms of 2,4-D injury are stalk bending or lodging, abnormal brace roots, and failure of leaves to unroll.

High temperature and high humidity can increase the potential for 2,4-D injury, especially if corn is growing rapidly. If it is necessary to spray under these conditions, it may be wise to reduce the rate by about 25 percent. Corn hybrids differ in their sensitivity, and the probability of injury increases when corn is under stress.

Buctril or Brominal (bromoxynil) may be used to control broadleaf weeds in field and silage corn. It is important to treat when the weeds are small. For ground applications, use 20 gallons of water per acre, a spray pressure of 30 psi, and flat fan nozzles.

Buctril 2E rates are 1 to 1½ pints per acre when corn and weeds are in the 3- to 8-leaf stage. Brominal 4E rates are ½ to 1 pint per acre when corn is in the 2-leaf to 14-inch stage and before weeds are 4 to 6 inches tall. Use the higher rate on larger corn and weeds. Most annual broadleaved weeds are controlled. Larger pigweed and velvetleaf may require the higher rate, or a combination with atrazine. Atrazine 4L at 0.5 to 1.0 quart (equivalent rates of 80W or 90DF) can be combined with Buctril or Brominal. Do not add Bladex to bromoxynil.

Bromoxynil will not volatilize and cause the drift injury associated with 2,4-D or Banvel. Bromoxynil, under some conditions, may cause some burning of corn leaf tips, but the effects are usually temporary. Do not add surfactant or crop oil to Buctril or Brominal.

Basagran (bentazon) is registered for postemergence use in corn similar to that for soybeans (see soybean section). The rate is 1½ to 2 pints of Basagran 2S per acre. Crop oil concentrate can be added at one quart per acre. Basagran is also cleared at the rate of 1 to 1½ pints per acre in combination with atrazine at 0.6 to 1.0 pound of 80W, 0.6 to 0.9 pound of 90DF, or 1 to 1½ pints of 4L per acre. Crop oil concentrate is added at 1 quart per acre. This combination controls only annual broadleaf weeds and not annual grasses. The combination provides better control of pigweed and lambsquarters than Basagran alone, and will create less risk of carryover than atrazine alone.

Roundup (glyphosate) may be applied as a spot treatment in corn prior to silking. For applications made on a spray-to-wet basis use a 1 to 2 percent solution of Roundup in water. For motorized spot treatments where less than complete coverage of weeds may result, use a 5 percent solution. Avoid contact of spray with the corn. Add a dye for increased visibility.

Postemergence Soil-Applied Herbicides

Prowl, Treflan, or Lasso can be applied to the soil as a postemergence treatment. It may be necessary to use drop nozzles to avoid interference from corn leaves and ensure uniform application to the soil.

Prowl (pendimethalin) or Treflan (trifluralin) may be applied to the soil and incorporated after field corn is 4 inches high (for Prowl) or 8 inches high (for Treflan) and up to the time of the last cultivation. The field should be cultivated to control existing weeds and cover the roots at the base of the corn before application. The herbicide should then be thoroughly and uniformly incorporated into the top inch of the soil with a sweep type or rolling cultivator. Prowl may not need incorporation if irrigation or rainfall occurs soon after application. Prowl can be combined with atrazine.

These treatments may help control late-emerging grasses such as shattercane, wild proso millet, fall panicum, or woolly cupgrass.

Lasso (alachlor) may be used alone or with atrazine as a soil-applied postemergence treatment to help control midseason annual grass weeds in corn that is grown for seed. Application should preferably be made after cultivation before weeds emerge and before the crop is 40 inches tall.

Directed Postemergence Herbicides

Directed sprays are sometimes needed for emergency situations, especially when grass weeds become too tall to be controlled by cultivation. However, weeds are often too large for directed sprays to be effective. Directed sprays cannot be used on small corn because a height difference between corn and weeds is needed to keep the spray off the corn. Corn leaves that come into contact with the spray can be killed, and injury may affect yields.

Lorox or Linex (linuron) may be applied as a directed spray after corn is at least 15 inches tall (free standing) but before weeds are 8 inches tall (preferably no more than 5 inches). Linuron controls broadleaf and grass weeds.

The broadcast rate is 1¼ to 3 pounds of Lorox 50W (or 50DF) or 1¼ to 3 pints of 4L per acre, depending on weed size and soil type. Add Surfactant WK at the rate of 1 pint per 25 gallons of spray mixture. Cover the weeds with the spray, but keep it off the corn as much as possible. *Consider this an emergency treatment.*

Evik 80W (ametryn) is registered for directed use when corn is more than 12 inches tall and weeds are less than 6 inches tall. Evik should not be applied within 3 weeks of tasseling. The rate is 2 to 2½ pounds Evik 80W per acre (broadcast) plus 2 quarts of surfactant per 100 gallons of spray mixture. Extreme care is necessary to keep the spray from contacting the leaves. *Consider this an emergency treatment.*

Bladex 80W (cyanazine) or Bladex 80W plus atrazine may be used as a directed spray for lay-by treatment for *corn seed production fields* at least 60 days before harvest. Seed corn should be at least 10 inches tall and there should be a sufficient height difference between the corn and the weeds to allow the spray to cover the weeds but not touch the corn leaves. This treatment can control weeds that are up to 1½ inches tall and suppress weeds that are a little taller. The use of nitrogen solutions as carriers and/or the addition of crop oil or surfactant can enhance control. Do not apply over the top of corn.

Herbicides for Sorghum

Many herbicides used to control weeds in corn can also be used in sorghum.

Atrazine may be used for weed control in sorghum (grain and forage types) or sorghum-sudan hybrids. Application may be made preemergence or postemergence. A preplant surface application may be made using a single application within 30 days of planting or a ⅔ plus ⅓ split application within 45 days of planting. Plant seed at least 1 inch deep. Do not use preplant or preemergence on soils with less than 1 percent organic matter. Incorporated treatments may cause injury if rainfall occurs prior to or shortly after sorghum emergence.

Injury may occur when sorghum is under stress from unusual soil or weather conditions or when rates are too high. The rate of application for preplant and preemergence is 2 to 3 pounds of atrazine 80W per acre. The postemergence rate is 4 to 6 pints 4L per acre without crop oil or 2.4 pints 4L (broadleaf control only) with crop oil or crop oil concentrate. Use equivalent rates of atrazine 80W or AAtrex 90DF formulations. Rotational crop recommendations and weed control are the same as for atrazine used in corn. Failure to control fall panicum has been a major problem.

Ramrod (propachlor) may be used alone or in combination with atrazine, Milogard, Bladex, or Modown for sorghum. Ramrod can improve grass control, but rates must not be skimpy, especially on soils that are relatively low in organic matter. For specific rates, consult the label. Do not graze or feed forage to dairy animals.

Lasso (alachlor) alone or plus atrazine may be preplant incorporated or used preemergence for grain sorghum if seed is treated with Screen (flurazole). This use also applies to Lasso/atrazine and Bronco (see below).

Dual (metolachlor) or Dual plus atrazine (Bicep) can be used for sorghum if seed has had the Concep-seed treatment. These herbicides will control grasses better than will atrazine applied alone. An early preplant treatment of Dual or Bicep may be used in a similar manner as for corn, but Concep-treated seed should still be used.

Basagran (bentazon) is registered for postemergence use in sorghum in a manner similar to that for corn (see corn section). Since sorghum is quite tolerant of Basagran up to and including early boot stage, the addition of a crop oil concentrate is considered relatively safe. Do not apply to grain sorghum that is heading or blooming. Apply Basagran at the rate of 1 to 1½ pints in combination with atrazine at 0.6 to 1.0 pound of 80W, 0.6 to 0.9 pound of 90WDG, or 1 to 1½ pints of 4L per acre.

2,4-D may be applied postemergence for broadleaf control in 4- to 24-inch-tall sorghum. Use drop pipes on nozzles if sorghum is more than 8 inches tall. Rates are similar to those for use in corn (see section on corn herbicides).

Banvel can be applied preplant to emerged and actively growing weeds up to 15 days before planting. It may be applied postemergence to sorghum that is between the 3-leaf and 15-inch stage. The 3- to 5-leaf stage is preferred. The rate is ½ pint per acre. Do not graze or feed treated forage or silage prior to the mature grain stage. Sorghum may be injured by Banvel.

Brominal or Buctril (bromoxynil) can control broadleaf weeds in grain sorghum that is past the 3-leaf stage and up to 14 inches tall and before weeds are 4 to 6 inches tall. It is generally safer than 2,4-D on grain sorghum. Combination with atrazine is also registered to improve pigweed control and provide some residual control of germinating seedlings.

Prowl (pendimethalin) may be applied to grain sorghum from the 4-inch growth stage to as late as the last cultivation primarily for control of late-season annual grass weeds. See the section entitled "Herbicides for Corn," subsection on postemergence soil-applied herbicides, for more information.

Roundup may be applied as a spot-treatment in sorghum (milo) prior to heading. For applications on a spray-to-wet basis use a 1 to 2 percent solution of Roundup in water. For motorized spot treatments where less complete coverage of weeds may result, use a 5 percent solution. Avoid contact with the sorghum. Add a dye for increased visibility.

Bronco (glyphosate plus alachlor) may be used alone or with atrazine where grain sorghum is to be planted directly into a cover crop or in previous crop residue. It can control emerged annual weeds and suppress many emerged perennial weeds, as well as give preemergence control. As with Lasso, grain sorghum seed must be treated with Screen.

Paraquat may be used for control of annual weeds where grain sorghum is to be planted into previous crop residues.

Herbicides for Soybeans

Consider the kinds of weeds expected when you select a herbicide program for soybeans, especially when growing soybeans in narrow rows. The herbicide selectivity table (see last page of this guide) lists herbicides and their relative weed control ratings for various weeds.

Soybeans may be injured by some herbicides. However, they usually outgrow early injury with little or no effect on yield if stands have not been significantly reduced. Significant yield decreases can result when injury occurs during the bloom to pod fill stages. Excessively shallow planting may increase the risk of injury from some herbicides. Accurate rate selection for soil type is especially essential for Lorox, Linex, Lexone, and Sencor. Do not apply Lorox, Linex, Lexone, Sencor, or Modown after soybeans have begun to emerge. Follow label instructions as to rates, timing, incorporation, and restrictions. For registered combinations, see Table 3.

Table 3. — Registered Herbicide Combinations for Preplant Incorporated (PPI) or Preemergence (Pre) Use in Soybeans

	Amiben	Sencor or Lexone	Amiben + Sencor or Lexone	Lorox or Linex
PPI only				
Sonalan	1	1	—	—
Treflan	1	1	1	—
PPI or Pre				
Dual	1,2	1,2	1,2	2
Lasso	1,2	1,2	1,2	2
Prowl	1,2	1,2	1,2	2
Surflan*	2	2	—	2

1 = Preplant incorporated; 2 = preemergence.
— = Not registered.
* Not for preplant incorporation.

Preplant Not Incorporated

Early preplant application can be utilized in many conservation tillage programs such as no-till, ridge-till, or mulch-till to minimize existing vegetation problems at planting and thus reduce the need for knockdown herbicides. Lorox or Linex (linuron) and Sencor or Lexone (metribuzin) have both postemergence and residual activity but postemergence activity varies with climatic conditions. If weeds have emerged prior to preplant application, the use of a foliar knockdown herbicide such as paraquat or Roundup may be necessary. (See No-Till subsection.)

Several preemergence herbicides are registered for application prior to planting soybeans. Surflan can be applied anytime prior to planting no-till soybeans. Surflan can be applied in fully-tillered wheat before heading, and soybeans can then be planted no-till into wheat before harvest or wheat stubble immediately after harvest. Surflan plus Lexone can be applied up to 30 days prior to planting. Prowl can be applied 15 to 30 days prior to planting. Dual can be applied up to 30 days prior to planting soybeans or as a split application using a ⅔ rate up to 45 days before planting, followed by a ⅓ rate at planting.

Sencor can be applied with Dual or Lasso 15 to 30 days prior to planting soybeans when using a sequential (split) preemergence application: the first made early followed by the second at planting.

Some foliar postemergence herbicides can also be used prior to planting soybeans.

Roundup can also be used preplant in soybeans to control small annual weeds. The rate is 12 to 16 fluid ounces (¾ to 1 pint) per acre in 5 to 10 gallons of water with the addition of a surfactant.

Poast may be applied prior to planting soybeans with no time interval restriction.

2,4-D *is not registered* prior to planting soybeans although a registration has been submitted to EPA.

Preplant Incorporation

Incorporation is required for Treflan, Sonalan, Vernam, and Reward. Incorporation is optional for Amiben, Dual, Lasso, Modown, and Prowl when used alone and in some combinations. Dyanap, Lorox, and Surflan should not be incorporated.

Incorporation can improve performance if rainfall is limited and may increase the effectiveness of Dual or Lasso in controlling nutsedge. Incorporation should distribute the herbicide evenly in the top 1 to 3 inches of soil. Deep incorporation or very early application of the herbicide can cause significant reductions in weed control. For more information, see the section entitled "Herbicide Incorporation."

Dinitroaniline herbicides registered for weed control in soybeans are Treflan, Prowl, Sonalan, and Surflan. Treflan and Sonalan should be incorporated because they have low solubility and are subject to loss by vaporization and photodecomposition. Incorporation is optional with Prowl, but variable weed control and soybean injury may result if Prowl is not incorporated. Incorporation should distribute the herbicide uniformly in the top 2 to 3 inches of soil (see label for implement settings). Do not incorporate Surflan (see preemergence section).

The dinitroaniline herbicides control annual grasses, pigweed, and lambsquarters and may provide some control of smartweed and annual morningglory. Prowl and Surflan may also partially control velvetleaf. However, acceptable control of most other broadleaf weeds requires combinations or sequential treatments with other herbicides.

Soybeans are sometimes injured by dinitroaniline herbicides. Plants that have been injured by incorporated treatments may be stunted and have swollen hypocotyls and shortened lateral roots. Such injuries are not usually serious. Plants injured by preemergence applications may have stem calluses at the soil surface, which can cause lodging and yield loss.

Corn, sorghum, and small grains may be injured if they are grown after a soybean crop that has been treated with a dinitroaniline herbicide. The symptoms are poor germination and stunted, purple plants with poor root systems. To avoid carryover, use no more than the recommended rates and be sure that application and incorporation are uniform. The likelihood of carryover increases with double cropping or late application and after a cool, dry season. Adequate tillage may help dilute herbicide residue to help alleviate a carryover problem.

Treflan (trifluralin) can be applied alone anytime in the spring. Combinations with Sencor or Lexone should be applied no more than 2 weeks prior to planting, and combinations with Amiben, Furloe, or Modown should be applied within a few days prior to planting. Incorporate as soon as possible, but do not delay incorporation more than 24 hours (8 hours if soil is warm and moist). The rate is 1 to 2 pints of Treflan 4E or 5 to 10 pounds of Treflan 10G per acre. Treflan MTF is a multitemperature formulation that can be used to avoid problems associated with freezing in storage. Treflan Pro-5 contains 5 pounds trifluralin per gallon.

Sonalan (**ethalfluralin**) may be applied up to 3 weeks prior to planting and should be incorporated within 2 days after application. The rate for general weed control ranges from 1½ to 3 pints per acre, depending on soil texture. Sonalan may provide some control of nightshade at rates of 3 to 3½ pints per acre, but for this purpose it should be used in conjunction with Amiben, Dual, or Lasso or followed with Blazer. Sonalan is less likely to injure corn following soybeans than is Treflan. Sonalan may be tank-mixed with Amiben, Lasso, Dual, metribuzin, or Vernam.

Prowl (**pendimethalin**) can be applied within 60 days (alone) or 7 days (with Sencor or Lexone) prior to planting soybeans or applied after planting (see preemergence section). Preplant treatments should be incorporated within 7 days of application. Mechanical incorporation may not be necessary if adequate rainfall occurs. Rates are 1 to 3 pints of Prowl 4E per acre, although rates for combinations with Sencor or Lexone are lower than when the herbicide is used alone.

Sencor or Lexone (**metribuzin**) **plus Treflan, Sonalan, or Prowl** can be tank-mixed and applied within 7 to 14 days of planting. Incorporate uniformly into the top 2 inches of soil. The rate of Sencor or Lexone in these combinations is ½ to 1 pint of 4L or ⅓ to ⅔ pound of 75DF. Use the normal rate, or slightly less, of the dinitroaniline herbicide (see labels).

The application of Sencor or Lexone can also be split, one part being incorporated and the other part applied to the surface preemergence. This method requires two applications but can give better broadleaf control and less injury than incorporating the same total amount of Sencor or Lexone in a single application.

Amiben (**chloramben**) can be incorporated with Treflan, Sonalan, or Prowl. The rate is 4 to 6 quarts of Amiben 2S or 2.4 to 3.6 pounds of 75DS per acre. Amiben can also be applied and incorporated with Treflan or Prowl plus Sencor or Lexone as a three-way combination.

Vernam (**vernolate**) **and Reward 6E** (**vernolate plus extender**) control annual grasses and pigweed. They sometimes provide fair control of annual morningglory, velvetleaf, and yellow nutsedge. Some soybean injury may occur in the form of delayed emergence, stunting, and leaf crinkling. Vernolate or Reward can be applied within 10 days prior to planting and should be incorporated immediately. The broadcast rate is 2⅓ to 3½ pints of Vernam 7E or 20 to 30 pounds of Vernam 10G or 2⅔ to 4 pints Reward 6E per acre. Vernam or Reward plus Treflan is labeled at the rate of 1 pint of Treflan plus 2⅓ to 3 pints of Vernam 7E or 2⅔ to 4 pints Reward 6E per acre. The combination may reduce the risk of soybean injury. For yellow nutsedge and velvetleaf control use at least 3 pints Vernam 7E or 3⅓ pints Reward 6E per acre. Other labeled combinations include Vernam or Reward plus Amiben, Sonalan, Prowl, Lasso, Furloe, or Treflan/Sencor or Lexone.

Preplant or Preemergence Herbicides

Lasso (**alachlor**) **or Dual** (**metolachlor**) can be applied to soybeans as a preplant incorporated or preemergence treatment. Lasso may be applied within 1 week of planting. Dual may be applied to the soil surface early preplant up to 30 days before planting as a single treatment. Or a ⅔ rate can be used within 45 days of planting along with a ⅓ rate at planting. If rainfall is limited, incorporation can improve performance and increase yellow nutsedge control. Soybeans are quite tolerant of Lasso or Dual. The first to second trifoliate leaves often appear crinkled and have a drawstring effect on the middle leaflet, but these symptoms should not cause concern.

Lasso or Dual controls annual grasses and pigweed and can help control nutsedge and black nightshade. These herbicides can be combined with Lexone, Sencor, or Amiben (incorporated or preemergence) and with Lorox or Dyanap (preemergence only) to improve broadleaf weed control.

The rate for Lasso is 2 to 4 quarts Lasso 4E or Microtech 4L or 16 to 26 pounds of Lasso II 15G per acre. The rate for Dual 8E is 1½ to 3 pints per acre, and the rate for Dual 25G is 6 to 12 pounds per acre. Use the higher amount for the soil when incorporating or when black nightshade or yellow nutsedge are to be controlled. The rate for combinations is slightly less than that for the herbicide used alone (see labels). Lasso may be applied after soybean emergence but before soybeans pass the unifoliate stage.

Amiben (**chloramben**) can control annual grasses and many broadleaf weeds in soybeans when used at the full rate. Do not expect control of cocklebur or annual morningglory. Control of velvetleaf and jimsonweed is often erratic. Amiben occasionally injures soybeans, but damage does not usually affect yield. Injured plants may be stunted and have abnormal, shortened roots. If rain does not occur within 3 to 5 days of an Amiben preemergence application, you should rotary hoe. Amiben is best suited to soils that have over 2.5 percent organic matter.

Amiben can be applied alone or with Dual, Lasso, or Prowl as a preplant-incorporated or preemergence treatment. Amiben plus Sencor can also be mixed with Lasso, Dual, or Prowl as a preplant or preemergence treatment. Amiben can be applied as a preemergence treatment with Lorox, Lexone, or Sencor.

The Amiben broadcast rate alone is 20 to 30 pounds of 10G, 4 to 6 quarts of 2S, or 2.4 to 3.6 pounds of 75DS per acre. The Amiben rate in combinations is 3 to 6 quarts of 2S (1.8 to 3.6 pounds of 75DS) per acre. Use the higher rate where black nightshade, velvetleaf, or common ragweed is a problem weed.

Sencor or Lexone (**metribuzin**) can be applied anytime during the 1 to 2 weeks prior to planting and incorporated with Dual, Lasso, Prowl, Sonalan, or Treflan. Incorporation should distribute the herbicide evenly in the top 2 inches of soil. It can be applied preemergence

by itself or with Amiben, Dual, Lasso, Prowl, Surflan, or Dyanap. A three way combination of metribuzin plus linuron (Lorox or Linex) plus Lasso or Dual can be applied preemergence.

Sencor or Lexone can control many annual broadleaf weeds but cannot control annual morningglory. Control of giant ragweed, jimsonweed, and cocklebur is marginal at the reduced rates necessary to minimize soybean injury.

Adjust rates accurately according to soil conditions. *Do not apply to very sandy soil.* Combinations allow for reduced rates and thus reduce risk of soybean injury. The combination rate of Sencor or Lexone is ½ to 1 pint of 4L, or ⅓ to ⅔ pound of 75DF. You can use higher amounts as a split preplant and preemergence application. The higher amounts can improve broadleaf control but also increase the risk of soybean injury.

One symptom of soybean injury is yellowing (chlorosis) of the lower leaves at about the first trifoliate stage or later; it may be followed by browning of leaves and death of plants, depending upon the severity of the injury. Seedling diseases, weather stress, and atrazine carryover may increase the possibility of soybean injury. Injury may be greater on soils with a pH over 7.5. Accurate, uniform application and incorporation are essential. Some soybean varieties are more sensitive than others. Injury has sometimes occurred when organophosphate insecticides such as Thimet, Counter, Dyfonate, Lorsban, or Mocap were left in applicators used for corn planting and were applied to soybeans that were then being treated with metribuzin.

Modown (bifenox) can control pigweed, lambsquarters, and smartweed and can provide some control of velvetleaf. Modown 4F rates are 2½ to 4 pints per acre. Combinations with Dual, Lasso, or Surflan, or an overlay after Treflan can improve grass control. For preplant incorporation, the application should be made within 2 to 3 days of planting, and incorporation should distribute the herbicides uniformly in the top 1 inch of soil. Do not apply Modown after soybeans begin to emerge.

Soybeans may show stunting from Modown, especially from preemergence use followed by cold, wet soil conditions during early growth stages. Injury symptoms are cupping and crinkling of the first few leaves. Soybean injury is usually not reflected in yield.

Furloe Chloro IPC (chlorpropham) can be preplant incorporated with Treflan or Vernam; or it can be applied preemergence by itself or with Lasso to improve smartweed control. Preplant application should be done within a few days of planting soybeans, and incorporation should distribute the herbicide uniformly in the top 1 to 2 inches of soil. The rate in sequential or tank mix combinations is 2 to 3 quarts of Furloe 4E per acre. Furloe 20G is used preemergence at 10 to 15 pounds per acre.

Preemergence Herbicides

Lorox or Linex (linuron) is best suited to silt loam soils that contain 1 to 3 percent organic matter. *Do not apply to very sandy soils.* Linuron controls broadleaf weeds better than grass weeds. It does not control annual morningglory, and control of cocklebur and jimsonweed is variable. Accurate and uniform application and proper rate selection are necessary to minimize the risk of crop injury. Tank mix combinations allow the use of a reduced rate of linuron to decrease the risk of soybean injury, but may also decrease the degree of weed control.

Linuron is registered in tank mix combinations with Amiben, Lasso, Dual, Prowl, or Surflan to improve grass control. The rate of linuron in these combinations is 1 to 1⅔ pounds of linuron 50W or 1 to 1⅔ pints of linuron 4L on silt loam soils that have less than 3 percent organic matter.

Surflan (oryzalin) can control annual grasses, pigweed, and lambsquarters if there is adequate rainfall. You should rotary hoe to control emerging weeds if adequate rain does not fall within 7 days after application. Surflan can be used for early preplant application for no-till soybeans. Do not use on soils that have more than 5 percent organic matter. The rate is 1 to 2 pounds per acre of Surflan 75W (¾ to 1½ quarts AS [aqueous suspension]) used alone or ⅔ to 1⅓ pounds of Surflan 75W in combinations. Surflan can be tank-mixed with Amiben, Lorox, Lexone, Sencor, or Dyanap to improve broadleaf weed control. Surflan may cause stem callusing, which can lead to soybean lodging. Do not allow Surflan to contact the soybean seed. For no-till soybeans, Surflan can be applied in fall or early spring over undisturbed stubble from the previous crop.

Prowl can be applied preemergence in combination with Amiben, Lorox, Lexone, or Sencor. When applied to the soil surface, Prowl may cause stem callusing, which can lead to soybean lodging. (See preplant section for more information.)

Dyanap (dinoseb plus naptalam) can be applied to soybeans from the time they are planted until the time the unifoliate leaves of the seedling unfold and expose the growing point. Tank mixes of Dyanap plus Lasso, Dual, or Surflan are registered to improve grass control. Dyanap can also be tank-mixed with Lasso 4E plus Sencor. The Dyanap rate is 4 to 6 quarts per acre for preemergence application.

Postemergence Herbicides

Research suggests that soybean yields will probably not be reduced if weeds are controlled within 3 to 4 weeks after planting. Postemergence herbicides are most effective when their use is part of a planned program and when they are applied while the weeds are young and tender. They should not be considered simply as emergency treatments. It is especially important to use timely treatments when using postemergence herbicides in narrow-row soybeans. Postemergence herbicides are often the best choice for controlling problem weeds such as cocklebur, annual morningglory, and volunteer corn. Registered combinations are shown in Table 4. For more

Table 4. — Registered Postemergence Herbicide Combinations for Broadleaf Weed Control in Soybeans

	Amiben	Blazer	Butoxone*	Butyrac*
Alanap	X	—	X	X
Amiben		X	—	X
Basagran	—	X	—	X
Blazer	X		X	X
Dyanap	—	—	X	X

X = Registered.
— = Not registered.
* 2,4-DB.

information on conditions affecting application, see the section entitled "Postemergence Herbicide Principles."

Basagran (bentazon) can control many broadleaf weeds, such as cocklebur, jimsonweed, and velvetleaf. It is weak on pigweed, lambsquarters, and annual morningglory. It can be used for control of yellow nutsedge and Canada thistle but does not control annual grasses.

The suggested rate for Basagran is ¾ to 1 quart per acre, depending on the weed size and species. Application should be made when weeds are small (2-3 inches) and actively growing. These conditions usually exist when the soybeans are in the unifoliate to second trifoliate stage or within 2 to 3 weeks of planting. Spraying during warm sunny weather can also improve performance. Do not spray if rain is expected within 8 hours. Use a minimum of 20 gallons of water per acre and 40 psi spray pressure to get complete weed coverage. Adding a crop oil concentrate to Basagran may increase performance on most weeds but may cause some soybean injury. Morningglory that is up to 10 inches long can be controlled with the addition of 2 fluid ounces of 2,4-DB with Basagran. Do not add crop oil when mixing with 2,4-DB. Do not mix or apply Basagran with other pesticides or liquid fertilizer except as specified on the product label. Basagran may be labeled in 1986 with a 28-0-0 liquid fertilizer adjuvant.

Blazer (acifluorfen) should be applied when broadleaf weeds are in the 2- to 4-inch stage and actively growing. Weeds controlled include annual morningglory, pigweed, jimsonweed, and black nightshade. Cocklebur and morningglory control can be improved with the addition of 2 fluid ounces of 2,4-DB. Apply the mixture when cocklebur and morningglory measure no more than 10 to 12 inches.

The rate is 2 pints of Blazer 2L per acre. Blazer requires the addition of a nonionic surfactant at a minimum of 1 pint per 100 gallons of spray. The rate of surfactant may be increased to 2 to 4 pints per acre to improve control of small escaped grasses. Surfactant addition is recommended when combining Blazer and 2,4-DB.

Since Blazer is a contact herbicide, leaf burn often occurs; however, the crop usually recovers within 2 to 3 weeks. For ground application, use 20 to 40 gallons of water per acre applied with a minimum spray pressure of 40 psi. Do not spray if rain is expected within 6 hours.

Basagran plus Blazer provides a means of broadening the spectrum of control. The rate is 1 to 2 pints of each product in the combination. Crop oil concentrate may be added. To improve velvetleaf control with Blazer plus Basagran, 10-34-0 liquid fertilizer can be used at one quart per acre to replace the surfactant or crop oil concentrate (COC). Do not add COC when using 10-34-0. A mixture of Blazer plus Basagran plus 2 fluid ounces of 2,4-DB can be used to control cocklebur and morningglory under dry weather conditions. Refer to individual product labels for specifics.

Dyanap (dinoseb plus naptalam) at 2 quarts per acre can be applied to soybeans after the first trifoliate leaf is fully expanded until the soybeans become 20 inches tall. After 2 trifoliates are fully expanded, 3 quarts per acre may be used. Dyanap controls cocklebur, jimsonweed, and annual morningglory. A split application of 2 quarts at the first to second trifoliate stage, followed by 2 quarts 10 to 14 days later, is suggested for severe weed infestations. The addition of 2 fluid ounces per acre of 2,4-DB can improve control of some of the larger and more difficult weeds, especially if they are over 6 inches tall.

Best results are obtained by using high pressure (40 to 60 psi) and 8 to 10 gallons of water per acre. Use 5 gallons of water for aerial application. Although leaf burn can occur, the crop usually recovers within 2 to 3 weeks with little or no yield loss. Do not apply Dyanap to wet soybean foliage or if rain is expected within 6 hours. Do not add a surfactant or crop oil.

Amiben (chloramben) can be used for postemergence application on soybeans in the cracking to fourth trifoliate stage, but only within 33 days after planting. This treatment can be especially helpful in controlling velvetleaf, but smartweed, common ragweed, and pigweed may also be controlled or suppressed. Velvetleaf may be 1 to 8 inches tall and smartweed may be 1 to 3 inches tall. For ground applications, 10 to 20 gallons of water per acre, a spray pressure of 30 psi, and flat fan nozzle tips are suggested. The rate of Amiben 2S alone is 6 quarts; it is 5 to 6 quarts per acre in combination with either 2 to 3 fluid ounces of Butyrac 200, 2 to 3 quarts of Alanap, or 1½ to 2 pints of Blazer per acre. Crop oil concentrate should be used at 1 quart per acre with the Amiben alone or tank-mixed with Alanap. Do not add crop oil when tank-mixing with Butyrac. The Amiben plus Alanap or 2,4-DB should be applied when soybeans are in the third to sixth trifoliate stage. Apply the Amiben tank-mixed with Blazer at the appropriate rate for the weed size indicated on the Blazer label but within 33 days after planting. If Amiben is also soil-applied, do not use more than a total of 12 quarts per season.

Rescue (naptalam plus 2,4-DB) can be used for mid- to late-season postemergence control of cocklebur, giant ragweed, and wild sunflower; it may also suppress annual morningglory. Apply 3 quarts per acre after soybeans are about 14 inches tall or after first bloom. Use the lower rate when weeds are less than 12 inches tall. The addition of a crop oil concentrate or surfactant can improve

control. Application before the weeds flower is suggested for best control. The water volume per acre is 10 to 25 gallons for ground application and a minimum of 5 gallons for aerial application. If rain occurs within 6 hours, effectiveness may be reduced. Activity may not be very noticeable until 10 to 14 days after application; maximum activity should occur 20 to 30 days after application. Crop injury such as leaf twisting and terminal droop may occur. To avoid possible yield losses, do not apply Rescue to soybeans under stress from drought, disease, or injury from another herbicide. *Do not apply Rescue within 60 days of harvest.*

Hoelon (diclofop) can control small annual grasses in the 1- to 4-leaf stage and volunteer corn. Let all the volunteer corn emerge, but apply Hoelon before the corn that emerged first is too large to obtain adequate spray coverage. For ground application, use a minimum of 20 gallons of water per acre and 40 psi spray pressure. For aerial application, use a minimum of 5 gallons of water per acre. The Hoelon rate for annual grasses, including volunteer corn, is 2 to 3⅓ pints. Crop oil concentrate can be added at 1 to 2 pints per acre. Do not tank-mix Hoelon with other postemergence herbicides. *Hoelon is a restricted-use herbicide.*

Poast (sethoxydim) can be used for postemergence control of annual and perennial grasses in soybeans. The rate is 1 pint per acre to control foxtails or most other annual grasses that are 3 to 18 inches tall or volunteer corn or shattercane that is 6 to 18 inches tall. Apply ½ pint per acre when wild proso millet is 4 to 10 inches tall. For control of volunteer cereals, apply 1½ pints per acre before tillering, up to 6 inches tall. Poast is not recommended for spring control of volunteer cereals that emerged the previous fall. Wirestem muhly up to 6 inches tall can usually be controlled by a single application of 1¼ pints per acre. Poast can also be used as a rescue treatment for controlling selected annual grasses. Apply Poast at a rate of 1½ pints per acre for control of actively growing foxtails or seedling johnsongrass (up to 16 inch height), fall panicum or barnyardgrass (up to 12 inch height), and crabgrass or goosegrass (up to 8 inch height). For control of actively growing wild proso millet up to 24 inch height, apply Poast at 1 pint per acre.

Use 5 to 20 gallons of spray solution per acre for ground application and a minimum of 5 gallons per acre for aerial application. Use only standard high pressure hollow cone or flat fan nozzles with pressure at the nozzle adjusted to a minimum of 40 psi and a maximum of 60 psi. Always add crop oil concentrate at 2 pints per acre. Do not cultivate 5 days prior to Poast application or within 7 days following application.

Poast can be tank-mixed with Basagran, provided the Poast rate is increased by 50 percent to compensate for the reduced grass control that often occurs with this treatment. Sequential applications at least 24 hours apart may be more economical and practical, depending upon the weeds to be controlled and their size. Do not apply Poast if rainfall is expected within 1 hour. Do not apply Poast to grasses under stress from hot, dry weather or herbicide injury.

Blazer may be tank mixed with Poast (Blazer label) for postemergence control of broadleaf and annual grasses in soybeans. The rate per acre is 1½ to 2 pints of Blazer plus 1 pint of Poast plus 2 pints of crop oil concentrate for fall panicum and giant foxtail that are 3 to 8 inches tall. For other annual grasses on the Poast label increase the rate of Poast by 50 percent. Sequential applications should always be used in place of the tank mixtures for perennials and may be more economical for many annuals.

Fusilade 2000 (fluazifop) can be used for postemergence control of annual and perennial grass weeds in soybeans. Apply only to actively growing grasses before they tiller. The rate is 1½ pints per acre when giant foxtail is 2 to 6 inches tall and other annual grass weeds are 2 to 4 inches tall. Use ¾ pint per acre when volunteer corn is 12 to 24 inches tall, shattercane is 6 to 12 inches tall, or wild proso millet is 6 to 12 inches tall. For control of volunteer cereals, apply 1 pint per acre before plants are 2 to 6 inches tall. To control wirestem muhly, apply 1½ pint per acre when plants are 4 to 12 inches tall. Fusilade can also control johnsongrass and quackgrass (see specific weed section), but sequential applications may be needed.

The spray volume should be a minimum of 10 gallons per acre for ground application and 5 gallons per acre for aerial application. Add either crop oil concentrate at 1 percent by volume (1 gallon per 100 gallons of spray) or a nonionic surfactant at ¼ percent of spray volume. For aerial application add 1 pint of crop oil concentrate or surfactant per acre. Apply before soybeans bloom. *Do not tank-mix Fusilade with other postemergence herbicides intended for control of broadleaf weeds except as specified.* A tank mix of Fusilade 4E and Blazer 2L is labeled for use without an increase in the Fusilade rate.

Roundup (glyphosate) can be applied through several types of selective applicators — recirculating sprayers, wipers, or rope wicks. This application is particularly useful for control of volunteer corn, shattercane, and johnsongrass. Roundup may also suppress hemp dogbane and common milkweed. Weeds should be at least 6 inches above the soybeans. Avoid contact with the crop. Equipment should be adjusted so that the lowest spray stream or wiper contact is at least 2 inches above the soybeans. For equipment calibration, refer to the Roundup label. For recirculating sprayers and wipers, use the rates given on the label. For rope-wick applicators, mix 1 gallon of Roundup in 2 gallons of water. A spot treatment with Roundup is also a good option in many fields. For application made on a spray-to-wet basis, use a 1 to 2 percent solution of Roundup in water. For motorized spot treatments where less than complete coverage of weeds may result, use a 5 percent solution. Avoid contact of the spray with the soybeans. Add a dye for increased visibility.

Paraquat Harvest Aid

Paraquat and Gramoxone are registered for drying weeds in soybeans just before harvest. For indeterminate varieties (most Illinois varieties), apply when 65 percent of the seed pods have reached a mature brown color or when seed moisture is 30 percent or less. For determinate varieties, apply when at least one-half of the leaves have dropped and the rest of the leaves are turning yellow.

The rate is ½ to 1 pint of Paraquat or Gramoxone per acre. The higher rate is for cocklebur. The total spray volume per acre is 2 to 5 gallons for aerial application and 20 to 40 gallons for ground application. Add 1 quart of nonionic surfactant per 100 gallons of spray. Do not pasture livestock within 15 days of treatment, and remove livestock from treated fields at least 30 days before slaughter.

Specific Weed Problems

Yellow Nutsedge

Yellow nutsedge is a perennial sedge with a triangular stem. It reproduces mainly by tubers. Yellow nutsedge tubers begin sprouting about May 1 in central Illinois. For the most effective control, soil-applied herbicides should be incorporated into the top 2 inches of the soil.

For soybeans, a delay in planting until late May allows time for two or three tillage operations to destroy many nutsedge sprouts. These operations help deplete food reserves in nutsedge tubers. Row cultivation is helpful. Preplant applications of Lasso, Dual, Vernam, or Reward will also help.

Lasso (**alachlor**) preplant incorporated at 2½ to 4 quarts per acre can often give good control of nutsedge.

Dual (**metolachlor**) can be applied at 2 to 3 pints per acre to control nutsedge. Preplant incorporated treatment is preferred to treatment at the preemergence stage.

Vernam 7E (**vernolate**) applied preplant at 3½ pints per acre is also effective against yellow nutsedge. Reward 6E at 4 pints per acre is an alternative to Vernam. Immediate incorporation is necessary with Vernam or Reward.

Basagran (**bentazon**) applied postemergence can also help control nutsedge in soybeans. When nutsedge is 6 to 8 inches tall, ¾ to 1 quart per acre can be applied. If needed, a second application can be made 7 to 10 days later. The addition of a crop oil concentrate to Basagran may improve performance.

For corn that is planted relatively early, preplant tillage before nutsedge sprouts is of little help in control. Timely cultivation gives some control, but a program of herbicides plus cultivation has provided the most effective control of nutsedge.

Several preplant treatments are available. **Eradicane Extra** at 2⅔ to 4 quarts or **Eradicane, Sutan+**, or **Genate Plus** at 4¾ to 7⅓ pints per acre are effective for control of yellow nutsedge in corn. They must be incorporated immediately. **Lasso** or **Dual** applied in corn as for soybeans can also be quite effective.

The combinations of **Lasso, Dual, Sutan+, Genate Plus** or **Eradicane** incorporated with atrazine may improve control of nutsedge while also controlling broadleaf weeds.

Atrazine or **Bladex** (**cyanazine**) can be used as a postemergence spray to control emerged yellow nutsedge when it is small. Split applications of atrazine plus oil have been more effective than single applications. **Basagran** can be used in corn in a manner similar to that for soybeans. **Lorox** or **Linex** (**linuron**) directed postemergence spray has also given some control.

Johnsongrass

Johnsongrass can reproduce both from seeds and by rhizomes. Both chemical and cultural methods are needed to control johnsongrass rhizomes.

Much of the rhizome growth occurs after the johnsongrass head begins to appear. Mowing, grazing, or cultivating to keep the grass less than 12 inches tall can reduce rhizome production significantly.

Control of johnsongrass can also be improved with tillage. Fall plowing and disking bring the rhizomes to the soil surface, where many of them are winter-killed. Disking also cuts the rhizomes into small pieces, making them more susceptible to chemical control.

Johnsongrass rhizomes can be controlled or suppressed with the use of certain herbicides in various cropping programs. Several herbicides can provide control of johnsongrass seedlings in soybeans or corn (see the table at the end of this publication).

Treflan (**trifluralin**) or **Prowl** (**pendimethalin**) used in a 3-year soybean program has been fairly successful in controlling rhizome johnsongrass. They are used at 1½ to 2 times the normal rate each year for 2 years; in the third year, either they are used at the normal rate, or another suitable herbicide is used before a regular cropping sequence is resumed. Thorough preplant tillage and incorporation are necessary for satisfactory control. Be certain not to plant crops such as corn or sorghum the year following application of these herbicides at the higher rates.

Fusilade 2000 (**fluazifop**) can control johnsongrass in soybeans. Apply 1½ pints per acre when the weed is 8 to 18 inches tall. Apply before the boot stage of growth. If new shoots or regrowth occur, make a second application of 1 pint per acre when johnsongrass is 6 to 12 inches tall. Always add crop oil concentrate at 1 percent of volume or nonionic surfactant at 0.25 percent of volume.

Poast (**sethoxydim**) can control johnsongrass in soybeans. Apply 1½ pints plus 1 quart crop oil concentrate per acre when the johnsongrass is 15 to 25 inches tall. If regrowth or new growth occurs, apply 1 pint per acre when the johnsongrass is 6 to 12 inches tall.

Eradicane Extra can help control rhizome johnsongrass in corn when used at a rate of 4 quarts per acre

with a tillage program; or Eradicane 6.7E can be used at 7⅓ pints per acre.

Roundup (glyphosate) can be used as a spot treatment to control johnsongrass in corn, soybeans, or sorghum. Apply a 1 percent solution when johnsongrass has reached the boot to head stage and is actively growing. Use of Roundup in rope-wick applicators or recovery-type sprayers is effective for control of johnsongrass in soybeans. (See section on postemergence herbicides for soybeans.)

Roundup may be applied in small grain stubble when johnsongrass is in the early head stage. Fall applications should be made before the first frost. At least 7 days should be allowed after treatment before tillage.

Quackgrass

Quackgrass is a perennial grass with shallow rhizomes. It is found primarily in the northern part of Illinois.

Atrazine is quite effective when used as a split application in corn. Apply 2 quarts of atrazine 4L per acre in the fall or spring and plow 1 to 3 weeks later. Another 2 quarts per acre should be applied as a preplant or preemergence treatment. Postemergence application is usually less effective. A single treatment with 3 to 4 quarts per acre can be applied either in the spring or fall 1 to 3 weeks before plowing, but the split application usually gives better control of annual weeds. Use equivalent rates of other formulations. If more than 3 pounds of atrazine active ingredient is applied per acre, plant no crops other than corn or sorghum the next year.

Eradicane Extra can be used to suppress quackgrass in corn where more flexibility in cropping sequence is desired. A rate of 2⅔ quarts per acre of Eradicane Extra can be used on light infestations, while 4 quarts per acre is suggested for heavier infestations. There is some risk of corn injury, especially at the higher rate. A tank mix with atrazine should improve control. If Eradicane 6.7E is used, the rate should range from 4¾ to 7⅓ pints per acre.

Fusilade 2000 (fluazifop) may be used for quackgrass control in soybeans at 1½ pints per acre. Apply when quackgrass is 6 to 10 inches tall. If regrowth occurs, a second application of 1 pint per acre may be made. Best results are obtained with Fusilade and most other treatments if rhizomes are cut up by preplant tillage to stimulate maximum emergence of grass shoots. Always add crop oil concentrate or nonionic surfactant to Fusilade.

Poast (sethoxydim) can be applied in soybeans at the rate of 2½ pints plus 1 quart of crop oil concentrate per acre when quackgrass is 6 to 8 inches tall. If regrowth occurs or new plants emerge, apply 1½ pints per acre when the quackgrass is 6 to 8 inches high.

Roundup (glyphosate) can be used for controlling quackgrass before planting corn, sorghum, or soybeans. Apply 1 to 3 quarts per acre when quackgrass is 8 inches tall and actively growing (fall or spring). For annual cropping systems apply 1 quart per acre in 5 to 10 gallons of spray with surfactant added. Delay tillage for 3 or more days after application.

Wirestem Muhly

Wirestem muhly occurs primarily as a problem in northern and western Illinois. It is a perennial which reproduces by seeds and scaly rhizomes. These rhizomes are often moved by chisel plows, field cultivators, and shovel cultivators. Many farmers report that delayed seedbed preparation, where possible, can provide some control of wirestem muhly. However, wirestem muhly does not start growth until late in the spring.

Roundup can be used early preplant (early June) or post-harvest when wirestem muhly is at least 8 inches tall and actively growing. Do not fall or spring till before applications. The rate is 1 quart of Roundup in 5 to 10 gallons of water per acre with surfactant added at 2 to 4 quarts per 100 gallons. Use flat fan nozzles. Wait 3 days before tillage after application.

Atrazine at high rates can provide some control of wirestem muhly in corn. Rates must be at highest labeled rates for the soil (see Quackgrass section).

Fusilade can be used postemergence to control wirestem muhly in soybeans. The rate is 1½ pints per acre when wirestem muhly plants are 4 to 12 inches.

Poast can also be used postemergence in soybeans to control wirestem muhly which is 6 inches tall. The rate is 1½ pints per acre. See Soybean Postemergence section for more information on Poast and Fusilade.

Canada Thistle

Canada thistle is a perennial weed that has large food reserves in its root system. There are several varieties of Canada thistle. They differ not only in appearance but also in their susceptibility to herbicides.

2,4-D may give fairly good control of some strains. Rates will depend on where the thistle is growing. For example, higher rates can be used in grass pastures or in noncrop areas than can be used in corn.

Banvel (dicamba) often is a little more effective than 2,4-D and may be used alone or in combination with 2,4-D. Banvel can be used as an after-harvest treatment in wheat, corn, or soybean fields or in fallow fields. Rates vary from 1 to 2 quarts of Banvel alone or in tank-mix combinations with 2,4-D or Roundup. Fall treatments should be applied before killing frosts. For best results thistles should be fully emerged and actively growing. Fields treated in the fall with Banvel may be planted to corn, sorghum, or wheat the next season.

Atrazine and oil applied postemergence has been fairly effective in controlling Canada thistle in corn. Make the application before thistles are 6 inches tall.

Basagran (bentazon) can be used for control of Canada thistle in soybeans or corn when the thistles are 8 to 12 inches tall. Apply ¾ to 1 quart per acre in a single application, or for better control make two applications of ¾ to 1 quart per acre each, 7 to 10 days apart.

Roundup (**glyphosate**) can be used at 2 to 3 quarts per acre when Canada thistle is at or beyond the early bud stage. Fall treatments must be applied before frost for best results. Allow 3 or more days after application before tillage.

Black Nightshade

Black nightshade has become an increasing problem for Illinois soybean growers. The berries are about the same size as soybeans at harvest. They contain a sticky juice that can gum up a combine.

Black nightshade can be controlled easier in corn than in soybeans. Herbicides such as atrazine, Bladex, Banvel, Lasso, and Dual are helpful for controlling this weed in corn.

If possible, plant suspect fields to corn rather than to soybeans. If soybeans must be planted, plant suspect fields last. Preemergence applications usually maintain control longer than those that are preplant incorporated.

For control in soybeans, Lasso, Dual, Amiben, or linuron at full rates or a combination of Amiben or linuron with Lasso or Dual is helpful. Suspect fields should be monitored and a postemergence application of Blazer considered. Blazer 2L at 2 pints per acre can control nightshade when applied at the 2- to 4-leaf stage.

Harvest-aid sprays generally do not solve the problem because they do not make the berries fall before the soybeans are harvested.

Additional Information

Not all herbicides and herbicide combinations available are mentioned in this publication. Some are relatively new and are still being tested. Some are not considered to be well adapted to Illinois or are not used very extensively. For further information on field crop weed control, consult your county extension adviser or write to the Department of Agronomy, N-305 Turner Hall, University of Illinois at Urbana-Champaign, 1102 S. Goodwin Avenue, Urbana, Illinois 61801.

Relative Effectiveness of Herbicides on Major Weeds

This chart gives a general comparative rating. Under unfavorable conditions, some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions, control may be better than indicated. Type of soil is also a very important factor to consider when selecting herbicides. Rate of herbicide used also will influence results. G = good, F = fair or variable, and P = poor.

	Grasses								Broadleaf Weeds									
	Crop tolerance	Foxtail	Barnyardgrass	Crabgrass	Fall panicum	Johnsongrass seedlings or Shattercane	Volunteer corn	Yellow nutsedge	Annual morningglory	Cocklebur	Jimsonweed	Lambsquarters	Nightshade, black	Pigweed	Ragweed, common	Ragweed, giant	Smartweed	Sunflower, wild	Velvetleaf
SOYBEANS																			
Preplant																			
Treflan, Sonalan	F-G	G	G	G	G	G	F	P	P-F	P	P	G	P-F	G	P	P	P-F	P	P
Sencor, Lexone + dinitroaniline	F	G	G	G	G	G	F	P	F	F	F-G	G	P	G	G	F	G	F	F-G
Vernam, Reward	F	G	G	G	G	G	P-F	F	P-F	P	P	F	P	G	P	P	P	P	F
Preplant or Preemergence																			
Amiben	F-G	G	F-G	F-G	F-G	F	P	P	P	P	P-F	G	F-G	G	F-G	F	F-G	P	F
Lasso, Dual	G	G	G	G	G	P-F	P	F-G	P	P	P	F	F-G	G	P-F	P	P-F	P	P
Lasso or Dual + Sencor or Lexone	F	G	G	G	G	P	P	F	P	F	F-G	G	F-G	G	F	F	G	F	F-G
Lasso or Dual + Lorox,[1] Linex[1]	F	G	G	G	G	P	P	P-F	P	F	F	G	F-G	G	G	F	G	F	F-G
Lorox,[1] Linex[1]	F	F	F	F	F	P	P	P	P	F	F	G	F	G	G	F	G	F	F-G
Sencor, Lexone	F	F	F	F	F	P	P	P	P	F	F-G	G	P	G	G	F	G	F	F-G
Surflan,[1] Prowl	F-G	G	G	G	G	G	F	P	P-F	P	P	G	P	G	P	P	P-F	P	P-F
Postemergence																			
Basagran	F-G	P	P	P	P	P	P	F	P-F	G	G	F-P	P	P	F	F	G	G	F-G
Blazer	F	P-F	P	P-F	P	P	P	P	G	F	G	F-P	F-G	G	F-G	F-G	G	F	P
Dyanap	F	P	P	P	P	P	P	P	F-G	G	G	F	P-F	F	F	F	P-F	F	P
2,4-DB	P-F	P	P	P	P	P	P	P	F-G	G	P-F	F	P	F	F	F	P	F	P
Poast, Fusilade	G	G	G	G	G	G	G	P	P	P	P	P	P	P	P	P	P	P	P
Rescue	F-G	P	P	P	P	P	P	P	F	G	F	P-F	P	F-G	P	G	P	G	P
CORN																			
Preplant																			
Butylate, EPTC	F-G	G	G	G	G	F-G		F-G	P	P	P	P-F	F	G	P	P	P	P	F
Butylate, EPTC + atrazine, Bladex	F-G	G	G	G	G	F-G		F-G	F-G	F-G	G	G	G	G	G	F	G	F-G	F-G
Princep + atrazine	G	F-G	F-G	F	F	P-F		P	F-G	F-G	G	G	G	G	G	G	G	G	F
Preplant or Preemergence																			
Atrazine	G	F-G	F	P	P	P		F	G	F-G	G	G	G	G	G	G	G	G	F-G
Bladex	F-G	F-G	F-G	F-G	G	P		P	F	F-G	G	G	G	F	G	F-G	G	F-G	F-G
Bladex + atrazine	F-G	F-G	F	F	F-G	P		P	F-G	F-G	G	G	G	G	G	F-G	G	F-G	F-G
Lasso, Dual	F-G	G	G	G	G	P-F		F-G	P	P	P	F	F-G	G	P-F	P	P-F	P	P
Lasso or Dual + atrazine or Bladex	F-G	G	G	G	G	P		F-G	F-G	F	G	G	G	G	G	F	G	F-G	F
Prowl + atrazine or Bladex[1]	F	G	G	G	G	F		P	F-G	F	G	G	G	G	G	F	G	F-G	F-G
Ramrod[1]	G	G	F	F-G	F	P		P-F	P	P	P	F	P	G	P	P	P	P	P
Postemergence																			
Atrazine + oil	F-G	F-G	G	P	P	P		F	G	G	G	G	G	G	G	F	G	G	G
Banvel	F-G	P	P	P	P	P		P	G	G	G	G	G	G	G	G	G	G	F
Basagran	G	P	P	P	P	P		F	P-F	G	G	F-P	P	P	F	F	G	G	F-G
Bladex	F-G	G	G	F	F-G	P		F	F	F-G	G	F	G	F-G	G	F	G	F	F-G
Buctril, Brominal	F-G	P	P	P	P	P		P	G	G	G	G	G	F	G	F	G	F-G	F
2,4-D	F	P	P	P	P	P		P	G	G	F	G	F	G	G	G	P-F	G	F-G

[1] Do not use for preplant incorporation.

Weed Control in Small Grains, Pastures, and Forages

Good weed control is essential for maximum production of high quality small grains, pastures, and forages in Illinois. When properly established, crops can usually compete effectively with weeds; herbicides may therefore be unnecessary. In some instances, however, weeds do become major problems that warrant control. For example, wild garlic is considered the worst weed problem in wheat in southern Illinois. Having a life cycle similar to winter wheat, wild garlic can establish itself with the wheat, grow to maturity, and produce large quantities of bulblets by wheat harvest time.

In pastures, brush species and thistles can often become troublesome. Annual grasses and broadleaf weeds such as chickweed and henbit may cause problems in hay crops. Through proper management, many of these weed problems can be effectively managed, if not avoided.

Small Grains

Good weed control is critical for maximum production of high quality small grains. Many weed problems can be dealt with before the establishment of oats or wheat. For example, wild garlic can be controlled in the late fall after corn or soybean harvest. When the weeds are actively growing, spray them with 2 to 3 quarts per acre of 2,4-D ester (4 pounds a.i.) on warm days.

Tillage is another method of controlling weeds. Although generally limited to preplant and postharvest operations, tillage can destroy many annual weeds and help suppress certain perennials. Good cultural practices such as proper seeding rate, optimum soil fertility, and timely planting will help establish the crop and make it more competitive with weeds.

If annual broadleaf weeds become a problem later on, the judicious use of recommended herbicides may be needed. Postemergence herbicides such as 2,4-D, MCPA, dicamba, and bromoxynil can provide relatively good control of susceptible species (see Table 1). However, most perennial broadleaf weeds cannot be controlled satisfactorily at the low herbicide rates used in small grains; higher rates are undesirable because they can cause serious crop injury. To control perennial weeds, translocated herbicides such as 2,4-D, dicamba, or glyphosate (Roundup) should be used in combination with tillage before establishing small grains.

A decision to use postemergence herbicides for broadleaf weed control in small grains should be based on several considerations:

1. *Nature of the weed problem.* Identify the species present and rank the severity of the infestation. Also note the size of the weeds. Weeds are usually best controlled while quite small.

2. *Stage of the crop.* Most herbicides are applied after full tiller until the boot stage. Don't apply herbicides from the boot stage up to the hard dough stage of most small grains. (Boot stage refers to the period when head formation causes the sheath to swell.)

3. *Presence of a legume underseeding.* Usually 2,4-D ester formulations and certain other herbicides listed in Table 2 should not be applied because they may damage the legume underseeding.

4. *Herbicide activity.* Determine crop tolerance and weed susceptibility to herbicides by referring to Tables 1 and 2. Use the lower rates in Table 2 on the more easily controlled weeds and the higher rates on the more difficult species. Tank mixes may broaden the weed spectrum and thereby improve control; check the herbicide label for registered combinations.

5. *Economic justification.* Consider cost of the treatment in terms of potential benefits such as value of increased yield, improved quality of grain, and ease of harvesting the crop.

Table 2 outlines current suggestions for weed control options in wheat and oats, the two most commonly grown small grains in Illinois. Always consult the herbicide label for specific information about the use of a given product.

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Grass Pastures

Unless properly managed, broadleaf weeds can become serious in grass pastures. They can compete directly with forage grasses and reduce the nutritional value and longevity of the pasture. Certain species such as white snakeroot and poison hemlock are poisonous to livestock.

Perennial weeds are probably of greatest concern. They can exist for many years, reproducing both from underground parent rootstocks and from seed. While occasional mowing or grazing helps control certain annuals, perennials can grow back from underground root reserves.

Certain biennials can also flourish in grass pastures. The first year, they exist as a prostrate rosette, so even close mowing does little to control their growth. The second year, biennials produce a seedstalk and a deep taproot. If grazed or mowed at this stage, root reserves can sometimes allow the plant to grow again, thereby increasing its chances of surviving to maturity.

In general, the use of good cultural practices such as optimum soil fertility, rotational grazing, and periodic mowing can help keep grass pastures in good condition and more competitive with weeds. However, where weeds become troublesome, 2,4-D or Banvel can be used; Tordon and Roundup can also be used as spot treatments.

Proper identification of the target weed species is important. As shown in Table 3, weed species vary in their susceptibility to different herbicides. Timing of application of a herbicide may also affect the degree of weed control. Annuals and biennials are most easily controlled while young and relatively small. A fall or early spring treatment may be called for if biennials or winter annuals are the main weed problem. Consider a spring or early summer treatment for summer annuals. To control established perennials, apply herbicides when weeds are in the bud to bloom stage. Perennials are most susceptible at this time because food reserves are moving back into the roots.

Spray woody brush species after they are fully leafed out and actively growing. Where regrowth occurs, a second treatment may be needed in the fall. During the dormant season, oil-soluble forms of 2,4-D or Banvel can be used in fuel oil.

The weed control options in grass pastures are shown in Table 4. Always consult the herbicide label for specific information about the use of a given product.

Forage Legumes

Weed control is very important in the management of forage legumes. Weeds can severely reduce the vigor of legume stands and thus cause losses in yield and forage quality. Good management begins with weed control practices that prevent weeds from becoming serious problems.

To minimize problems, prepare the seedbed properly so that it is clean and firm, and select an appropriate legume variety. If you use high quality seed and follow the recommendations for liming and fertility, the legume crop may vigorously crowd out many weeds and reduce the need for herbicides.

In fields where companion crops such as oats are used to reduce weed competition, seed at about half the rate for grain production to ensure that the legumes will become established without undue stress. If the legume is seeded without a companion crop (direct seeded), the use of an appropriate herbicide is suggested.

Balan and Eptam or Genep are registered for preplant incorporation for legumes that are not seeded with grass or small grain companion crops. These herbicides will control most grasses and some broadleaf weeds. In fall plantings, the weeds controlled include winter annuals such as downy bromegrass and cheat. In spring legume plantings, the summer annual weeds controlled include foxtails, pigweeds, lambsquarters, crabgrass, and fall panicum.

Eptam or Genep may also help suppress johnsongrass seedlings, yellow nutsedge, and shattercane, but will not effectively control mustards, smartweed, or established perennials. Balan and Eptam or Genep need to be thoroughly incorporated soon after application to prevent herbicide loss. They should be applied shortly before the legume is seeded so that they will remain effective as long as possible into the growing season.

Weeds that emerge during crop establishment should be evaluated for their potential to become problems. If they do not reduce the nutritional value of the forage or if they can be controlled by mowing, they should not be the primary target of postemergence herbicides. Winter annual weeds, for instance, do not compete vigorously with the crop after the first spring cutting. Unless these weeds are unusually dense or weed seed production becomes a concern, they may not be a significant problem. Some weeds such as dandelions are palatable and may not need to be controlled if the overall legume stand is dense and healthy. However, undesirable weeds must be controlled early to prevent their establishment.

Table 5 outlines current suggestions for weed control options in legume forages. The degree of control will often vary with weed size, application rate, and environmental conditions. Be sure to select the correct postemergence herbicide for the specific weeds to be controlled (see Table 6). Always consult the herbicide label for specific information about the use of a given product.

Table 1. — Effectiveness of Herbicides on Weeds in Small Grains

This table gives a general comparative rating. Under unfavorable conditions, some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions, control may be better than indicated. Rate of herbicide used will also influence results. E = excellent, G = good, F = fair or variable, and P = poor.

Weed	Life cycle	Susceptibility to herbicide			
		2,4-D (many)	MCPA (many)	Dicamba (Banvel)	Bromoxynil (Buctril, Brominal)
Dandelion	perennial	F	F	E	P
Horseweed (marestail)	annual	F	F	E	F
Lambsquarters, common	annual	E	E	E	G
Mustard, wild	annual	E	E	F	F
Nightshade, eastern black	annual	F	F	G	G
Pennycress, field	annual	E	E	F	F
Pigweed spp.	annual	E	E	E	F
Ragweed, common	annual	E	F	E	F
Ragweed, giant	annual	E	F	E	F
Shepherdspurse	annual	G	G	F	F
Smartweed	annual	G	F	E	G
Velvetleaf	annual	G	G	F	E
Wild buckwheat	annual	F	F	E	G
Wild garlic	perennial	G	F	P	P
Wild lettuce	annual	E	G	E	F

Table 2. — Weed Control in Small Grains

Herbicide	Broadcast rate/acre	Remarks	Restrictions
OATS AND WHEAT			
2,4-D, 4 lb a.i. (amine)	½ to 1½ pt	Winter wheat more tolerant than oats. Apply in spring after full tiller but before boot stage. Do not treat in fall. Use lower rate of amine if underseeded with legume. Some legume damage may occur. May be used as preharvest treatment at 1 to 2 pints per acre during hard dough stage.	Do not forage or graze within 2 weeks after treatment. Do not feed treated straw to livestock.
MCPA (amine)	¼ to 3 pt	Less likely than 2,4-D to damage oats and legume underseeding. Apply from 3-leaf stage up to boot stage. Rate varies with crop and weed size and presence of legume underseeding.	Do not graze dairy animals on treated areas for 7 days after treatment.
Banvel, 4 lb a.i. Banvel II, 2 lb a.i.	4 fl oz 8 fl oz	Do not apply to small grains with legume underseeding. In fall-seeded wheat, apply before jointing stage. In spring-seeded oats, apply before oats exceed 5-leaf stage.	Do not graze or harvest for dairy feed before ensilage (milk) stage.
Bromoxynil (Buctril 2E or Brominal ME4)	1½ to 2 pt ½ to 1 pt	Do not apply to small grains with legume underseeding. Apply bromoxynil alone to fall-seeded small grains in the fall or spring but before the boot stage. In spring-seeded oats apply from the one-leaf stage up to the boot stage. Weeds are best controlled before they are past the 3- to 4-leaf stage or less than 1½ inches across if rosettes.	Do not graze treated fields for 30 days after application.
WHEAT ONLY			
2,4-D, 4 lb a.i. (ester)	½ to ¾ pt	Do not apply to wheat with legume underseeding. Apply in spring after full tiller but before boot stage. For preharvest treatment apply 1 to 2 pints per acre during hard dough stage. For control of wild garlic or wild onion apply 1 to 2 pints in the spring when wheat is 4 to 8 inches high after tillering but before jointing. These rates may injure the crop.	Do not forage or graze within 2 weeks after treatment. Do not feed treated straw to livestock.

Table 3. — Effectiveness of Herbicides on Weeds in Grass Pastures

This table gives a general comparative rating. Under unfavorable conditions, some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions, control may be better than indicated. Rate of herbicide used will also influence results. E = excellent, G = good, F = fair or variable, P = poor, and N = none.

Weed	Life cycle	Susceptibility to herbicide			
		2,4-D (many)	Dicamba (Banvel)	Picloram (Tordon)	Glyphosate (Roundup)
Burdock, common	biennial	E	E	E	G
Daisy, oxeye	perennial	F	E	E	G
Dandelion	perennial	E	E	E	G
Dock, curly	perennial	P-F	E	E	G
Goldenrod spp.	perennial	F	G	E	E
Horseweed (marestail)	annual	F	E	E	E
Ironweed	perennial	F	G	E	E
Milkweed, common	perennial	P	F	G	F
Multiflora rose	perennial	F	G	G	G
Nettle, stinging	perennial	G	G	G	G
Pennycress, field	annual	E	E	E	E
Plantain spp.	perennial	E	G	E	G
Poison hemlock	biennial	G	E	E	G
Ragweed, common	annual	E	E	E	E
Ragweed, giant	annual	E	E	E	E
Snakeroot, white	perennial	F	G	G	G
Sorrel, red	perennial	N	E	E	E
Sowthistle	perennial	F	G	G	G
Thistle, bull	biennial	E	E	E	E
Thistle, Canada	perennial	F	E	E	G
Thistle, musk	biennial	E	G	E	E
Water hemlock, spotted	perennial	G	E	E	G

Table 4. — Broadleaf Weed Control in Grass Pastures

Herbicide	Rate/acre	Remarks	Restrictions
2,4-D, 4 lb a.i. (amine or low volatile ester)	2 to 4 pt	Broadleaf weeds should be actively growing. Higher rates may be needed for less susceptible weeds and some perennials. Spray bull or musk thistles in the rosette stage (spring or fall) while actively growing. Spray perennials such as Canada thistle in the bud stage. Spray susceptible woody species in spring when leaves are fully expanded.	Do not graze dairy animals within 7 days after treatment. Do not apply to newly seeded areas or after heading begins. Do not apply to grass when in boot to milk stage.
Banvel, 4 lb a.i. Banvel II, 2 lb a.i. (double the rate shown at right)	Annuals: ½ to 1½ pt Biennials: ½ to 3 pt Perennials: 1 to 2 pt (suppression) Perennials: 1 to 6 qt (control) Woody brush: 1 to 2 pt (suppression) Woody brush: 1 to 8 qt (control)	Use lower rates for susceptible annuals when small and actively growing and for susceptible biennials in the early rosette stage. Use higher rates for larger weeds, for less susceptible weeds, for established perennials in dense stands, and for certain woody brush species.	Refer to label for specific timing restrictions for lactating dairy animals. Remove meat animals from treated areas 30 days before slaughter.
Tordon 10K (picloram)	40 lb/acre or 1 lb/1,000 sq ft or 1½ oz/100 sq ft	Apply to soil for control of undesirable woody plants such as multiflora rose, hawthorn, juniper, sumac. Applications are best made in spring or early summer or during times of rapid growth. Apply to individual plants and clumps or to larger, dense infestations. Spread uniformly over plant root areas. Will not be effective until it rains. More than one treatment may be needed. Injury or suppression of certain grasses such as smooth bromegrass may occur. May kill or injure desirable forbs, trees, or shrubs from root uptake.	A restricted-use pesticide. Limit coverage to 25% of an applicator's acreage. Do not use in sandy soils where groundwater levels are less than 10 feet deep. Use spot treatment on slopes where rapid runoff can occur. Do not use where surface runoff may flow to adjacent broadleaf crop areas. Apply to forage grasses only. Do not rotate treated pastures to other crops for at least 2 years after application. Do not treat pastures having desirable legumes. Do not move livestock from a treated area to a broadleaf crop area without first grazing 7 days on untreated grass pasture.
Roundup (glyphosate)	2% solution (spot treatment)	Controls a variety of herbaceous and woody brush species such as multiflora rose, brambles, poison ivy, quackgrass. Spray foliage of target vegetation completely and uniformly, but not to point of runoff. Avoid contact with desirable nontarget vegetation. Consult label for recommended timing of application for maximum effectiveness on target species.	No more than 1/10 of any acre should be treated at one time. Further applications may be made in the same area at 30-day intervals. Allow 14 days after application before grazing or harvesting forage.

Table 5. — Weed Control in Forages

Herbicide	Legume	Time of application	Broadcast rate/acre	Remarks	Restrictions
PURE LEGUME FORAGES					
Seedling year					
Balan 1.5EC	Alfalfa, birdsfoot trefoil, red clover, ladino clover, alsike clover	Preplant incorporated	3 to 4 qt	Apply shortly before seeding. Do not use with any companion crop of small grains.	Do not use on soils high in organic matter.
Eptam 7E or Genep 7E	Alfalfa, birdsfoot trefoil, lespedeza, clovers	Preplant incorporated	3½ to 4½ pt	Apply shortly before seeding. Do not use with any companion crop of small grains.	Do not use on white Dutch clover.
Butyrac 200 or Butoxone	Alfalfa, birdsfoot trefoil, ladino clover, red clover, alsike clover, white clover	Postemergence	1 to 3 qt (amine) 3 to 4 pt (ester)	Use amine or ester formulation when weeds are less than 3 inches high, or less than 3 inches across if rosettes. Use higher rates for seedling smartweed or curly dock. Do not use on sweet clover.	Do not harvest or graze for 60 days following treatment.
Dinoseb (amine)	Alfalfa, birdsfoot trefoil, red clover, ladino clover, sweet clover	Postemergence	1½ to 2 qt	Apply when legume has two or more leaves and weeds are small. Cool (below 70°F) or drought conditions may reduce control.	Do not harvest or graze for 6 weeks following application.
Furloe 4EC	Alfalfa only Certain clovers and birdsfoot trefoil	Postemergence	1 to 3 qt 1 to 2 qt	Apply after the 4-leaf stage in alfalfa. Used mainly for chickweed control.	Do not harvest or graze for 40 days.
Kerb 50W	Alfalfa, birdsfoot trefoil, crown vetch, clovers	Postemergence	1 to 3 lb	In fall-seeded legumes, apply after legumes have reached trifoliate stage. In spring-seeded legumes, apply next fall.	Do not graze or harvest for 120 days following application.
Established stands					
Butyrac 200 or Butoxone	Alfalfa only	Growing	1 to 3 qt (amine) 3 to 4 pt (ester)	Use amine or ester formulation. Spray when weeds are less than 3 inches high, or less than 3 inches wide if rosettes. Fall treatment of fall-emerged weeds may be better than spring treatment. Do not apply to sweet clover.	Do not harvest or graze for 30 days following application.
Furloe 4EC	Alfalfa only Certain clovers and birdsfoot trefoil	Growing or dormant	1 to 3 qt 1 to 2 qt	Apply when moisture is sufficient to move herbicide into root zone. Used mainly for chickweed control.	Do not harvest or graze for 40 days following application.
Kerb 50W	Alfalfa only	Growing or dormant	1 to 3 lb	Apply in fall after last cutting when weather and soil temperatures are cool.	Do not harvest or graze for 120 days.
Dinoseb (amine)	Alfalfa, birdsfoot trefoil, ladino clover, red clover, sweet clover only	Growing or dormant	1 to 4 qt	Use lower rates for chickweed seedlings in growing legumes. Where weeds become well established, use higher rates but delay application until legume is dormant.	Do not graze or feed treated forage within 6 weeks after spraying.
Princep 80W	Alfalfa only	Growing or dormant	1 to 1½ lb	Apply once per year in the fall after last cutting but before ground freezes permanently.	Do not use on sandy soils. Allow 30 days between application and grazing livestock; 60 days between application and cutting for hay.

Table 5. — Weed Control in Forages (continued)

Herbicide	Legume	Time of application	Broadcast rate/acre	Remarks	Restrictions
Sencor or Lexone 4L 75 DF 50 WP	Alfalfa only	Dormant	¾ to 2 pt (4L) ½ to 1⅓ lb (75 DF) ¾ to 2 lb (50 WP)	Apply once in the fall or spring before new growth starts. Rate based upon soil type and organic matter content.	Do not use on sandy soils or soils with pH greater than 7.5. Do not graze or harvest for 28 days.
Sinbar 80W	Alfalfa only	Dormant	½ to 1½ lb	Apply once in the fall or spring before new growth starts. Use lower rates for coarser soils.	Do not use on sandy soils with less than 1% organic matter. Do not plant any crop for 2 years.
Velpar L	Alfalfa only	Dormant	1 to 3 qt	Apply in the fall or spring before new growth exceeds 2 inches in height. Can also be applied to stubble after hay crop removal but before regrowth exceeds 2 inches.	Do not plant any crop except corn within 2 years of treatment. Corn may be planted 12 months after treatment, provided deep tillage is used. Do not graze or harvest for 30 days.
Paraquat CL Gramoxone	Alfalfa only	Dormant	2 to 3 pt	Apply after last fall cutting or before spring growth is 1 inch tall. Weeds should be succulent and growing at the time of application. Weeds germinating after treatment will not be controlled.	A restricted use herbicide. Do not apply if fall regrowth following the last fall cutting is more than 6 inches tall. Do not harvest or graze for 60 days.
Roundup	Alfalfa or clover	Growing	2% solution (spot treatment)	Apply to actively growing, susceptible weeds. Avoid contact with desirable, nontarget vegetation as damage may occur. Refer to label for recommended timing of application for maximum effectiveness on target species.	No more than 1/10 of any acre should be treated at one time. Further applications may be made in the same area at 30-day intervals. Do not graze or harvest for 14 days.
MIXED GRASS-LEGUME FORAGES					
Established stands					
Sencor or Lexone 4L 75 DF 50 WP	Alfalfa-grass mixtures	Dormant	¾ to 1½ pt (4L) ½ to 1 lb (75 DF) ¾ to 1½ lb (50 WP)	Apply once in the fall or spring before new growth starts. Rate based on soil type and organic matter content. Higher rates may injure grass component.	Do not use on sandy soils or soils with pH greater than 7.5. Do not graze or harvest for 28 days.
Roundup	Alfalfa or clover-grass mixture	Growing	2% solution (spot treatment)	Apply to actively growing, susceptible weeds. Avoid contact with desirable, nontarget vegetation as damage may occur. Refer to label for recommended timing of application for maximum effectiveness on target species.	No more than 1/10 of any acre should be treated at one time. Further applications may be made in the same area at 30-day intervals. Do not graze or harvest for 14 days.

Table 6. — Effectiveness of Herbicides on Weeds in Legume and Legume-Grass[a] Forages

This table gives a general comparative rating. Under unfavorable conditions, some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions, control may be better than indicated. Rate of herbicide used will also influence results. E = excellent, G = good, F = fair or variable, and P = poor.

	Balan	Genep Eptam	Butyrac, Butox-one	Dino-seb	Furloe	Kerb	Para-quat, Gramox-one	Prin-cep	Sencor, Lexone[a]	Sin-bar	Vel-par	Roundup[a]
Barnyardgrass	G	G	P	P	P	F	F	F	F	F	G	E
Chickweed, common	P	P	P	G	G	F	G	G	G	G	G	E
Crabgrass	G	G	P	P	P	F	F	F	F	G	G	E
Dandelion	P	P	F	P	P	P	F	F	G	P	G	G
Dock, curly	P	P	P	P	P	P	F	P	P	P	P	G
Downy brome	G	G	P	P	G	G	G	G	G	G	F	G
Fall panicum	G	G	P	P	P	P	F	F	F	P	P	E
Foxtails	G	G	P	P	P	F	F	F	F	G	G	E
Lambsquarters	G	G	F	G	P	P	F	G	G	G	G	E
Mustard, wild	P	P	E	G	P	P	G	F	G	G	G	E
Nightshade[b]	P	F	F	F	F	P	F	P	G	P	P	E
Orchardgrass	P	P	P	P	P	F	F	F	F	F	G	F
Pigweed	G	G	F	G	P	P	F	G	G	F	G	E
Quackgrass	P	F	P	P	P	P	P	F	F	F	F	G
Ragweed, common	P	P	G	G	P	P	F	G	G	F	F	E
Shepherdspurse	P	P	G	G	P	P	G	G	G	G	G	E
Smartweed	P	P	P	G	F	P	F	F	F	F	F	E
Yellow nutsedge	P	F	P	P	P	P	P	P	F	P	P	F

[a] Sencor, Lexone, and Roundup are labelled for use in mixed legume-grass forages. No other herbicides are cleared for this use.
[b] Control of different species may vary.

Weed Management Guide 1986

FOR COMMERCIAL VEGETABLE GROWERS

Restricted-use herbicides are identified with an asterisk(*).
You must be certified as a pesticide applicator to use restricted-use pesticides.
See your county Extension adviser in agriculture for information.

WEED GROWTH reduces the income of vegetable growers in the United States by millions of dollars annually as a result of lower yields, poorer quality, and added labor in harvesting and processing.

This guide should be used together with the grower's knowledge of soil types and the crop and weed history of the area to be treated. Whether to use herbicides or other means of weed control depends in part on the severity of past weed infestations. In some instances, mechanical control may be sufficient. If so, shave off weeds with a sharp hoe or cultivator while gently breaking up the crust. Deep tillage causes severe injury to many shallow-rooted plants and helps place a fresh supply of weed seeds in position to germinate. Keeping equipment sharp and in good condition will help reduce injury to desirable plants. Hoe carefully around your plants, and hand pull weeds close to the plants.

For warm season crops such as fresh market tomatoes, peppers, eggplant, okra, cucumbers, and melon, black polyethylene mulch will control annual weeds, conserve moisture, and increase the soil temperature in early spring. The higher temperature increases early season growth. Natural mulch materials may require considerable hand labor for application. Most organic materials are bulky and must be hauled to the place of use. This is a problem for large commercial plantings. Organic mulches tend to reduce soil temperature.

Herbicide application may be needed in addition to mechanical control. Several herbicides may be suggested for some crops. These herbicides have shown good control with no injury to the vegetables under test conditions. Not all herbicides cleared for use on a species are necessarily listed. Where the choice of more than one herbicide is suggested, the decision rests with the grower and is based on his knowledge of past weed infestations, crop rotations, and material costs. Where one herbicide will not control the weeds present, a combination of herbicides may be suggested. When using a herbicide for the first time, it is advisable to use a small-scale trial.

These suggestions for weed control in vegetables are based on research at the Illinois Agricultural Experiment Station, the U.S. Department of Agriculture, and other research institutions. The University of Illinois and its agents assume no responsibility for results from the use of herbicides, whether or not they were used in accordance with suggestions, recommendations, or directions of the manufacturer or any governmental agency.

Reading the label of the herbicide container is the most profitable time you spend in weed control. Use of the material and methods of application and use depend on registration of the herbicide by federal and state Environmental Protection Agencies (EPA). Do not use any herbicide *unless the label states that it is cleared for the use on the crop to be treated.*

Herbicides are being classified for *general use* or *restricted use* by the U.S. Environmental Protection Agency. A person wishing to use a herbicide classified for restricted use must be certified as a private or commercial pesticide applicator by the Illinois Department of Agriculture. Contact your county Extension adviser in agriculture for details about this program. Only a few herbicides have been classified at this time.

When applying mixtures of chemicals, the *user* assumes responsibility for freedom from residues if the mixture is not labeled by the EPA.

Suggestions sometimes change during the growing season, based on EPA clearances that were made after this circular was issued. This publication, printed once a year, is subject to change without notification.

Watch for notice of changes in the EPA registration of herbicides (as released by the EPA) in the *Illinois Vegetable Farmer's Letter* and the *Insect, Weed, and Plant Disease Survey Bulletin.* Subscription forms for the latter are available from the Agricultural Newsletter Service, 116 Mumford Hall, 1301 West Gregory Drive, Urbana, Illinois 61801, or your county Extension Office. You can obtain the *Vegetable Farmer's Letter* from Vegetable Crops Extension, University of Illinois, 1103 West Dorner Drive, Urbana, Illinois 61801. Some changes will be released through the Vegetable Growers "Hotline."

Prepared by the Department of Horticulture

CIRCULAR 907

For Application During the Growing Season (1986 Only)

Crop	*Treatment*	*Active ingredient per acre actually covered*[a]	*Weeds controlled*	*Timing of application (based on crop stage)*	*Remarks, cautions, limitations*
Asparagus (seedlings)	Amiben	3 lb.	Annuals	Immediately after seeding	Irrigation or rainfall after treatment will give maximum control.
Asparagus (established plantings)[b,c]	dalapon	5-10 lb.	Perennial grass	End of harvest season following disking	Apply when grass weeds are 3 to 4 in. tall. Direct spray under fern growth. Use surfactant as directed on label.
	diuron	1-4 lb.	Annuals	In spring, after harvest, or both	Apply after disking. Do not exceed 6 lb. per growing season; use a lighter rate on sandy soil. With diuron and Princep, a spring application may be sufficient after the first year.
	Princep	3-4 lb.	Annuals	In spring, after harvest, or both	Apply after disking. Do not treat during the last year in asparagus because of residue.
	Sinbar	1.2-2.4 lb.	Annuals	In spring, after harvest, or both	Use lower rates on coarse soils. Do not apply more than 2.4 lb. per acre per year. Do not use on soils with less than 1 percent organic matter. Do not plant to any other crop for two years after application.
	metribuzin	1-2 lb.	Primarily broadleaf weeds	Early spring before the spears emerge or after harvest	Apply after disking. Do not apply within 14 days of harvest. Can help control broadleaf weeds when used with dalapon, diuron, or Princep. Do not apply more than 2 lb./acre per growing season.
	Preemergence				
Beans, dry, lima and snap[d]	Treflan	0.5-0.75 lb.	Annuals[e] (primarily grasses)	Preplant soil application, incorporate with soil immediately	Plant crop immediately, or within 3 weeks after application. Can use up to 1 lb. per acre on dry beans.
	Basalin	0.75-1.5 lb.	Annuals (primarily grasses)	Preplant soil application, incorporate with soil immediately	
	dinoseb	6-7.5 lb.	Annuals	Can be used between planting and crop emergence	Do not use on light, sandy soil. Some stand reduction may result from use. See label for precautions.
	Postemergence				
	Basagran	0.75-1 lb.	Annual broadleaf weeds, Canada thistle, nutsedge	When weeds are small and are actively growing; after the first trifoliate leaf appears on beans	Can provide good, broad-spectrum control when combined with a grass-active herbicide. Do not mix with other pesticides. See Basagran entry under corn, postemergence for Canada thistle and nutsedge control.
Beans, snap	Amiben	2-2.5 lb.	Broad spectrum of annual weeds	Preemergence only	Do not use on sandy soils or those with less than 1% organic matter.
	EPTC Eptam Extra	3 lb.	Annual grasses and nutgrass[f]	Preplant soil application, incorporate with soil immediately	
	EPTC + Treflan	2-3 lb. 0.5-0.75 lb.		Preplant soil application, incorporate with soil immediately	Research results have shown this combination to control a broader spectrum of weeds than either herbicide alone.
	Dacthal	6-10 lb.	Annuals[e] (primarily grasses)	Immediately after seeding	Do not feed treated plant parts to livestock.
Beans, lima and dry	Amiben	2-3 lb.	Broad spectrum of annual weeds	Immediately after seeding, or preplant-incorporated for lima beans	Field may be rotary-hoed without destroying herbicide action.
	Dual	1.5-3 lb	Annuals	Preplant soil application, incorporate with soil, or preemergence	
	Lasso	2-3 lb.	Annuals	Lima beans: preplant soil application, incorporate into upper 1 to 2 inches, or preemergence. Dry beans: preplant soil application, incorporate into upper 1 to 2 inches, or preemergence	
Beans, dry	EPTC + Treflan	2-3 lb. 0.5-0.75 lb.		Preplant soil application, incorporate with soil immediately	Research results have shown this combination to control a broader spectrum of weeds than either herbicide alone.
	Sonalan	0.5-1.5 lb.	Annual grass and nightshade	Preplant soil application, incorporate with soil immediately	Sonalan has a tank mix or overlay label for dry beans with Amiben, Dual, Eptam, Lasso, or Basagran.
Beets, garden[d]	Pyramin	4 lb.	Annuals (primarily broadleaved)	Preemergence or after beets emerge and before weeds have two true leaves	Rainfall or irrigation needed to activate. Where grasses are a severe problem, use 4 lb. of Pyramin plus 4 lb. of Ro-Neet.
	Ro-Neet	4 lb.	Annual grasses	Preplant soil application, incorporate with soil immediately	Use a combination treatment with Pyramin to broaden control spectrum.
	Direct-seeded or transplanted				
Broccoli[d] Brussels sprouts[d] Cabbage[d] Cauliflower[d]	Treflan	0.5-0.75 lb.	Annuals[e] (primarily grasses)	Preplant soil application, incorporate with soil immediately	Stunting or growth reduction may occur at recommended rates under growth stress conditions. Can use up to 1 lb. per acre on transplants.
	Dacthal	6-10 lb.	Annuals[e] (primarily grasses)	Immediately after seeding. Can also be incorporated preplant	
Broccoli Brussels sprouts Cauliflower	Devrinol	1-2 lb.	Annuals	Preplant soil incorporated	Devrinol performs better when used in combination with a second herbicide than when used alone.

All notes are at the end of this table

For Application During the Growing Season (continued)

Crop	Treatment	Active ingredient per acre actually covered[a]	Weeds controlled	Timing of application (based on crop stage)	Remarks, cautions, limitations
Carrots[d]	**Preemergence**				
	Treflan	0.5-1 lb.	Annuals[e] (primarily grasses)	Preplant soil application, incorporate with soil immediately	Seed after application to 3 weeks later.
	Postemergence				
	linuron	0.75-1.5 lb.	Annuals	Postemergence on carrots only after the crop is 3 in. tall; grasses, less than 2 in.; broadleaves, less than 6 in.	Do not feed treated foliage to livestock or replant treated area for 4 months. More than one application may be made, but do not exceed a total of 2 lb. per acre. Do not use over 40 PSI. Use no surfactants when temperatures exceed 80°F., or crop injury may result.
	Stoddard Solvent	60-80 gal.	Annuals	After two true leaves have appeared (do not apply to carrots or parsnips after they are ¼ in. in diameter, since an oily taste may result)	Most effective when sprayed on cloudy days or during high humidity, and when weeds are not more than 2 inches high. May not control ragweed. Do not apply within 40 days of harvest. Can be used on celery, dill, parsnips, and parsley.
Corn, pop[d]	**Preemergence**				
	atrazine	2-3 lb.	(See sweet corn)	(See sweet corn)	See sweet corn, *except the section on preemergence combinations.*
	Bladex	(See remarks)	Annuals	Preemergence only	Some pop corn varieties are sensitive to the application rate. (See remarks on Bladex under sweet corn.)
	Dual	1.5-3 lb.	Annuals	Preplant soil application, incorporate with soil, or preemergence	
	Eradicane, Eradicane Extra	4-6 lb.	Difficult-to-control weeds	Preplant soil application, incorporate with soil	See sweet corn.
	Lasso	2-4 lb.	Annuals	Preemergence	See sweet corn.
	Princep	2-4 lb.	Annuals	Preemergence	Plant only crops so specified on the label the following year. Do not graze treated areas.
	Sutan+	3-4 lb.	Primarily annual grasses	Preplant soil application, incorporate with soil	See sweet corn.
	Postemergence				
	2,4-D	0.5 lb.	Broadleaved weeds	Postemergence	Apply when corn is 3 to 10 in. tall.
	Basagran	0.75-1 lb.	Broadleaved annual weeds, Canada thistle, and nutsedge	(See sweet corn)	(See sweet corn)
Corn, sweet[c,d]	**Preemergence**				
	atrazine	2-3 lb.	Annuals, annual and perennial grasses[h]	Preemergence, apply no later than 3 weeks after seeding. Shallow cultivation may improve weed control during dry weather.	Grow corn a second year without atrazine treatment. This chemical has a high soil residue. Do not plant other vegetable crops on a sprayed area until a second year of corn has been grown. Use atrazine where quackgrass is a problem. Residue hazard decreased when banded or in combination with Lasso, propachlor, or Sutan.
	Bladex	(See remarks)	Annuals	Preemergence only	Some sweet corn varieties are sensitive to the application rate. Has been shown to have less soil residue than atrazine. See label for rates and precautions. Do not use postemergence, or on sandy or loamy-sandy soils (under 1 percent organic matter). Can be combined with other herbicides to reduce the rate being used. NOTE: The Shell Chemical Co. has a bulletin on using Bladex on pop and sweet corn.
	Dual	1.5-3 lb.	Annuals	Preplant soil application, incorporate with soil, or preemergence	
	Eradicane, Eradicane Extra	4-6 lb. 4 lb.	Difficult-to-control weeds	Preplant soil application, incorporate with soil	Use to control weeds that are difficult to control with other herbicides, such as wild cane, nutsedge, quackgrass, wild Proso millet, and seedling Johnsongrass. Eradicane Extra contains an "extender" which may lengthen the period of control in fields where Eradicane control has been shortened after several years of continuous use.
	Lasso	2-4 lb.	Annuals	Preemergence	Preplant incorporation may aid control of nutgrass.
	propachlor	4-6 lb.	Annuals	Preemergence	Do *not* use on sandy soils. Is an excellent herbicide on soils with a high organic-matter content.
	butylate +	3-4 lb.	Primarily annual grasses	Preplant soil application, incorporate with soil	Especially useful on sandy soil and where nutgrass is a problem.
	Combinations				
	Dual, Eradicane, Eradicane Extra, Lasso, propachlor, and Sutan+ may be combined with atrazine or Bladex or Basagran to broaden the spectrum of weed control and reduce residue and carryover. See labels of herbicides for rates and application methods.				
	Postemergence				
	2,4-D (amine)	0.5 lb.	Broadleaved weeds	Postemergence	Preferably, apply before corn is 6 in. tall. If corn is over 12 in., reduce the rate to ¼ lb.

Corn continued on the next page.

All notes are at the end of this table

For Application During the Growing Season (continued)

Crop	Treatment	Active ingredient per acre actually covered[a]	Weeds controlled	Timing of application (based on crop stage)	Remarks, cautions, limitations
Corn, sweet (continued)[c,d]	atrazine	2 lb.	Annuals, annual and perennial grasses[b]	Directed spray 3 weeks after emergence	Can be combined with crop oils for postemergence application as emergency measure. This may increase residue the following year; preemergence use preferred. Do not graze or feed treated foliage for 21 days after treatment.
	Basagran	0.75-1 lb.	Broadleaved annual weeds, Canada thistle, and nutsedge	Early postemergence when the weeds are small and actively growing. Delay will result in less control.	For Canada thistle and nutsedge, split applications are preferred. Make the first one when the plants are 6 to 8 in. tall; for nutsedge, 7 to 10 days later; for Canada thistle, 10 to 14 days later (or use one application plus cultivation). Do not mix with other pesticides.
Cucumbers Muskmelons[e] Watermelons[e]	Alanap L	3-5 lb. 3-3.5 lb.	Annuals[f]	Immediately after seeding or transplanting After transplanting or vining	Do not use on cold soil. Rainfall or irrigation after treatment gives maximum control. Keep away from foliage. Apply to soil after the weeds have been removed.
	Amiben	2-3 lb.	Annuals	Direct-seeded application of a spray	Use only when protected by an application of activated carbon. See Amiben label for other instructions.
	Prefar	4-6 lb.	Annuals (primarily grasses)	Preplant soil application, incorporate with soil immediately	Is primarily a grasskiller. Consult label for sensitive crops within 18 months after application. Can be used in rotation with tomatoes, broccoli, cauliflower, lettuce, carrots, onions, and summer squash within 18 months. Soybeans can be planted 12 months after application.
	Prefar plus Alanap L	4 lb. +2-3 lb.	Grasses and broadleaved weeds	Preplant light incorporation	Has value for broad-spectrum weed control. Consult label for sensitive crops within 18 months after Prefar application. Has EPA approval as a tank mixture.
	Where earliness is desired, black polyethylene mulch can be used as an alternative to herbicides. It will control annual weeds, conserve moisture, and increase the soil temperature in early spring.				
Eggplant	Dacthal	6-10 lb.	Annuals[g] (primarily grasses)	After plants are established, 4-6 weeks after transplanting	Cultivate and weed prior to application. Can be applied to plants as part of a uniform soil application.
	Devrinol	1-2 lb.	Annuals	Preplant soil incorporation	For use in transplanted eggplant.
	Where earliness is desired, black polyethylene mulch can be used as an alternative to herbicides. It will control annual weeds, conserve moisture, and increase the soil temperature in early spring.				
Greens (for beets, mustard greens, and spinach — see note d)	Dacthal	6-10 lb.	Annuals[g] (primarily grasses)	Immediately after seeding	For use on collards, kale, mustard greens, and turnips.
	Treflan	0.5-0.75 lb.	Annuals[g] (primarily grasses)	Preplant soil application, incorporate with soil immediately	For use on collards, kale, mustard greens, and turnip greens.
	Furloe	1-2 lb.	Primarily broadleaved annuals	Preemergence	For spinach only. Use lower rates in cool, wet weather.
Horseradish[d]	Dacthal	6-10 lb.	Annuals[g] (primarily grasses)	Immediately after transplanting	
Lettuce[c,d]	Balan	1.5 lb.	Annuals	Preplant soil incorporation Incorporate with soil immediately	Is primarily a grasskiller. Seed after application to 3 weeks later. Do not plant wheat, barley, rye, grass, onions, oats, beets, or spinach for 12 months after application.
	Kerb	1-2 lb.	Annuals	Preemergence or preplant-incorporated	Do not use when the air temperature exceeds 85° F. Use the lower rates listed on sandy soil. Do not use on peat or muck soils. See label for rotation crops. For best results, rainfall or irrigation is needed 1 to 2 days after application, especially during warm weather.
Okra[d]	Dual	1.5-3 lb.	Annuals	Preplant soil application, incorporate with soil, or preemergence	
	Enide	3-5 lb.	Annuals	At planting	
	Treflan	0.5-1 lb.	Annuals (primarily grasses)	Preplant soil application, incorporate with soil immediately	
	Where earliness is desired, black polyethylene mulch can be used as an alternative to herbicides. It will control annual weeds, conserve moisture, and increase the soil temperature in early spring.				
	Preemergence				
Onions[b]	Dacthal	6-10 lb.	Annuals[g] (primarily grasses)	Immediately after seeding or transplanting	May not kill smartweed or common ragweed. Can be used on seeds, sets, or seedlings. Use only on mineral soils. Use lower rates on sandy soils. A double application of Dacthal can be used at seeding, layby, or both.
	Postemergence				
	Goal	0.12 lb.	Broadleaved weeds	Postemergence after onions have 2 true leaves or to transplants. Best control when weeds are in 2- to 4-leaf stage.	Multiple applications may be made, but do not exceed 0.5 lb. per season. Use in combination with a preemergence grass herbicide.
	Furloe	3-6 lb.	Broadleaved weeds (especially smartweed)	On seeded onions: loop stage or after 3- to 4-leaf stage	In later sprays, direct at base of onion plant. If applied more than once, do not exceed 6 lb. per acre for the season. *Use lower rates in cool, wet weather.* Use no later than 30 days before harvest. Do not use on sandy soils.
	Brominal	0.25-0.38 lb.	Broadleaved weeds	When onions have 2 to 5 true leaves	Use 50 to 70 gallons of water per acre. Apply when onion foliage is dry for greatest crop safety. Suggested temperature for spraying is 80° F with low humidity.

All notes are at the end of this table

For Application During the Growing Season (continued)

Crop	Treatment	Active ingredient per acre actually covered[a]	Weeds controlled	Timing of application (based on crop stage)	Remarks, cautions, limitations
Peas[d]	**Preemergence**				
	propachlor	4-5 lb.	Annuals	Preemergence	Do *not* use on sandy soil.
	Treflan	0.5-0.75 lb.	Annuals[e]	Preplant soil incorporation, incorporate with soil immediately	Seed after application to 3 weeks later. Some reduction of growth and stand reduction possible under stress. May suppress some root rot.
	Treflan + Surflan	0.5 lb. + 0.5 lb.	Annuals	Preplant soil application, incorporate with soil immediately	Do not use on soils of less than 1.5 percent organic matter. May suppress Aphanomyces root rot. May broaden weed control more than either herbicide alone. Do not feed forage to livestock. Do not plant any root crop for 12 months after application.
	Basalin	0.5-0.75 lb.	Annuals (primarily grasses)	Preplant soil application, incorporate with soil immediately	
	Dual	1.5-3 lb.	Annuals	Preplant soil application, incorporate with soil, or preemergence	
	Preemergence or Postemergence				
	dinoseb	0.3-9 lb.	Annuals (primarily broadleaved weeds)	Preemergence or postemergence	Preemergence, use 6 to 9 lb.; postemergence, use 0.3 to 1.1 lb. Apply prior to bloom when peas are 2 to 8 in. tall. See label for further precautions. Preemergence use may help suppress root rot.
	Postemergence				
	Basagran	0.75-1 lb.	Annual broadleaved weeds, Canada thistle, nutsedge	When weeds are small and are actively growing; after peas have 3 pairs of leaves (or 4 nodes)	Can help control Canada thistle. Can provide good, broad-spectrum control when used with a grass-active herbicide. Do not mix with other pesticides. See Basagran entry under corn, postemergence for Canada thistle and nutgrass control. Do not use crop oil.
	MCPB	1 lb.	Broadleaved weeds and Canada thistle	When peas are 3-7 in. tall and no later than 4 nodes prior to pea blossom	May delay maturity 1 to 4 days. Use at least 20 gallons of water per acre. Do not feed vines to livestock. MCPA is more effective on mustard. MCPB or Vacate may be less injurious to peas.
	MCPA (Na salt)	0.25-0.5 lb.			
	Vacate (MCPA amine)	0.115-0.154 lb.			
Potatoes, Irish[c,d]	Dual	1.5-3 lb.	Annuals	Drag-off treatment at emergence	Labeled for use in a tank mix with Lorox.
	EPTC	3-6 lb.	Annual grasses and nutgrass[f]	Drag-off treatment at emergence or preplant soil application; incorporate with soil immediately	Use lower rate on sandy soil.
	Treflan	0.5-1 lb.	Annuals[e] (primarily grasses)	Drag-off treatment at emergence	Use a light incorporation.
	linuron	0.75-2 lb.	Annuals	Apply prior to potato emergence	Plant tubers at least 2 in. deep. Do not replant treated area to other crops for 4 months after treatment. May injure crop on light, sandy soil. Do not apply over exposed tubers. Labeled for use in a tank mix with Dual.
	dalapon	7 lb.	Quackgrass	Before plowing in spring; wait 4 days before plowing and planting	Not for fields intended for red-skinned varieties or White Rose. Do not plant potatoes for 4 weeks. Use surfactant as directed on label.
	metribuzin	0.25-0.5 lb.	Annuals (primarily broadleaved)	Postemergence, following a preemergence grass herbicide	Can be used preemergence also. Do not exceed 1 lb. per acre in a season. Do not apply within 60 days of harvest. Do not use on red-skinned or early-maturing white varieties. Do not apply in cool, wet weather.
	Prowl	0.75-1.5 lb.	Annuals	Drag-off treatment at emergence	Use a light incorporation within 7 days. May be combined with Sencor/Lexone, EPTC, or linuron.
	Surflan	0.75-1 lb.	Annuals	Postemergence	May be tank mixed with metribuzin for broader control.
Potatoes, sweet[b]	Dacthal	6-10 lb.	Annuals[g] (primarily grasses)	Immediately after planting	
	Amiben	3 lb.	Annuals	Immediately after planting	
	Enide	4-6 lb.	Annuals	Immediately after transplanting	Do not plant nonapproved crops on treated soil during the same season.
Squash Pumpkins	Amiben	3-4 lb.	Annuals	As soon after seeding as possible, or preplant-incorporated	Use on loam soils. Amiben can be applied broadcast or banded over the row in pumpkins.
	Prefar	4-6 lb.	Annuals (primarily grasses)	Preplant soil application, incorporate with soil immediately	Use on sandy soils. Is primarily a grasskiller. Consult label for sensitive crops within 18 months after application. Can be used in rotation only with tomatoes, broccoli, cauliflower, lettuce, carrots, onions, and summer squash within 18 months of application. Soybeans can be planted 12 months after application.

All notes are at the end of this table

For Application During the Growing Season (continued)

Crop	*Treatment*	*Active ingredient per acre actually covered*[a]	*Weeds controlled*	*Timing of application (based on crop stage)*	*Remarks, cautions, limitations*
Pumpkins	propachlor	4-5 lb.	Annuals	Preemergence	Do *not* use on sandy soils. For use on processing pumpkins only. Do not use on "jack-o-lantern" type pumpkins.
Rhubarb[e]	paraquat*	(See following table)			
Tomatoes, direct-seeded and transplanted[c]	Enide	4-6 lb.	Annuals	Preemergence	Do not plant other food crops on treated areas for 6 months. If used under dry soil conditions, a shallow (1 in.) incorporation as a preplant treatment may improve weed control. Can also be used on transplanted peppers.
	Devrinol	1-2 lb.	Annuals	Preplant soil incorporated	Also used on direct-seeded and transplanted peppers. Enide + Devrinol is labeled as a tank mixture.
	Amiben	3-4 lb.	Annuals	Direct-seeded tomato plants must have 5-6 true leaves; transplants must be established	Use granular formulation and apply to dry foliage to avoid leaf burn. Do not use on sandy soils.
		2-3 lb.	Annuals	Direct-seeded application of a spray application	Use only when protected by a band application of a mixture of activated carbon plus vermiculite. See Amiben label for other use and application instructions.
	metribuzin	0.25-1 lb. (min.-max.)	Primarily broadleaf. Should be used with a grass-active herbicide.	Preplant incorporated. Postemergence, can be broadcast or directed.	Apply with ground equipment to seeded and transplanted tomatoes. Do not use air-blast or other high-pressure spray equipment. Do not use on peppers.
		0.25-0.5 lb.		Preplant incorporated, transplant tomatoes	Alone or in a tank-mix combination with Treflan.
		0.25-0.5 lb.		Broadcast spray, established tomatoes	Single or multiple applications. Minimum of 14 days between treatments. Direct-seeded plants should have 5 or 6 leaves; transplants should show new growth.
		0.5-1 lb.		Directed spray, established tomatoes	Recommended for use in fields with severe weed problems, or for fields with hard-to-control weeds.
		(For min.-max. rates)			Do not apply within 7 days of harvest, or within 3 days following cool, wet, or cloudy weather; otherwise, crop injury may occur. Do not apply to established tomatoes within 24 hours after application of other pesticides. Do not apply more than 1 lb./acre per crop season, or more than 1 lb./acre within a 35-day period. Allow at least 14 days between applications, regardless of the dosage or method used. Do not use hot caps on tomatoes within 7 days before application, or at any time afterward. Do not tank-mix with other pesticides, except Treflan.
Tomatoes and Peppers, transplanted	Treflan	0.5-1 lb.	Annuals[e] (primarily grasses)	Preplant soil application, incorporate with soil immediately	Some reduction of growth may be possible under growth stress conditions, or if rates are higher than suggested for the soil type.
	Where earliness is desired, black polyethylene mulch can be used as an alternative to herbicides. It will control annual weeds, conserve moisture, and increase the soil temperature in early spring.				

*** Restricted-use herbicide.**

[a] Based on active ingredients (actual amount of active herbicide in material or acid equivalent). Use lower rate on sandy soil and higher rate on clay and loam soils. When using a band application over the row, adjust amount of material applied to the part of an acre treated. [b] For perennial weed control, applications during and outside the growing season, see the following table. [c] For stale seedbeds, before crop emergence, see the following table. [d] For perennial grass control, applications outside the growing season, see the following table. [e] May not control ragweed and panicum. [f] May not control smartweed. [g] May not control ragweed, smartweed, and velvetleaf. [h] May not control crabgrass.

For Application Outside the Growing Season

	Stale seedbed, before crop emergence				
Asparagus	paraquat*	0.5-1 lb.	All emerged green foliage	Before crop emergence; allow maximum weed emergence prior to treatment	Weeds that emerge after treatment will not be controlled. Crop plants that have emerged at application will be injured. Do not apply within 18 months of harvest. Use with a preemergence or preplant sustained-action weed control system.
Rhubarb	paraquat*	0.5-1 lb.	All emerged green foliage	Before crop emergence; allow maximum weed emergence prior to treatment but apply before dormant rhubarb buds in crown begin to grow.	Weeds that emerge after treatment will not be controlled.
Corn, sweet Lettuce Melons Peppers Potatoes Tomatoes	paraquat*	0.5-1 lb.	All emerged green foliage	Before crop emergence	Weeds that emerge after treatment will not be controlled. Crop plants that have emerged at application will be injured. Use with a preemergence or preplant, sustained-action weed control system.

*** Restricted-use herbicide.** CAUTION: Special care should be taken when handling paraquat (Paraquat and Gramoxone). Wear rubber or neoprene gloves, a dual cartridge respirator, and an eye shield. Prevent all contact with skin and eyes. Follow closely all precautions outlined on the product label.

For Application Outside the Growing Season (continued)

Crop	Treatment	Active ingredient per acre actually covered*	Weeds controlled	Timing of application (based on crop stage)	Remarks, cautions, limitations
	Perennial weed control, applications during and outside the growing season				
Asparagus	Roundup	2-5 lb.	(See remarks)	Before emergence, or with shielded or directed sprays during fern growth	Use to control milkweed, thistle, field bindweed, quackgrass, or Johnsongrass. Apply to quackgrass when it is 6-8 in. tall in the fall or spring. Apply to Johnsongrass when it is at least 12 in. tall and actively growing. Do not till for the specified time for each species (see label). Does not provide residual weed control. Do not mix, store, or apply Roundup spray solutions in containers or spray tanks made of galvanized or unlined steel (except stainless steel).
	Perennial grass control, applications outside the growing season				
Asparagus Beans, edible Beet greens Beets, red Broccoli Cabbage Cauliflower Corn, sweet and pop Horseradish, as a weed and as a crop Jerusalem artichoke	Roundup	2-3 lb.	(See remarks)	(See remarks)	Use for quackgrass or Johnsongrass control. Apply to quackgrass when 6 to 8 in. tall in fall or spring. Apply to Johnsongrass when at least 12 in. tall and actively growing. Do not till until 3 to 7 days after application. Does not provide residual weed control. Do not mix, store, or apply Roundup spray solutions in galvanized steel or unlined steel containers (except stainless steel). For control of volunteer horseradish, apply 3 to 4 lb. in mid-September. Field should have been disced 4 to 6 weeks prior to application. For this control practice, use spray coverage only.
	Kale Lentils Lettuce Mustard greens Okra Onions Peas Potato, Irish and sweet		Radishes Spinach		

NOTE: In the suggestions in this publication, trade names of herbicides are usually used. The list below shows trade names and their corresponding common names. **Restricted-use herbicides are identified with an asterisk (*).**

Common name	Trade name	Common name	Trade name	Common name	Trade name
alachlor	Lasso	diphenamid	Enide	napropamide	Devrinol
atrazine	AAtrex and Atrazine	diuron	Karmex and others	naptalam	Alanap L
benefin	Balan	ethalfluralin	Sonalan	paraquat*	Paraquat,* Gramoxone*
bensulide	Prefar	EPTC	Eptam, Genep	pendimethalin	Prowl
bentazon	Basagran	EPTC + extender	Eptam Extra	pronamide	Kerb
bromoxynil	Brominal	EPTC+safener	Eradicane	propachlor	Ramrod, Propachlor
butylate+safener	Genate+, Sutan+	EPTC + safener + extender	Eradicane Extra	pyrazon	Pyramin
chloramben	Amiben	fluchloralin	Basalin	oryzalin	Surflan
chlorpropham	Furloe	glyphosate	Roundup, Kleen Up	oxyfluorfen	Goal
cyanazine	Bladex	linuron	Lorox, Linex	simazine	Princep
cycloate	Ro-Neet	MCPA, MCPB	Vacate, numerous	terbacil	Sinbar
dalapon	Dowpon	metolachlor	Dual	trifluralin	Treflan
DCPA	Dacthal	metribuzin	Lexone, Sencor	Petroleum solvent	Stoddard Solvent
dinoseb	Premerge-3, Sinox, Dinoseb			2,4-D (amine)	(numerous)

Storing Pesticides and Containers

Keep pesticides and containers in a separate building, room, or enclosure used only for this purpose. Such building or rooms should be dry, ventilated, and locked. Fence outside storage areas to protect children and animals and to discourage pilferage. CAUTION: Do not store weedkillers, herbicides, or defoliants in the same room with insecticides. Chlorate salts can create a fire or explosion hazard. Remove only the pesticides needed for one day's operation and return empty containers — and any unused pesticide — to the storage area each day.

Disposing of Pesticides and Containers

Surplus pesticides. To dispose of surplus pesticide mixtures, try to find other areas with the same pest problem and use up any extra tank mix or rinse water on these areas. Do not drain surplus pesticides in any location where they can contaminate wells, streams, rivers, lakes, or ponds.

Operators of landfills meeting environmental safety standards can obtain supplemental permits to handle toxic waste materials, including pesticides. To dispose of large quantities of surplus pesticides, contact the Illinois EPA Division of Land Pollution Control to locate the nearest landfill with a supplemental permit for toxic waste or to obtain specific instructions about disposal.

Pesticide containers. All empty pesticide containers, regardless of their type, should be rinsed three times before disposal. Rinse water should be dumped in the tank. Triple-rinsed containers should be punctured or broken to facilitate drainage and to prevent reuse for any purpose. They should then be hauled to a sanitary landfill for dis-

posal. Small quantities of containers may be buried singly in open fields, with due regard for the protection of surface and subsurface water.

Illinois regulations permit the burning of combustible containers provided that they are burned on the premises where they were used, that they are burned more than 1,000 feet from residential areas, that the burning will not cause undue visibility or environmental hazards, and that no reasonable alternative disposal method is available.

Do not breathe smoke from burning pesticide containers, and do not burn containers that have weedkillers such as 2,4-D or similar herbicides. When these change to a gas, the vapors may damage nearby crops and shrubbery. Pesticides containing chlorates may explode when heated and therefore should not be burned.

CAUTION: Banvel (dicamba), 2,4-D, and related chemicals (phenoxys) may seriously damage crops of grapes, tomatoes, other broadleaf vegetables, fruit trees, and ornamental plants. Spray only on tolerant crops. Before starting, survey the area for desirable plants that might be damaged by the herbicide. Spraying 2,4-D and Banvel close to a susceptible crop poses a serious threat. Sprays may drift up to a mile under certain conditions.

Spray on calm days or when there is a light breeze away from the susceptible crop. Use as low a pressure as possible to reduce drift. Use nozzles that produce large droplets or antidrift additives. Use the amine formulations to reduce the possibility of vapor drift. Use mechanical methods of weed and brush control where the spray risk is high.

Use a special sprayer for herbicides such as 2,4-D. Such chemicals are almost impossible to remove completely from a sprayer, and the remaining traces may contaminate other solutions and damage susceptible crops.

Growers with Several Crops in a Small Area

Growers with several crops in a small area should be especially careful when applying herbicides. The tendency is to apply more if the quantity measured out "looks" as if it is not enough. A low-percentage granular formulation is suggested for small areas. *Check rates and application techniques on the container label very carefully. Applications must be accurate and uniform. Excessive amounts may cause injury to present or subsequent crops.*

Ideally, a specific herbicide should be fitted to a specific crop species. When growing several different crops in a small area, however, it is often impractical and expensive to use all the appropriate herbicides. Following are two herbicides that can be used on a wide range of vegetables.

Dacthal. Dacthal is cleared on a large number of vegetables. As listed in this circular, it may not always be the herbicide of preference. It can be used on broccoli, brussels sprouts, cauliflower, cabbage, snap beans, mung beans, Southern peas, soybeans, seeded melons, cucumbers, squash, collards, kale, mustard greens, turnips (root and greens), garlic, horseradish, onions, potatoes (Irish), sweet potatoes and yams, tomatoes, eggplant, peppers, and strawberries. *Do not use on beets or Swiss chard.* Dacthal is a preemergence herbicide that must be applied to weed-free soil. It controls very small weed seedlings soon after the weed seeds germinate. It is most effective if rainfall occurs or if the soil is irrigated within 2 to 3 days after application.

A one-time application to all species is not always possible because some plants are susceptible to injury in early-growth stages. It is preferable to use Dacthal at seeding or transplanting time if the species is adapted to it. When this is not possible, the weeds should be removed and Dacthal applied to prevent further weed development. Consult the label for the appropriate application time. Dacthal is effective in controlling annual grasses that are a problem in the spring. Broadleaf weeds that escape control should be mechanically removed.

Treflan. Treflan is widely available because it is used in soybean culture in Illinois. It can be purchased as a liquid with 4 pounds of active ingredient per gallon for large garden areas or as a low-percentage granular formulation for smaller areas. The amount of Treflan to use correlates very closely with the type of soil. The appropriate amounts are shown on the container label. Treflan can be used for weed control in beans (green, lima, and dry), broccoli, brussels sprouts, cabbage, cauliflower, carrots, kale, mustard greens, okra, peas, peppers, tomatoes, and turnip greens. *Treflan may injure sweet corn.*

Treflan must be mixed with or watered into the soil to prevent loss of the chemical from the soil surface. A rototiller, disc, or similar implement should be used to mix Treflan with the soil to a 3- to 4-inch depth. When it is impractical to mix Treflan with the soil mechanically, remove all germinated and growing weeds and allow the herbicide to be carried into the soil through rainfall or sprinkle irrigation. Treflan is quite effective on annual grasses, but many broadleaf weeds will need to be mechanically removed.

Mulches — see paragraph 3, page 1

Other Publications on Weed Control

Copies of other publications on weed control are available from the office of your county Extension adviser in agriculture and the Office of Agricultural Publications, 47 Mumford Hall, 1301 West Gregory Drive, Urbana, Illinois 61801.

H-659

1986 Herbicides for Commercial Fruit Crops in Illinois

D.B. Meador, C.C. Doll, and J.W. Courter

The suggestions in this publication comply with the regulations of the U.S. Department of Agriculture and the Environmental Protection Agency in effect at the time this publication was assembled. Since such regulations are subject to change, consult the most recent product label for use restrictions. *Do not use any herbicide unless the label states that it may be used on the crop to be treated.*

When mixtures of chemicals are applied, the user will assume the responsibility for freedom of residues if such applications are not labeled by the EPA as a mixture.

This guide is provided for your information. The University of Illinois and its agents assume no responsibility for results from using herbicides, whether or not they are used according to suggestions, recommendations, or directions of the manufacturer or any governmental agency.

CAUTION

Rates are in the amounts of *product* rather than in amounts of *active ingredients.*

Rates are for full coverage per acre. For spot or band treatments reduce rates in proportion to the area actually treated.

All rates are for silt and/or clay loam soils. Some residual herbicides SHOULD NOT be used on sandy soils. Others can be used on sandy soils at reduced rates. See label.

CROP	CHEMICAL AND/OR TRADE NAMES AND FORMULATIONS	AMOUNT OF PRODUCT PER TREATED ACRE	REMARKS
APPLES	Sinbar 80W or Princep 80W or Karmex 80W or Surflan 75W or Devrinol 50W	2 to 4 lb. 2-1/2 to 5 lb. 2 to 4 lb. 2-1/2 to 5 lb. 8 lb.	These are preemergence herbicides. They may be used in conjunction with a postemergence herbicide. Apply in the spring before weeds emerge. Do not use on sandy soil. Surflan and Devrinol may be applied to newly planted trees after the soil settles and to bearing and nonbearing trees. Do not use Sinbar on trees established less than 3 years, or Princep or Karmex on trees established less than 1 year. Do not use Karmex on full-dwarf trees. Half rate of two of these materials is sometimes more effective than a full rate of one material. Devrinol must be incorporated within 24 hours by 1/2 inch of rain or irrigation or by shallow cultivation.
	Paraquat or Gramoxone	1 to 2 qt.	A postemergence herbicide. Use lower rate on young, tender weeds and higher rate on older weeds. Use 8 oz. of nonionic surfactant per 100 gal. of spray to increase effectiveness. Wet foliage! Keep off tree foliage and tender bark. May be used in conjunction with a residual herbicide. Paraquat kills the tops but frequently does not kill the roots.
	2,4-D amine, oil-soluble amine, and acid forms Dacamine 4D and others	see remarks	Use 2 quarts of 4D amine or oil-soluble amine or 3EC acid form plus 2 oz. of surfactant per 100 gal. of water. Spot treat in May, June, July, and August to control bindweed, climbing milkweed, and other broad-leaved weeds. Spray before vines climb into trees. Keep spray drift off apple foliage. May be used as a broadcast treatment in late fall to kill dandelions.
	Ammate X-NI-95W	see remarks	For poison ivy use 60 lb. of Ammate X-NI plus 1 qt. of Surfactant WK per 100 gal. of water. Spot treat in May, June, and July, wetting the ivy foliage. Keep off apple foliage.
	Casoron 4G or Norosac 4G	100 to 150 lb.	This material is both a postemergence herbicide and a residual herbicide. Its action is good in cool weather but dissipates after about 2 months of warm weather. Effective against quackgrass when applied in late fall. Use granular form. Apply any time from fall to early spring.

CROP	CHEMICAL AND/OR TRADE NAMES AND FORMULATIONS	AMOUNT OF PRODUCT PER TREATED ACRE	REMARKS
APPLES (Continued)	Roundup 4EC	1-1/2 to 5 qt.	Roundup is a systemic-type postemergence herbicide to be used in a manner similar to Paraquat. Use sufficient water to wet grass and weed foliage. The rate depends on the weed species. Keep off apple foliage and green-colored bark tissue. It is more effective than Paraquat against perennials. Do not apply within 14 days of harvest.
PEARS	Same as apples, EXCEPT that Sinbar is not registered for pears.		
PEACHES	Princep 80W, or Sinbar 80W, or Karmex 80W, or Devrinol 50W, or Surflan 75W	2-1/2 to 5 lb. 2 to 4 lb. 2 to 4 lb. 8 lb. 2-1/2 to 5 lb.	See remarks under apples. Do not apply Princep on trees established less than 1 year, or Sinbar or Karmex on trees established less than 3 years. Surflan and Devrinol may be used on newly planted trees after the ground settles and on bearing and nonbearing trees.
	Paraquat or Gramoxone	1 to 2 qt.	See remarks under apples.
	Casoron 4G or Norosac 4G	100 to 150 lb.	See remarks under apples.
CHERRIES AND PLUMS	Princep 80W, or Devrinol 50W, or Surflan 75W	2-1/2 to 5 lb. 8 lb. 2-1/2 to 5 lb.	See remarks under apples. Restrictions are the same as for peaches for Princep, Devrinol, and Surflan.
	Paraquat or Gramoxone	1 to 2 qt.	See remarks under apples.
	Roundup 4EC	1-1/2 to 5 qt.	Use only on cherries, not on plums. Do not allow spray drift to contact foliage, fruit, green bark or suckers, or the bark of trees established less than 2 years. See remarks under apples.
	Casoron 4G or Norosac 4G	100 to 150 lb.	See remarks under apples.
NON-BEARING: APPLES, BLACKBERRIES, BLUEBERRIES, CHERRIES, GRAPES, PEACHES, PEARS, PLUMS, RASPBERRIES, AND STRAWBERRIES	Fusilade 4E	1 pt.	A grass killer. Use as a directed spray to actively growing grass 2-8 inches tall, avoiding spray contact with crop foliage. Use 1 pint of Fusilade plus either 1 quart of crop oil concentrate or 1/2 pint of nonionic surfactant in 25 gallons of water per acre. Do not apply within 12 months of harvest.
BLACKBERRIES AND RASPBERRIES	Princep 80W or Princep 4G or Sinbar 80W	2-1/2 to 5 lb. 50 to 100 lb. 1 to 2 lb.	For plantings at least 1 year old. Apply in early spring before weeds emerge and before canes leaf out. On mowed-off Heritage, apply before new shoots emerge. Apply to soil surface at base of plants in a band along each side of the row. If winter weeds are a problem in established plantings, use half dosage in late fall and again in early spring. Treated area should not be disturbed or have untreated soil piled over it by cultivating equipment.
	Surflan 75W or Devrinol 50W	2-1/2 to 5 lb. 8 lb.	May be applied to new plantings after the ground settles and to established plantings in the spring before weeds emerge in a band over or along the row. Devrinol must be incorporated with 1/2 inch of rain or irrigation within 24 hours after application.
	Casoron 4G or Norosac 4G	100 lb.	Use 4-percent granules. Apply any time from late fall to early spring to kill existing grass and weeds and to reduce growth of young weeds into early summer.

CROP	CHEMICAL AND/OR TRADE NAMES AND FORMULATIONS	AMOUNT OF PRODUCT PER TREATED ACRE	REMARKS
BLACKBERRIES AND RASPBERRIES (Continued)	Enide 90W	4.4 to 6.6 lb.	Apply as a band application on new plantings of raspberries and blackberries. May be applied in the spring on established raspberries. Do not apply on raspberries within 60 days of harvest or on blackberries within 12 months of harvest.
	Paraquat or Gramoxone	1 to 2 qt.	Apply in spring before emergence of new canes or shoots.
BLUEBERRIES	Princep 80W or Princep 4G or Sinbar 80W or Devrinol 50W	2-1/2 to 5 lb. 50 to 100 lb. 2 to 4 lb. 8 lb.	See remarks under blackberries and raspberries. Apply in early spring. Devrinol may be applied to newly planted and established crops. Princep and Sinbar may be applied on crops established at least 1 year.
	Casoron 4G or Norosac 4G	100 lb.	See remarks under blackberries and raspberries.
	Paraquat or Gramoxone	1 to 2 qt.	See remarks under blackberries and raspberries.
GRAPES	Karmex 80W or Princep 80W	2 to 6 lb. 2-1/2 to 6 lb.	Use in vineyards established at least 3 years. Apply in early spring to soil under trellis in a band 30 inches wide.
	Devrinol 50W or Surflan 75W	8 lb. 2-1/2 to 5 lb.	May be applied to newly planted vines after the soil settles and to nonbearing and bearing vines. Devrinol must be incorporated within 24 hours by 1/2 inch of rain or irrigation or by shallow cultivation.
	Paraquat or Gramoxone	1 to 2 qt.	Apply as a postemergent spray when annual grasses and weeds become a problem. Keep spray off foliage. Use the surfactant suggested by the manufacturer.
	Casoron 4G or Norosac 4G	100 to 150 lb.	Use 4-percent granules. Apply from late fall to early spring to kill established weeds and grass. Residual effect to kill germinating weeds and grass will last until warm weather.
	Roundup 4EC	1 to 5 qt.	Use as a directed spray in vineyards established at least 3 years or for site preparation prior to planting for control of emerged annual and perennial weeds. Keep spray off green foliage, green bark, and suckers.
STRAWBERRIES	Dacthal 75W	8 to 12 lb.	Preemergence action. May be applied immediately after planting or during the growing season to weed-free soil except when blossoms or fruit are present on beds to be harvested. Effective weed control usually lasts 4 to 8 weeks. May be repeated. Weak against velvetleaf, ragweed, smartweed, and nutsedge. Incorporate with 1/2 inch of rain or irrigation or shallow cultivation.
	Devrinol 50W	8 lb.	Devrinol retards root development of runner plants; therefore it should not be applied until the desired number of runner plants is well rooted in both new plantings and in renovated plantings. An application in late fall just before mulching should last through harvest. Must be incorporated with 1/2 inch of rain or irrigation within 24 hours.

CROP	CHEMICAL AND/OR TRADE NAMES AND FORMULATIONS	AMOUNT OF PRODUCT PER TREATED ACRE	REMARKS
STRAWBERRIES (Continued)	Enide 90W	6.6 lb.	On new beds Enide may be applied to weed-free soil after the plants are established. On established beds it is most effective at renovation time and in late fall just before mulching. Incorporate with 1 inch of rain or irrigation. No more than 2 applications per year. Do not apply within 60 days of harvest.
	Paraquat or Gramoxone	1 qt.	A directed spray to weeds between rows. Must use shields to protect strawberry plants. No more than 3 sprays per season. Do not apply within 21 days of harvest.
	Sinbar	1/4 to 1/2 lb.	Apply no more than 1 pound per year. May be applied at renovation if all leaves are removed before spraying. Or apply to fully dormant plants from late fall to late winter. May apply 1/2 pound at renovation and again in late fall. Application rate must be accurate and must be adjusted to soil type and soil organic matter content. See label. Excess rates may cause serious injury. Growers using Sinbar for the first time should limit application to a small part of their plantings.
	Tenoran 50W	8 lb.	Postemergence action against young weeds less than 2 inches tall (many broadleafed and some grasses). Also has residual properties for preemergence action against germinating seeds. Delay application on new plantings until plants are established. No more than 2 applications per year. Do not apply within 60 days of harvest. See label for mixing and application instructions.

CAUTIONS

If you are applying herbicides for the first time or are trying a new herbicide, learn on a small area.

Avoid spray drifts Use low pressure (30 to 60 pounds per square inch) with nozzles close to the ground. Spray when wind velocity is low.

Calibrate equipment to apply the correct amount of material per acre. Excessive amounts may cause damage to fruit plants. Lesser amounts may not give control. Uniform application is essential.

Clean sprayers after applying herbicides. Use detergent and water (2 cups in 25 gallons) or ammonia and water (1 quart in 25 gallons) to clean out wettable-powder sprays. Emulsifiable liquids should first be washed out with kerosene, then with detergent and water or ammonia and water. Do not allow drain solutions to run into streams or other water sources.

For herbicide suggestions in home fruit plantings, see Circular 1144, "Controlling Weeds in Home Fruit Plantings."

1986 Chemical Weed Control Recommendations for Landscape Plantings

Many landscape managers consider weeds to be their most common and bothersome pest problem. Weeds are ubiquitous, infesting beds of woody and herbaceous ornamental plants, turf areas, and cracks in paved areas such as sidewalks and parking lots.

Beside being unsightly and giving an unmanicured appearance to commercial and residential landscape sites, weeds compete with desirable ornamental plants for nutrients, light, and growing space. They also can harbor insect and disease pests; they can be fire hazards, and noxious weeds such as poison ivy and ragweed can be health hazards.

Weed management programs for landscape sites include methods for both the eradication and prevention of weeds. The goal of a successful weed control program should be to integrate cultural decisions, mechanical methods, and chemical methods into an efficient and effective strategy to control weeds with a minimum of labor, cost, and environmental hazard.

The remainder of this article concentrates on the chemical component of weed control in programs of landscape plantings of herbaceous and woody ornamental plants.

HERBICIDE SELECTION

Herbicides provide an efficient means for controlling weeds. They are precise in their activity, but satisfactory results can only be achieved if herbicides are used properly. The first step in selecting a herbicide is to identify your weed problem.

Herbicides are classified as selective or nonselective, depending on the range of plants they kill. Selective herbicides kill certain plants with little or no injury to others. This is of the utmost importance when applying herbicides to areas containing ornamental plants. Selective herbicides include both foliage and soil applied herbicides.

Nonselective herbicides are toxic to almost all plants. Some herbicides that are selective at a low rate may be nonselective when appplied at a high rate. Nonselective herbicides are useful in areas where total vegetation control is desired, such as in industrial areas, along fences, around buildings, and in other noncrop areas. Nonselective herbicides can be either foliage- or soil-applied.

Herbicides are also classified according to when and how they are applied to the ornamental plants or weeds. Preplant herbicides are applied before the ornamentals are planted. They are frequently incorporated into the soil and then referred to as preplant incorporated (PPI). Preemergence refers to the use of a herbicide before direct-seeded ornamental plants or weeds emerge, or before the weeds appear in landscape plantings. Most soil-applied herbicides require moisture to facilitate absorption by emerging weed seedlings. Rainfall can move

the herbicide into the soil and provide the moisture for absorption. Mechanical incorporation can also move the herbicide into soil, and if sufficient soil moisture is available this can mean less dependence on rainfall. Soil texture and organic matter content affect the activity of soil-applied herbicides. The residual activity of the preemergnce herbicides can vary from several weeks to several months.

Postemergence refers to the use of herbicide after the crop or weeds have emerged. Postemergence herbicides are applied to the foliage of the weeds. Most must remain on the weed foliage for several hours to be effective. If rain falls shortly after application, retreatment may be necessary. Postemergence herbicides may be broadcast over-the-top if both ornamental plants and weeds if they are sufficiently selective to kill weeds without significantly affecting the ornamentals. Some less selective herbicides may be applied as directed postemergence, when the spray is directed onto the weeds and kept off the ornamental plants as much as possible. For directed sprays, it is helpful to have a height differential with weeds smaller than the ornamental plants. Earlier cultural practices, mechanical cultivation, or herbicides can sometimes help to establish this height differential. Spot treatments are applied to individual weeds or small patches of weeds.

Herbicides are also classified by their type of activity. Translocated or systemic herbicides move (translocate) in the plant from the site of uptake. The site of uptake can be either the roots or emerging shoots when the herbicide is applied to the soil, or the foliage and/or stem when an aboveground treatment is made. Since the plant must be actively growing for these herbicides to translocate to sites of action, most are applied during the growing season. Injury symptoms may take several days to several weeks to develop, depending on the type of herbicide. Since translocated herbicides can move throughout the plant system, they are effective against annuals, biennials, and perennials. Depending on the particular herbicide, activity may be selective or nonselective.

Nontranslocated herbicides are active at the site of absorption or contact. They do not translocate within the plant. They are either soil-applied or foliage-applied. They can be applied at various times.

Foliage-applied nontranslocated herbicides are usually called contact herbicides. They nonselectively kill green foliage on contact by killing the plant tissue. Since only the tissue actually may be killed, surfactants are often added to improve coverage of the foliage. Contact herbicides can be effective for the control of annual plants if all the growing points are aboveground and thoroughly sprayed. They will also burn back the aboveground portions of biennial and perennial plants, but regrowth may occur since these plants have growing points that are underground and therefore protected. The injury symptoms of a plant treated with a contact herbicide are usually visible within a matter of hours. Contact herbicides usually have little or no residual soil activity.

To ensure that the proper herbicide is chosen for the ornamental planting and the particular weed problem, always read the label. The label gives rates and directions for use as well as precautions to prevent possible harm to the applicator, other people, animals, and the environment.

The different herbicide categories are discussed in greater detail on the next page.

PREEMERGENCE HERBICIDES

Alachlor (Lasso)* is available in emulsifiable concentrate and granular formulations. It is labeled for use on a limited number of woody plant species. Apply at 4 pounds active ingredient per acre (aia) for the control of annual grasses.

Bensulide (Betasan)* is used primarily for the control of annual grasses. Apply at a rate of 10 to 12 pounds aia and irrigate after application. Bensulide can be used in established flower beds and carpet bugle, ivy, pachysandra, and sedum groundcovers.

Chloramben (Ornamental Weeder, Amiben, Garden Weeder, Weedone)* is used for control of a number of annual broadleaf and grass weeds. Apply at 4 pounds aia to weed-free soil and irrigate following application. Chloramben is registered for use in established flower beds. Vegiben* is another formulation registered for several vegetable crops.

Chlorpropham (Furloe, Chloro-IPC, CIPC)* is available in emulsifiable and granular formulations. The granular formulation is commonly used in ornamenals. Apply at 4 pounds aia on sandy soil and 6 pounds aia on heavier soils for control of annual broadleaf and grass weeds. Chlorpropham is very effective for chickweed control, both pre- and postemergence. It has an extensive label including many species of trees, shrubs, flowers, and groundcovers.

DCPA (Dacthal)* is available in wettable powder and granular formulations. Apply at 10 to 12 pounds aia to a weed-free area primarily for the control of annual grasses. DCPA has a very extensive list of establishd flower species on its label. It is also labeled for use in many woody species. In areas without vegetative cover, more than one application per growing season may be necessary.

Dichlobenil (Barrier, Casoron, Dyclomec, Norosac)* is available in wettable powder and granular formulations. Apply at 4 to 6 pounds aia to control annual and perennial grasses and many broadleaf weeds. Use only on woody plants listed on the label. Dichlobenil is recommended for use in late fall and winter. If it is applied in warm weather, it should be incorporated into the soil or covered with mulch.

Diphenamid (Enide)* is recommended for annual weed control in flower beds and planting of woody ornamentals. Apply at 8 pounds aia to sandy soils and 12 pounds aia to heavy soils. Effectiveness will be increased with shallow incorporation or irrigation following application. More than one application will be necessary for season-long control.

EPTC (Eptam)* is available in emulsifiable concentrate and granular formulations. Apply at 5 pounds aia for control of annual weeds and suppression of certain perennial weeds such as nutsedge and quackgrass. Incorporation is necessary for good control.

Metolachlor (Dual)* has recently been labeled for use in a number of woody ornamental species. It will effectively control annual grasses, a number of broadleaf weeds, and nutsedge. Applications of 4 pounds aia will last for one growing season.

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*Trade name.

Napropamide (Devrinol)* is available in wettable powder and granular formulations. It is labeled for use in annual and perennial flower beds, groundcovers, and woody plants. Apply at 4 to 6 pounds aia for control of annual grasses and some broadleaf weeds. Incorporate to a depth of 2 inches or irrigate following application to improve control.

Oryzalin (Surflan)* can be used to control annual grasses and some broadleaf weeds in established plantings of groundcovers and woody ornamentals. It does not require incorporation, but it should be irrigated into the soil if there is no rainfall within a week or two of application.

Oxyfluorfen (Goal)* can be used as both a preemergence and postemergence herbicide. Its postemergence activity is limited to young broadleaf weeds. Groundsel and chickweed are controlled by this herbicide. The granular formulation is recommended for deciduous plants. Either the EC or granular formulation can be used on conifers.

Oxidiazon (Ronstar or Scott's Pro Grow Herbicide I)* is used in new and establishd plantings of groundcovers and woody ornamental plants. Apply at 4 pounds aia. Two applications may be needed for season-long weed control. It will control a broad spectrum of weed species.

Pronamide (Kerb]* should be applied in the fall at 2 pounds aia for the control of winter annuals, chickweed, and quackgrass. It is one of the only selective herbicides that control quackgrass in established landscape plantings.

Simazine (Princep)* is available in wettable powder and granular formulations. Spring or fall application at 2 pounds aia to weed-free, woody ornamentals will control a broad spectrum of weeds. Be careful to apply to only labeled species and at recommended rates since simazine will injure a number of ornamental species.

Trifluralin (Treflan or Preen)* is available in emulsifiable concentrate and granular formulations. Apply at 1 pound aia and incorporate into the soil. It is used in flower beds, groundcovers, and woody ornamental plantings. Since it needs to be incorporated it is not easy to use in thickly established plantings.

POSTEMERGENCE HERBICIDES

Basfapon

Dalapon (Basfapon, Dowpon M and other)* is used for postemergence control of annual and perennial grasses. Apply at 5 pounds aia. Dalapon will provide excellent control of cattails if applied when the plants are small.

Fluaziflop-butyl (Fusilade 2000)* is a grass-selective postemergence herbicide effective at controlling a wide range of grass species. It should be applied to young grasses in the 3- to 5-leaf stage.

Glyphosate (Roundup, Kleenup)* is a nonselective systemic postemergence herbicide. After being applied to the foliage of weeds, it is translocated into the root system and the entire plant is killed. Even though enough of this

*Trade name.

herbicide to kill the plant will enter the tissue within hours, it may take 10 days to 2 weeks for the weed to appear completely dead. Keep this herbicide off the foliage of ornamental plants. There is no soil activity, therefore it can be applied over the root systems of herbaceous and woody ornamentals. It can be used to remove grass from around the base of mature trees since it will not injure the trees' bark. However, applicators should avoid spraying glyphosate on the foliage of suckers at the base of trees. Applicators such as rope wicks, wipers, lighting hoes, etc., have been developed for selectively placed glyphosate on weed foliage but not for the foliage of ornamental and crop plants.

Oxyfluorfen (Goal)* has postemergence as well as preemergence herbicide activity. It will control many broadleaf weeds when they are in the seedling stage. It will not control mature plants postemergence.

Paraquat (Ortho Paraquat QL, Gramoxone)* is a contact postemergence herbicide. It will give excellent control of annual weeds; however, perennial weeds often grow back from the root system. Apply at 0.5-1.0 pounds aia.

Since the area to be treated is often less than 1 acre, Table 1 gives a conversion table for using herbicides on small areas where rate per acre is given. Rates per acre are usually given on the label.

Sethoxydim (Poast)* is a grass-selective postemergence herbicide labeled for a number of ornamental plants. Grasses are best controlled in the 3- to 5-leaf stage.

HERBACEOUS PLANTINGS

The problematic periods in plantings of annual and perennial bedding plants and groundcovers are during establishment and then during maintenance of the plantings. As many weeds as possible should be controlled prior to planting.

New bed areas are often developed in locations covered with turf that is full of perennial weeds. Spading or rototilling is not adequate to control perennial weeds. There are two approaches to controlling perennial weeds before planting. The first is to treat the perennial weeds with a systemic postemergence herbicide before preparing the soil in the bed area. The best herbicide for this is glyphosate. If the weed infestation is heavy and there is a significant perennial weed population, use two applications of glyphosate one month apart prior to planting.

Another approach to controlling perennial weeds prior to planting is to fumigate the beds. Methyl bromide, chloropicrin, methane-sodium, and Volex (Table 2) are fumigants available for this purpose. Methyl bromide and methyl bromide:chloropicrin combinations are most commonly used for this purpose.

After the bed is prepared, preemergence herbicides may be used either before or after planting, depending on the herbicide used. If the preemergence herbicides are used prior to planting, they should be incorporated into the upper 4 inches of soil. If the preemergnce herbicides are applied after planting, they should be incorporated into the soil and irrigated. Mulch before planting since it is easier to plant through a mulch than to place mulch on small plants.

*Trade name.

Preemergence herbicides recommended for use in herbaceous plantings are bensulide, chloramben, chlorpropham, DCPA, diphenamid, napropamide, and trifluralin. Other herbicides may be labeled for use, but the above-mentioned compounds represent those materials with the most extensive list of herbaceous ornamental plants on their labels.

Plantings of Woody Landscape Plants

Beds of new plantings should be cleaned of weeds treated with a preemergence herbicide and mulched. This will provide weed control for one season. Future applications of preemergence herbicides can be made in the fall or spring, depending on the herbicide used and the time available. Ideally, a fall treatment for the control of winter annuals followed by a spring application to control summer annuals will give the most satisfactory results.

It should be remembered that no preemergence herbicide will control all species of weeds. A combination of two herbicides controlling different weed species will provide a broader spectrum of weed control. If two preemergence herbicides are used together, use each of them at one-half the rate recommended when they are used alone. Combinations for broad spectrum weed control are simazine + metolachlor, simazine + napropamide, simazine + surflan, simazine + DCPA, or oxidiazon + chlorpropham.

All of the postemergence herbicides mentioned above can be used with care in plantings of woody ornamentals. Glyphosate and paraquat should be kept off the foliage of landscape plants. Paraquat should also be kept off the bark of young trees. Combinations of postemergence and preemergence herbicides will control existing weeds as well as weeds that are yet to germinate.

Successful use of herbicides depends upon their proper selection and application. Weed control programs in landscape plantings are only as good as the people who plan, administer, and apply them. Remember, the key to a good weed control program is people and their willingness to keep current with the ever-changing field of herbicide technology.

Table 1. Conversion Table for Use of Herbicides on Small Areas When Rate per Acre is Given

Rate of commercial formulations per acre	Approximate rate per 1,000 square feet
Liquid materials	
1 pint	3/4 tbls*
1 quart	1 1/2 tbls
2 quarts	3 tbls
1 gallon	6 tbls
Dry materials	
1 pound	2 1/4 tsps**
2 pounds	4 1/2 tsps
3 pounds	2 1/4 tbls
4 pounds	3 tbls
5 pounds	4 tbls
10 pounds	1/2 cup
100 pounds	2 1/4 pounds

* = tablespoons
** = teaspoons

Table 2. Common and Trade Names of Fumigants for Preplant Bed Preparation

Common name	Trade name
methyl bromide	Brom-O-Gas, Dowfume, Fumigant-1, Meth-O-Gas, Pestmaster, Terr-O-Gas
methan-sodium	Best Vapam Soil Fumigant, Science Vapam, Vapam, VPM
chloropicrin	Chlor-O-Pic, Pic-clor, Tri-clor, Larvacide
methylisothiocynanate + dichloropentene-dichloropropane	Vorlex, Di-Tapex
methyl bromide + chloropicrin	Dowfume MC-33, Dowfume MC-2, many more formulations

	(PPI		) (PRE																) (POST**					)
	EPTAM	LASSO	TREFLAN	BETASAN	CASORON	CHIPCO RONSTAR	DACTHAL	DEVRINOL	DUAL	ENIDE	FURLOE	GOAL	KERB	LASSO	OH 1	OH 2	OR. WEEDER	PRINCEP	ROUT	SURFLAN	TREFLAN	FUSILADE	GOAL	KERB	PARAQUAT	POAST	ROUNDUP
Abelia spp.				F			F	X												X						
Abelia grandiflora				F		C	F	X								X				X						
Abies spp.	F						F	X			Y		F									F	F	F	F	F	F
Abies balsamea	F		F				F	X			Y		F					F		F	F	F			F		F
Abies fraseri	F						F	X		S	Y	Z	F					F		F		F	Z		F	F	F
Acer spp.	F				F		F	F	X	F	Y											F					F
Acer ginnala	F				F	F	F	F	X	F	Y											F					F
Acer palmatum	F				F		F	F	X	F	Y											F					F
Acer plantanoides	F		F		F		F	F	X	F	Y										F	F					F
Acer rubrum	F		F		F		F	F	X	F	Y						F				F	F				F	F
Acer saccharinum	F		F		F		F	F	X	F	Y										F	F				F	F
Acer saccharum	F		F		F		F	F	X	F	Y										F	F					F
Ajuga spp.	F			F				F														F					
Ajuga reptans	F			F		F		F														F				F	
Berberis spp.	F				F	X	F		X		Y							F				F				F	
Berberis thungergii	F		F		F	X	F		X	F	Y							F	X	X	F	F				F	
Betula spp.					F		F			F	Y											F				F	
Betula nigra					F		F			F	Y											F				F	
Betula papyrifera					F	F	F			F	Y											F					
Betula pendula			F		F		F			F	Y										F	F				F	
Buxus spp.	F			F	F	C	F	X	X		Y					X						F					F
Buxus microphylla	F		F	F	F	C	F	X	X		Y				X	X			X	X	F	F					F
Buxux sempervirens			F	F	F	C	F	X	X		Y				X	X				X	F	F				F	F
Carya spp. (Ilickory)					F												F										
Carya illinoiensis					F			F		F																F	
Castanea spp.							F																				
Castanea mollissima			F				F														F						
Cedrus spp.								X			Y																
Cedrus deodora								X																			
Cercis canadensis			F				F			F											F	F					
Chaenomeles japonica					F																	F					
Chamaecyparis spp.	F																			X							
Chamaecyparis obtusa	F															X				X							
Chamaecyparis thyoides	F									F										X							
Cornus spp.	F	F			F		F				Y			F		X	F	F				F				F	
Cornus florida	F	F	F		F	F	F			F	Y			F		X	F	F				F				F	
Cornus sericea (C.stolonifera)	F	F			F	X	F		X		Y			F		X	F	F				F				F	
Cortaderia selloana																											
Cotoneaster spp.		F			F	X	F		X	F	Y						F	F				F				F	
Cotoneaster apiculatus		F	F		F	X	F		X	F	Y				X	X	F	F		X	F	F				F	
Cotoneaster dammeri		F			F	X	F		X	F	Y						F	F	X	X		F				F	
Cotoneaster horizontalis		F			F	X	F		X	F	Y						F	F		X		F					
Cotoneaster microphyllus		F			F	X	F		X	F	Y						F	F		X		F					
Cotoneaster zabelii		F	F		F	X	F		X	F	Y						F	F				F					
Crataegus spp.							F	F													F						
Deutzia spp.			F		F		F														F						
Elaeagnus spp.					F		F			F	F							F									
Elaeagnus angustifolia					F	F	F			F								F								F	
Elaeagnus pungens			F		F		F			F								F			F						
Euonymus spp.	F	F			F	X	F	X	X	F	Y			F		X	F					F				F	F
Euonymus alatus	F	F			F	X	F	X	X	F	Y			F			F		X	X	F	F				F	F
Euonymus fortunei	F	F	F		F	X	F	X	X	F	Y			F	X	X	F		X	X	F	F					F
Fagus grandifolia										F												F					
Forsythia spp.			F		F	X	F		X	F	Y		F								F	F		F		F	
Forsythia intermedia			F		F	X	F		X	F	Y		F			X				X	F	F		F			
Fraxinus spp.					F		F	F														F			F		

Ornamental Herbicide Registrations* (continued)

	(PPI					)(PRE														)(POST**				
	EPTAM	LASSO	TREFLAN	BETASAN	CASORON	CHIPCO RONSTAR	DACTHAL	DEVRINOL	DUAL	ENIDE	FUROLE	GOAL	KERB	LASSO	OH 1	OH 2	OR. WEEDER	PRINCEP	ROUT	SURFLAN	TREFLAN	FUSILADE	GOAL	KERB	PARAQUAT	POAST	ROUNDUP
Fraxinus americana			F		F		F	F		F							F				F	F			F	F	
Fraxinus pennsylvanica					F		F	F														F			F	F	
Ginkgo biloba						C														X							
Gleditsia triacanthos			F		F		F	F			Y							F			F					F	
Hedera helix	F		F	F	F	X	F	X	X	F	Y						F			X		F				F	
Hibiscus syriacus								F		F									X	X							
Hosta spp.																											
Hydrangea spp.							F			F	Y				X												
Hypericum spp.	F		F	F				F		F									X	X							
Iberis sempervirens				F			F												X								
Ilex spp.		X		F			F	X		F	Y		F		X		F	F				F		F			F
Ilex aquifolium		X		F	F	X	F	X		F	Y		F				F	F		F		F		F			F
Ilex cornuta		X		F	F	X	F	X		F	Y		F		X	X	F	F	X	X	F	F		F		F	F
Ilex crenata	F	X	F	F		X	F	X	X	F	Y		F		X	X	F	F		X		F		F		F	F
Ilex glabra		X		F	F		F	X		F	Y		F				F	F				F		F			F
Ilex opaca	F	X		F	F		F	X	X	F	Y		F		X		F	F				F		F			F
Juglans spp.							F	F																	F		
Juglans nigra			F				F	F		Z								F			F				F	F	
Juniperus spp.	F	X		F	F		F	X		F	Y		F	X			F	F		X		F	C	F		F	
Juniperus chinensis	F	X	F	F	F	X	F	X		F	Y	C	F	X	X	X	F	F	X	X	F	F	C	F		F	
Juniperus conferta	F	X	F	F	F	C	F	X	X	F	Y		F	X			F	F	X	X	F	F		F		F	
Juniperus horizontalis	F	X		F	F	X	F	X	X	F	Y	C	F	X	X	X	F	F	X	X		F	C	F		F	
Juniperus procumbens	F	X		F	F	C	F	X	X	F	Y		F	X			F	F		X		F		F			
Juniperus virginiana	F	X	F	F	F		F	X		F	Y		F	X			F	F		X	F	F		F		F	
Kalmia spp.							F		X	F	Y																
Kalmia latifolia			F		F		F		X		Y									X	F						
Koelreuteria paniculata					F	F																					
Kolkwitzia amabilis						F				F																	
Lagerstroemia indica				F		C													X	X		F					
Leucothoe spp.	F				F	C			X		Y																
Leucothoe axillaris	F					C			X		Y									X							
Ligustrum spp.				F	F		F	X	X	F	Y											F				F	F
Ligustrum ovalifolium			F	F	F	X	F	X	X	F	Y										F	F					F
Liquidambar styraciflua			F				F			F										X	F	F				F	
Liorodendron tulipifera			F		F		F			F	Y										F	F				F	
Liriope spp.			F					X												X		F				F	
Lonicera spp.(Xylosema)			F	F	F	X	F		X	F	Y					X				X	F						
Lonicera fragrantissima			F	F	F	X	F		X	F	Y							F		X							
Magnolia spp.	F				F		F				Y						F					F					F
Magnolia grandiflora	F				F	C	F				Y						F			X						F	F
Mahonia spp.										F	Y							F		X							
Malus spp.		F	F		F			F	X	F										F	F	F			F	F	F
Malus floribunda		F	F		F	F	F	F	X	F	Y			F						F		F			F	F	F
Malus pumila		F	F		F			F	X	F								F		F		F			F		F
Nyssa sylvatica			F																		F						
Osmanthus spp.					F	C			X																		
Osmanthus heterophyllus									X											X							
Pachysandra terminalis	F			F			F	F	X		Y															F	
Parthenocissus tricuspidata							F																			F	
Philadelphus spp.			F		F		F			F	Y										F						
Picea spp.	F						F	F			Y											F					F
Picea abies	F		F			F	F	F		S	Y	W						F	X	F	F	F	W			F	F
Picea glauca	F		F				F	F		S	Y				X			F	X	F	F	F				F	F
Picea pungens	F		F				F	F			Y	W			X			F		X	F	F	W			F	F
Pieris spp.	F					C	F		X		Y						F	F									
Pinus spp.	F						F	X			Y		F				F					F		F	F		F
Pinus mugo	F						F	X			Y	C	F		X		F	F	X	X		F	C	F	F	F	F

Ornamental Herbicide Registrations* (continued)

	(PPI)(						PRE												)(POST**)					
	EPTAM	LASSO	TREFLAN	BETASAN	CASORON	CHIPCO RONSTAR	DACTHAL	DEVRINOL	DUAL	ENIDE	FURLOE	GOAL	KERB	LASSO	OH 1	OH 2	OR. WEEDER	PRINCEP	ROUT	SURFLAN	TREFLAN	FUSILADE	GOAL	KERB	PARAQUAT	POAST	ROUNDUP
Pinus nigra	F		F			X	F	X		S	Y	C	F				F			F	F	F	C	F	F	F	F
Pinus resinosa	F		F			F	F	X			Y		F				F	F				F		F	F		F
Pinus strobus	F		F			F	F	X		S	Y	W	F				F	F	X	X	F	F	W	F	F	F	F
Pinus sylvestris	F		F			X	F	X		S	Y	C	F				F	F		F	F	F	C	F	F	F	F
Pinus thunbergii	F		F			X	F	X			Y		F			X	F		X	X	F	F		F	F	F	F
Pinus virginiana	F						F	X			Y	W	F		X	X	F				F	F	W	F	F	F	F
Platanus spp.							F				Y																
Platanus acerifolia		F	F				F				Y										F						
Platanus occidentalis			F				F			F	Y										F					F	
Platycladus orientalis (Thuja)							F		X			C			X		F	F		X		F	C				
Populus spp.					F		F	F			Y																
Populus deltoides			F		F		F	F		F	Y										F						
Prunus spp.(peach & cherry)			F					F		F	Y				F						F	F			F	F	
Prunus spp.(plum)			F					F		F	Y									F		F			F	F	
Prunus caroliniana			F					F		F	Y									F	F	F			F		
Prunus cerasifera								F		F	Y									F		F			F		
Prunus laurocerasus					F			F		F	Y									F		F			F		
Prunus persica								F		F										F		F			F		
Prunus sargentii								F		F	Y									F		F			F		
Prunus serrulata								F		F	Y									F		F			F		
Prunus subhirtella pendulata								F		F	Y									F		F			F		
Prunus yedoensis								F		F	Y									F		F			F		
Pseudotsuga menziesii/ taxifolia			F				F	X		S	Y	Z	F					F		F	F	F	Z	F		F	F
Pyracantha spp.			F	F	F	C		X	X	F										X	F	F					
Pyracantha coccinea				F	F	C		X	X	F						X				X		F					
Pyrus spp.(pear)					F			F		F										F		F				F	
Pyrus calleryana 'Bradford'					F			F												F		F					
Quercus spp.	F				F	C	F			F						X						F			F	F	F
Quercus alba	F				F	C	F			F												F			F		F
Quercus coccinea	F		F		F	C	F			F											F	F			F		F
Quercus palustris	F		F			C	F			F											F	F			F		F
Quercus phellos	F					C	F			F												F			F	F	F
Quercus rubra	F		F			X	F			F							F	F			F	F			F		F
Rhododendron spp. (azalea)				F			F	X		F	Y		F			X	F	X		X		F		F		F	F
Rhododendron spp. (rhodo.)	F				F		F	X	X	F	Y		F		X	X	F			X		F		F		F	F
Rhododendron,Azalea hybrids-Exbury, Satsuki, Glen Dale				F			F	X		F	Y		F			X	F		X	X		F		F			F
Rhododendron indica			F	F		X	F	X		F	Y		F			X	F			X	F	F		F		F	F
Rhododendron molle				F	F		F	X		F	Y		F			X	F			X		F		F		F	F
Rhododendron obtusum			F	F	F	X	F	X		F	Y		F		X	X	F		X	X	F	F		F		F	F
Rosa spp.	F		F		F	X	F	X	X	Z	Y									X	F						
Salix spp.			F		F		F			F											F	F				F	
Sedum spp.	F			F		F	F													X							
Spiraea spp.					F		F		X	F	Y				X	X	F					F				F	
Spiraea vanhouttei			F		F		F		X	F	Y				X	X	F				F	F				F	
Syringa spp.	F				F		F				Y																F
Syringa persica	F				F	F	F				Y																F
Syringa vulgaris	F		F		F		F			F	Y									X	F						F
Taxodium distichum			F							Z											F						

Ornamental Herbicide Registrations* (continued)

	(PPI)(				PRE													)(POST**)					
	EPTAM	LASSO	TREFLAN	BETASAN	CASORON	CHIPCO RONSTAR	DACTHAL	DEVRINOL	DUAL	ENIDE	FURLOE	GOAL	KERB	LASSO	OH 1	OH 2	OR. WEEDER	PRINCEP	ROUT	SURFLAN	TREFLAN	FUSILADE	GOAL	KERB	PARAQUAT	POAST	ROUNDUP
Taxus spp.	F	F			F		F	F	X		Y	C	F	F		X	F	F				F	C	F			F
Taxus canadensis	F	F			F		F	F	X	F	Y	C	F				F	F				F	C				F
Taxus cuspidata	F	F	F		F		F	F	X		Y	C	F			X	F	F		X	F	F	C				F
Taxus media	F	F	F		F	F	F	F	X		Y	C	F				F	F			F	F	C				F
Thuja spp.					F	C	F	C	X		Y	C				X	F	F		X		F	C		F		F
Thuja occidentalis			F		F	F	F	C	X	Z	Y	C				X	F	F	X			F	C		F	F	F
Tilia spp.	F				F																					F	
Tsuga spp.	F							F			Y						F	F				F					F
Tsuga canadensis	F		F			F		F		Z	Y	S					F	F			F	F	S			F	F
Tsuga caroliniana	F							F			Y						F	F				F					F
Ulmus spp.					F		F											F				F		F		
Ulmus americana					F		F											F				F		F		
Vaccinium spp.										F																
Viburnum spp.	F					X	F		X	F	Y					X	F		X			F				
Viburnum suspensum	F		F			X	F		X	F	Y						F			X	F	F					
Viburnum wrightii	F		F			X	F		X	F	Y						F				F	F					
Vinca spp.	F		F	F				F	X	F																	
Vinca minor	F		F	F		X		F	X	F	Y									X		F				F	
Weigela spp.			F		F		F		X	F									X	X	F						
Wisteria spp.																											
Yucca spp.																											
Yucca filamentosa															X												
Zelkova serrata																											

** Many chemicals are labeled for directed applications only; check labels for specific restrictions.

KEY TO WEED CONTROL:
F=field
D=dormant stock only
Y=field-dormant stock
W=field + container + seedbed
C=container
S=seedbed
X=field + container
Z=field + seedbed

Controlling Weeds in the Home Garden

A weed is a plant growing where it is not wanted. Weeds compete with desirable plants for water, soil nutrients, sunlight, and gaseous components of the air needed for growth. Many weeds also harbor diseases and insects that may attack plants around the home.

Three general methods of weed control can be used in the home garden: (1) cultivation and mechanical removal (hoeing, pulling, etc.); (2) mulching (smothering of weeds); and (3) herbicides (weed killers). Usually, one or more of these methods are used.

CULTIVATION AND MECHANICAL REMOVAL

Cultivation and mechanical removal is the safest and most common method for controlling weeds in small home gardens. Since only those weeds that are actually present can be controlled, the process must be repeated several times throughout the growing season. It may be difficult to control weeds adequately during vacations or busy work periods with this method.

Deeply rooted weeds should be shaved off with a sharp hoe while gently breaking up the crust. Deep tillage causes severe injury to many shallow-rooted plants and helps place a fresh supply of weed seeds in position to germinate. Keeping equipment sharp and in good condition will help reduce injury to desirable plants. Hoe carefully around your plants and hand pull weeds close to the plants.

Weeds can be controlled by wheel and hand hoes in smaller areas or by power equipment such as rototillers and garden-type tractors in large gardens. This equipment should be set shallow when used in a garden for weed control. Avoid cultivating too close to crop plants in order to prevent root injury.

MULCHING

Mulching controls weeds by preventing light from reaching the weed seeds or seedlings. This method will control many annual weeds--those that germinate from seed each year. Perennial weeds (those that sprout each year from below-ground plant parts) usually must be removed by cultivation or hoeing.

The advantages of mulching include moisture conservation, prevention of soil crusting, reduction of erosion, increased spring soil temperatures, and keeping edible aboveground plant portions clean.

*Originial article by H.J. Hopen. Revised by D.J. Williams

Revision of
Circular 1051

ORGANIC MULCHES

The organic materials most frequently used for mulching include plant residues such as straw or hay (free of weed seeds); crushed corncobs; various nut hulls; leaf and grass composts; peat; weed products such as sawdust, wood chips, shredded bark, and shavings; and well-rotted animal manures. Use the most economical mulch available. A combination of several thicknesses of newspaper (use papers with black ink, not colored ink) covered by organic materials has shown promise as a summer type of mulch. To function effectively, these materials should be applied at a depth of about four to six inches.

Natural mulch materials may require considerable hand labor for application. Most organic materials are bulky and must be hauled to the place of use. This is not a serious problem for small gardens.

Organic mulches return organic matter and some plant nutrients to the soil and improve soil tilth as they decompose. Added benefits are prevention of soil compaction, conservation of soil moisture, erosion control on slopes, cooler summer soil temperatures, and the added attractiveness of the garden.

When organic materials are used, you may need to add nitrogen fertilizer to prevent a deficiency of nitrogen in the mulched crop. With legume mulches (alfalfa or clover), however, excess nitrogen is released during decomposition.

Organic mulch material	Nitrogen required for decomposition (pounds per ton of mulch)
Cocoa pods	6.0
Corncobs, ground	22.5
Hay, grass	7.6
Peanut hulls	8.5
Sawdust, fresh	26.0
Wheat straw	17.6

SYNTHETIC MULCHES

Common synthetic mulches include polyethylene, paper, paper-polyethylene combinations, black polypropylene mats, fiberglass mats, wax-coated papers, and aluminum and steel foils.

Polyethylene film is used in a thickness of 1 to 1 1/2 mils (0.001 inch = 1 mil) and a width of three to six feet. Black polyethylene is preferable for the home vegetable garden because it prevents light from reaching the weed seedlings. It is generally not practical to use transparent polyethylene as a full season mulch because weed problems develop under the polyethylene.

Press the edges of the mulch down into furrows and cover firmly with soil. Do not throw excess soil on top of the mulch. A push-type, one-wheel cultivator works well to open and close furrows. The mulch may also be installed by using a rake or shovel to cover the edges with soil.

It is better to apply synthetic mulches in crop rows rather than attempt to cover the entire area. The area between the rows of polyethylene mulch must be carefully cultivated and hoed.

Use of polyethylene mulch will increase spring soil temperatures and hasten the development of some crops.

HERBICIDES

It is not a good practice to use herbicides in small ornamental and vegetable gardens containing several crop species because different flowers, vegetables, and weeds vary in their tolerance to herbicides. Some herbicides may remain in the soil longer than one growing season and may kill or injure some species the following year (especially if excessive rates are used). Ideally, a specific herbicide should be used for each crop species, but most people have small areas of several species in their gardens, and it would often be impractical and expensive to buy the several herbicides that would be needed.

Application methods must be carefully controlled when a herbicide is used on small areas. The tendency is to apply additional amounts if the quantity measured out "looks" as if it is not enough. A low percentage granular formulation is suggested for small garden areas. Check rates of material to use and application techniques on the container label very carefully. Applications must be accurate and uniform. Excessive amounts may cause injury to the present or subsequent crops.

If a gardener is unwilling to remove weeds by hand in the home garden, Dacthal, Amiben,, Treflan, or Eptam can be used on several species. These herbicides may not be the most effective for a large planting of the individual fruit or vegetable species. Herbicides for these large plantings are listed in the commercial

Trade name	Common name	Chemical name
Dacthal	DCPA	dimethyl 2,3,5,6-tetrachloroterephthalate
Roundup, Kleen Up	glyphosate	N-(phosphonomethyl) glycine
Treflan, Preen	trifluralin	α, ,α-trifluoro-2,6 dinitro-N-N-dipropyl-p-toluidine
Devrinol	napropamide	N,N-Diethyl-2-(1-napthalenyloxy)-proprionamide
Amiben, Weedone Garden Weeder, Ornamental Weeder	chloramben	3-amino-2,5-dichlorobenzoic acid
Eptam	EPTC	ethyl N,n-dipropylthiol carbamate
Basfapon, Dowpon (and others)	dalapon	2,2 dichloropropionic acid

growers' recommendations (see Extension Circular 907, 1986 Weed Management Guide for Commercial Vegetable Growers, or Horticulture Fact Sheet H-659, 1986 Herbicides for Commercial Fruit Crops in Illinois).

Herbicides may be sold under several trade names. If you cannot identify the trade names on the container, look for the common name or chemical name on the label. The trade names listed are for products commonly used in Illinois. Products of identical content marketed under other trade names may be equally acceptable.

DCPA

DCPA is a preemergence (before the weeds emerge) herbicide that must be applied to weed-free soil. It controls very small weed seedlings soon after the weed seeds germinate. The herbicide action is most effective if rainfall occurs or the soil is irrigated within two to three days after application of the herbicide.

DCPA is available as a 75 percent wettable powder and a 5 percent granular formulation. This material can be used for annual grass control in lawns, on a number of species of flowers, and on strawberries, broccoli, brussels sprouts, cauliflower, cabbage, dry and snap beans, cucumbers, squash, melons, collards, kale, mustard greens, turnips, garlic, onions, potatoes, sweet potatoes, yams, tomatoes, eggplants, peppers, and horseradish.

Do not use DCPA on beets, bugle weed, button pink, carnation, geum, germander, mesembryanthemum, pansy, phlox, sweet william, and telanthera.

A one-time application to all species is not always possible in a garden of flowers or vegetables because some plants are susceptible to injury in early growth stages. It is preferable to use DCPA at seeding or transplanting time if the species is adapted for it. When this is not possible, the weeds should be removed and Dacthal applied to prevent further weed development. Consult the container label for the appropriate application time.

DCPA is effective in controlling annual grasses that are a problem in the spring. Those broadleaf weeds that escape control should be mechnically removed.

DCPA is the best multipurpose herbicide for home-garden use.

Trifluralin

Since trifluralin is used in soybean culture in Illinois, it is widely available. It can be purchased as a liquid with four pounds of active ingredient per gallon for large garden areas or as a low percentage granular for smaller areas.

Trifluralin can be used for weed control in green, lima, and dry beans, broccoli, brussels sprouts, cabbage, cauliflower, carrots, kale, mustard greens, okra, peas, peppers, tomatoes, and turnip greens, or in growing apricots, cherries, grapes, peaches, and plums. Established trees, some ornamentals, and many established flowers will tolerate trifluralin. Do not use on ground covers, sweet corn, strawberries, bramble fruits, or blueberries, since injury may result.

Trifluralin must be mixed with or watered into the soil to prevent loss of the chemical from the soil surface. A rototiller or similar equipment should be used to mix trifluralin with the soil to a three- to four-inch depth. When it is

impractical to mix trifluralin with the soil mechanically, all germinated and growing weeds should be removed and the herbicide carried into the soil through rainfall or sprinkle irrigation.

The amount of trifluralin to use is correlated very closely with the type of soil. The appropriate amounts are shown on the container label.

Trifluralin is quite effective on annual grasses, but many broadleaf weeds will need to be mechanically removed.

Napropamide

Napropamide is a preemergence (before the weeds emerge) herbicide that must be applied to a weed-free soil. It should be incorporated into the soil by mechanical means or irrigation to be effective.

Napropamide can be used in asparagus, tomatoes, peppers, strawberries, tree fruits, nuts, shrubs, and shade trees. It will control annual grasses such as barnyardgrass, crabgrass, fall panicum, and goosegrass. Broadleaf weeds controlled by napropamide include carpetweed, purslane, lambsquarter, and pigweed.

Chloramben

Chloramben is also available to many farmers because it is used in soybean culture. It should be applied to the soil surface before weed seeds germinate. The herbicide action is most effective if rainfall occurs or the soil is irrigated two to three days after application of the herbicide.

Chloramben is available as a liquid with two pounds of active ingredient per gallon for large garden areas and as a low percentage granular material. It can be used on young asparagus beds when they will not be harvested, lima beans, pumpkins and squash, sweet potatoes, and transplanted tomatoes and peppers. It can be used on cucumbers, green beans, and muskmelons, but some injury may occur on these vine crops. Do not use on other vegetable or fruit crops

As indicated on the container label, a number of annual flowers and established shrubs will tolerate chloramben. Chloramben controls a wider range of annual grass and broadleaf weeds than DCPA, trifluralin, or EPTC, but it is not as effective on common purslane, which is often a problem in home gardens.

Chloramben should not be used on gardens in sandy soil.

EPTC

EPTC can be purchased as a liquid with seven pounds of active ingredient per gallon for large gardens or as 10 percent granular material for smaller areas. It can be used for weed control in green or dry beans, and Irish potatoes.

EPTC is not persistent in the soil. It must be mixed with or watered into the soil immediately after application to prevent loss of the chemical from the soil surface. A rototiller or similar equipment should be used to mix EPTC with the soil to a three- to four-inch depth. When it is impractical to mix it with the soil mechanically, all germinated and growing weeds should be removed and the herbicide carried into the soil through rainfall or sprinkle irrigation.

EPTC is quite effective on annual grasses, but many broadleaf weeds will need to be mechanically removed.

Perennial Weed Control

Cultivation and mulching do not control most perennial weeds. One method of control would be to remove the top growth to deplete the underground storage tissues. This method may suppress the growth of perennial weeds, but completely eradicating the weeds in this way is very difficult.

Glyphosate (Roundup, Kleen UP) must be applied to green, actively growing plants to be effective. It can be applied in the early spring, as it is nonpersistent. Glyphosate can also be applied in the fall, after the edible plants have been removed from the garden, but while the perennial weeds are still growing. Do not apply glyphosate to or let it drift onto desirable or edible plants since it is nonselective. Be sure to read the label for complete application instructions.

Glyphosate can used to control perennial weeds in vegetable gardens where labeled vegetable species will be grown. It must not be aplied when nonlabeled vegetable species are to be grown. If gardeners in areas that are infested with perennial weeds are willing to restrict their choice of crops for one year, this method can effectively reduce the weeds. To find out which species are labeled, check the glyphosate label or ask your Extension adviser.

PRECAUTIONS

General

Phenoxy herbicides (2,4-D and others) and dicamba (Banvel) are used to control broadleaf weeds in corn, turf areas, and roadways. Most flowers, shrubs, shade trees, small fruits, tree fruits, and vegetables are susceptible to injury by these herbicides. When applying these materials, be sure that spray, drifting spray, or fumes do not reach susceptible plants.

Use the amine formulation of 2,4-D, which is less volatile and does not drift as easily as the esters, and apply it under as calm conditions as possible. A sprayer used to apply phenoxy herbicides or dicamba on grass should not be used to apply other pesticides on gardens. Phenoxys usually cannot be cleaned out of sprayers thoroughly enough to avoid injury to broadleaf plants.

Soil Deactivation

If a garden area becomes contaminated with a persistent herbicide or a soil sterilant, this area can be decontaminated by applying activated carbon to inactivate the herbicide. See Horticulture Fact Sheet VC-15.

Disposal of Pesticide Containers and Surplus Pesticides

Use pesticides safely-read the label. If pesticides are handled or applied improperly, or if unused parts are disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, pollinating insects, and fish or other wildlife, and they may contaminate water supplies. Use pesticides only when needed and handle them with care. Follow the directions and heed all precautions on the container labels.

Store all pesticides in a cool, dry, locked storage area so that they are not accessible to children, irresponsible persons, and animals. Do not dispose of pesticides through sewage systems. Haul them or have them hauled to a sanitary land fill for burial.

Never place pressure cans on a stove or heater or near any source of heat that might exceed 120°F. Store in a cool place--not in the hot sun. Have empty pressure cans hauled away and buried by experienced disposal crews. Do not incinerate.

Classification of Herbicides

The U.S. Environmenal Protection Agency is classifying herbicides for general use or restricted use. An Illinois resident wishing to use a herbicide classified for restricted use must be certified as a private or commercial pesticide applicator by the Illinois Department of Agriculture. Your county Extension adviser in agriculture can give you details on this program. None of the herbicides discussed in this paper have been classified for restricted use.

Controlling Weeds in Noncrop Areas

Total vegetation management is the application of nonselective chemicals or nonselective rates of selective chemicals as a means of controlling all vegetation in such noncrop areas as parking lots, drive-in theaters, driveways, patios, and certain industrial sites.

Herbicides can be classified by their length of control. Those with little or no residual activity are the fumigants and the contact herbicides. Fumigants are volatile materials that can affect the viability of weed seeds as well as existing growth. Contact herbicides, such as paraquat, control only the existing vegetation with which the spray comes in contact.

Amitrole, dalapon, 2,4-D, and DSMA give temporary control for four months or less. Semipermanent control is provided by some inorganic salts, such as sodium borate and sodium chlorate. Organic compounds that provide semipermanent control are the uracils (bromacil), substituted ureas (monuron, diuron, and tebuthiuron), and the triazines (atrazine, simazine, and prometon).

Areas where total vegetation management is desirable include the following: (1) beneath asphalt pavement, (2) along railroads, (3) around buildings as a means of preventing the growth of weeds that are unsightly or present a fire hazard, and (4) along fences to control weeds. As an alternative to chemical control, it may be preferable to establish desirable, competitive vegetation along a fence to discourage weed growth and to provide protective soil and wildlife cover. Short-term herbicides, such as 2,4-D and dalapon, might be used for temporary control until desirable vegetation can be established.

PRECAUTIONS AND GENERAL PROCEDURES

Several precautions must be observed when you use nonselective chemicals. You must know what weeds are to be controlled and select the correct chemical for those particular problems. A survey of the area must be made, noting any desirable vegetation in the immediate or adjacent areas that could be affected by spray drift, chemical runoff, or leaching into the root zone.

Appropriate precautions should be taken to prevent damage to desirable plants. The risk of injury with some of these materials may be too great to allow their use in some areas, so be certain that you are familiar with the product and aware of the risks before using these materials. Some treatments should be made only by professional applicators.

The type of vegetation to be controlled will affect your decision in selecting a chemical. Perennial grasses can be controlled with dalapon, amitrole, pronamide, or DSMA; woody perennials with picloram. Deep-rooted vines, such as bindweed, can be controlled with fenac, dicamba, or picloram.

Application timing is very important. The best time to apply nonselective, soil-residual herbicides is early in the spring before herbaceous weeds have emerged. If vegetation is heavy, it may be necessary to remove existing vegetation or to add a contact or foliar herbicide or mix the herbicides with diesel fuel to speed topkill. After existing vegetation is under control, the rate can be reduced for maintenance applications in the future.

Adjust the application rates according to the soil types or for the desired length of control. When you want to control growth for two or three years, maintenance applications are better than an initial application that is too high.

HERBICIDES FOR NONCROPLAND

Inorganic Compounds

1. Sodium chlorate has both foliar and root activity. This compound, however, presents an extreme fire hazard, so fire retardants such as calcium chloride or the borates are often added to reduce the hazard. Altacide is sodium chlorate with a fire retardant. Another drawback to sodium chlorate is the fact that it may be toxic to livestock that seek its salty taste. The rate is 500 to 1,000 pounds per acre.

2. Sodium borate (Borax, Polybor) has primarily root activity. Very high rates are required (1 to 2 tons per acre), so it is often used only as a granular carrier for organic compounds.

3. Sodium arsenite is a highly toxic compound. It is not usually recommended because safer products are now available. Sodium arsenite is formulated as a 9.5-pound-per-gallon liquid. The rate is 55 to 110 gallons per acre.

4. Ammonium sulfamate (Ammate-X) is formulated as 95-percent soluble crystals for weed control on woody plants and herbaceous weeds. It is sometimes used for brush control where volatilization of phenoxy herbicides would be a hazard. It is corrosive to metals. The rate is 60 to 100 pounds per acre.

Organic Compounds for Long-Term Control

1. Asulam (Asulox) is a 3.34-pound-per-gallon formulation that is used at the rate of 1 to 2 gallons per acre. It controls grasses better than broadleaf weeds.

2. Bromacil (Hyvar-X) has both foliar and soil activity. It is formulated as an 80-percent wettable powder (WP) and a 2-pound-per-gallon liquid. The rate of active ingredient is 5 to 15 pounds per acre. Urox-'B' is a 4-pound-per-gallon liquid of bromacil.

3. Bromacil + diuron (Krovar I) is formulated as an 80-percent, 1:1 combination of bromacil:diuron. It is used to control shallow-germinating weeds and deep-rooted perennials. The rate is 6 to 30 pounds per acre. Krovar II is a 2:1, bromacil:diuron formulation.

4. Simazine (Princep) is formulated as an 80-percent WP, a 4-pound-per-gallon liquid, and a 4-percent granule. It has little foliar activity but has a longer residual control than atrazine. The rate is 5 to 40 pounds per acre of the 80-percent WP.

5. Atrazine is an 80-percent WP, a 4-pound-per-gallon liquid, or a 90-percent WDG. Atratol 8P is 8-percent atrazine on a chlorate-borate pellet. The rate is 5 to 40 pounds per acre of the 80-percent WP, 0.25 to 1 pound per 1,000 square feet of the pellet, or 0.12 to 1 pound per 1,000 square feet of the water-dispersible granule.

6. Prometone (Pramitol) is available as a 2-pound-per-gallon liquid, an 80-percent WP, and a 5-percent pellet. It has more foliar activity than atrazine. The rate for the liquid is 5 to 30 gallons per acre. For the pellets, the rate is 12.5 to 75 pounds per acre or 0.5 to 2 pounds per 100 square feet.

7. Hexazinone (Velpar) is available as a 90-percent water-soluble powder (SP), a 25-percent water-dispersible liquid (WDL), and as 20- or 10-percent pellets. Apply 2 to 5 pounds SP or 1 to 2 1/2 gallons WDL per acre for contact kill and short-term control and 6 to 12 pounds SP or 3 to 6 gallons WDL for season-long control. The gridball formulations are recommended at 1 to 4 pounds active ingredient per acre.

8. Tebuthuiron (Spike) is available as an 80-percent WP and as a 1 or 5 percent G. Apply before or during periods of active growth at a rate of 5 to 20 pounds per acre.

9. Diuron (Karmex) is an 80-percent WP. The rate is 10 to 60 pounds per acre. It is sometimes mixed with bromacil (see no. 3).

10. Dichlobenil (Casoron) is available as a 50-percent WP and a 4-percent pellet. It is more commonly used for nursery weed control than for soil sterilization. The rate is 10 to 40 pounds per acre of the 50-percent WP.

11. Amizine is a combination of amitrole and simazine, bringing together the foliar activity of amitrole with the residual activity of simazine. The suggested rate for general vegetation control is 20 pounds or 18 gallons of Amizine in 100 gallons of water per acre.

12. Chlorsulfuron (Telar) is a 75 percent WDG that is most effective when applied postemergence, but is also labeled for preemergence application. The rate is 1/4 to 3 ounces per acre.

13. Sulfometuron (Oust) is a 75 percent WDG that is labeled for preemergence application and postemergence application to young weeds. The rate is 1 to 12 ounces per acre.

Many of the granular or pelleted materials are organic herbicides formulated on sodium borate or borate-chlorate granules. They can be applied dry, which is often convenient for spot treatment or application on small areas.

Organic Herbicides for Short-Term Control

1. Amitrole is available as Weedazol and Amino Triazole. It is a translocated herbicide that is especially effective on poison ivy and Canada thistle as well as perennial grasses such as quackgrass. Amino Triazole is a 90-percent soluble powder and is applied at a rate of 2 to 5 pounds per acre. Weedazol is a 50-percent soluble powder and is applied at a rate of 2 to 8 pounds per acre.

2. Amitrole-T is available as Cytrol and Amitrol-T with 2 pounds per gallon of amitrole plus ammonium thiocyanate. Since Amitrole-T is formulated as a liquid, it is sometimes considered more convenient to handle than amitrole. The rate is 1 to 3 gallons per acre.

3. Dalapon (Dowpon-M) is a foliar-applied, systemic grass killer. It is also available with TCA (Dowpon-C, Revenge) for longer residual control. The rate is 10 to 15 pounds per acre of the 85-percent soluble powder. A wetting agent improves the control. Perennial grass may require more than one application.

4. Sodium-TCA is a root-absorbed grass killer that remains in the soil longer than dalapon. It is a 90-percent soluble powder used at 50 to 150 pounds per acre.

5. MSMA is available as Daconate, a 6-pound-per-gallon liquid with surfactant. It is used for perennial grass control at 0.5 to 1.5 gallons per acre. More than one application may be necessary.

6. DSMA is available as a liquid or soluble powder. It is frequently used for spot treatment of johnsongrass. The rate is 3 to 9 pounds per acre of the soluble powder or 1 to 2 gallons per acre of the liquid.

7. Paraquat is a 2-pound-per-gallon contact herbicide with little residual activity. The volume of water should be adjusted to the amount of vegetation. The rate is 1 to 3 quarts per acre. A surfactant is added at the time of application. Paraquat is restricted to use by certified applicators.

8. Glyphosate (Roundup) is available as a 4-pound-per-gallon systemic herbicide that is nonpersistent. Unlike paraquat, it will translocate to kill perennial weeds. The rate is 1 to 5 quarts per acre.

9. Dinoseb ("dinitro") is a contact herbicide often mixed with fuel oil. It is quite toxic and will stain clothes and skin. Mix 1 to 2 quarts per 30 to 50 gallons of fuel oil with enough water to make a total volume of 100 gallons.

HERBICIDES FOR BROADLEAF WEED AND BRUSH CONTROL

1. Dicamba (Banvel) is available as a 2- or 4-pound per gallon formulation, or as 5 percent granules. The Banvel II formulation is less subject to vapor drift than Banvel, but both present a hazard to nearby soybeans, tomatoes, and desirable woody plants. The rate is 1 to 4 quarts per acre Banvel and 2 to 8 quarts per acre of Banvel II.

2. Picloram (Tordon) is a persistent, broadleaf herbicide. It is formulated as liquid Tordon K or pelleted Tordon 2K or 10K. Mixtures with 2,4-D are Tordon 101, to be applied to stems and foliage, and Tordon 101R or RTU, which is formulated for cut-surface treatments. Special care must be taken because of picloram's soil mobility and long soil life. Tordon is restricted to use by certified applicators.

3. Fenac is closely related to 2,3,6-TBA in terms of controlling deep-rooted, perennial broadleaf weeds. It is formulated as a 1.5-pound-per-gallon liquid. The application rate is 2 to 15 gallons per acre.

4. 2,4-D is a broadleaf herbicide with short persistence. Amine formulations present less hazard to nearby sensitive plants than ester forms. The common formulation is as a 4-pound-per-gallon liquid. Mixtures of 2,4-D and dalapon are often used for short-term control of both broadleaf and grass weeds.

5. Dichlorprop (Weedone 2,4-DP) gives better control of some woody plants than 2,4-D. Commercial mixtures of dichlorprop plus 2,4-D (Weedone 170 and Weedone CB) are available for broader spectrum control.

6. Bromacil (Hyvar-XL) is a 2-pound-per-gallon liquid for basal spraying of brush. A 10-percent pellet (HABCO-10B) is also available.

7. Krenite is available as a 4-pound-per-gallon formulation. When it is applied within two months of fall leaf discoloration, no symptoms are evident until the following spring. Because it does not translocate, it can be used for chemical trimming. The rate is 1.34 to 3 gallons per acre.

LONG-TERM RESIDUAL CONTROL

Spray Applications

Many of these chemicals are WPs and will require thorough agitation for spray application. The rates listed are for the different types of weeds to be controlled. Initial applications are often made at the higher rate, with subsequent treatments at the lower rate.

Herbicide	Rate of formulation per acre		
	Annuals	Shallow perennials	Deep perennials
AAtrex (80W)	6 to 12.5 lb	12.5 to 25 lb	25 to 50 lb
Amizine (60W)	6 lb	12 lb	20 lb
Asulox (3.3 lb/gal)	1 to 2 gal	1 to 2 gal	---
Casoron (50W)	8 to 12 lb	12 to 25 lb	25 to 40 lb
Hyvar-X (80W)	3 to 6 lb	7 to 12 lb	15 to 30 lb
Hyvar-XL (2 lb/gal)	1.5 to 3 gal	3 to 6 gal	6 to 12 gal
Karmex (80W)	5 to 20 lb	20 to 40 lb	20 to 60 lb
Krovar I (80W)	4 to 6 lb	7 to 18 lb	19 to 40 lb
Oust (75WDG)[a]	3 to 5 oz	6 to 12 oz	6 to 12 oz
Pramitol 25E (2 lb/gal)	5 to 7.5 gal	7.5 to 15 gal	15 to 30 gal
Princep (80W)	6 to 12.5 lb	12.5 to 25 lb	25 to 50 lb
Sodium chlorate	300 to 500 lb	500 to 750 lb	750 to 1,300 lb
Spike (80W)	5 to 10 lb	10 to 20 lb	---
Telar (75 WDG)[a]	1/4 to 1 oz	1 to 3 oz	---
Velpar (90W)	2 to 5 lb	6 to 12 lb	---
Velpar L (2 lb/gal WDL)	1 to 2.5 lb	3 to 6 lb	---

[a]Note that rate of formulation is in ounces per acre.

Granular or Pellet Application

Granulars are often more convenient for spot treatment and for small areas. Many granules are on a sodium chlorate--borate base. See the table on the following page.

Herbicide	No. of lbs/1,000 sq ft
Atratol 8P	5 to 10
Banvel G	2.3 to 4.6
Casoron-10P	5 to 10
Chlorea-3	10 to 20
Concentrated Borascu	40 to 60
Pramitol 5P	10 to 20
Princep 4G	5 to 25
Sodium chlorate--borate	30 to 40
Sodium chlorate--modified	20 to 40
Spike 1G	5 to 14
Tordon 10K	1
Urox--'HX'	7 to 14
Velpar Gridball	0.2 to 0.9
Velpar Gridball 1cc	0.1 to 0.5

BROADLEAF WEEDS

These weeds are often best controlled with foliar applications. Deep-rooted perennials can usually be controlled best when they are at the early bud to early bloom stage. The herbicides listed below can move through the air and damage nearby desirable broadleaf plants. They are quite soluble and mobile in the soil and can move into the soil and damage trees or other desirable shrubs and broadleaf plants.

Herbicide	Rate of formulation per acre: Annual and shallow perennials	Rate of formulation per acre: Deep-rooted perennials
Banvel (dicamba)	0.5 to 1 qt	1 to 4 qt
Crossbow (triclopyr + 2,4-D)	1 to 2 qt	2 qt
Fenac	2 to 5 gal	10 to 15 gal
Roundup	1 to 3 qt	4 to 6 qt
Tordon 101 (picloram + 2,4-D)	2 to 3 qt	1 to 3 gal
2,4-D	1 to 2 qt	2 to 4 qt

UNDESIRABLE WOODY PLANTS

Most of the materials used to control woody plants are applied to the foliage, but they can be applied (1) as basal bark treatments if the trees are less than 3 inches in diameter or (2) as frilled treatments if the trees are larger. The basal treatment can be applied in fuel oil during the dormant season. Foliar treatments are usually applied as soon as the brush or trees have leaves fully expanded. See the table on the following page.

Herbicide	Method of application	Rate of formulation
Ammate-X (ammonium sulfamate)	Foliar	60 lb/A
Banvel (4 lb/gal dicamba)	Foliar	2 to 4 qt/A
Crossbow (triclopyr + 2,4-D)	Foliar	4 to 6 qt/A
Garlon 3A (44.4 percent triclopyr)	Foliar	2 to 3 gal/A
Garlon 4 (61.6 percent triclopyr)	Foliar or basal	4 to 8 qt/A
Krenite (4 lb/gal)	Foliar	1.5 to 3 gal/A
Tordon 101 (picloram + 2,4-D)	Foliar or basal	1 to 4 gal/A
2,4-D	Foliar or basal	2 to 4 qt/A

WEEDY GRASS CONTROL

Weedy grass control is often best accomplished with the herbicides listed below. The use of a spreader-sticker (surfactant) often helps.

Herbicide	Rate of formulation per acre	
	Annuals	Perennials
Asulox	1 to 2 gal	1 to 2 gal
Cytrol, Amitrol-T	1 gal	2 to 3 gal
Daconate	2 to 3 qt	3 to 5 qt
Dowpon	5 to 10 lb	10 to 30 lb
MSMA, DSMA	1 to 2 qt	2 to 4 qt
Roundup	1 to 2 qt	2 to 5 qt
Sodium-TCA	20 to 50 lb	100 to 150 lb

CONTACT WEED CONTROL

Contact herbicides kill the plant tissue with which they come in contact; thus, adequate spray volume is needed for full coverage. The use of a surfactant often helps the spray to spread on the plants.

Herbicide	Rate per acre
Fuel oil + dinoseb	50 gal + 2 qt
Herbicidal naphtha	30 to 50 gal
Paraquat	1 to 3 qt/A

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Brush Control in Illinois

The control of brush or undesirable woody plants is required in many situations. Brush control is often used to improve pastures and recreational areas, and to maintain fence-rows, drainage-ditch banks, roadsides, and right-of-ways. Brush can be controlled by mechanical means such as cutting or digging, by herbicide treatments, or with a combination of mechanical and chemical control measures that remove the plant and prevent resprouting.

Mechanical control is costly and time-consuming. And because resprouting often occurs, retreatment may be required for complete control.

Herbicides are often used for brush control because they are less time-consuming than mechanical control methods. Complete control can be achieved with one treatment if the control program is carefully planned, although using chemical control alone allows dead plants to remain. The potential of injury from spray drift or runoff is an important consideration when using herbicides to control brush. Many brush herbicides are selective enough that they leave grasses unharmed while controlling brush and broadleaf weeds. Nonselective herbicides can be used in spot treatments to leave desirable species adjacent to the brush unharmed. Some herbicides have grazing and harvest restrictions. Others cannot be applied to aquatic areas. Be sure to follow label restrictions and recommendations closely.

METHOD OF APPLICATION

Various methods can be employed to get the herbicide into the target plant. Table 1 indicates label clearances for methods of applying common brush herbicides.

Foliar treatments are most effective when applied to fully developed plant foliage during late spring or early summer. Some herbicides can be applied throughout the growing season although translocation may be restricted by adverse temperature or moisture stress. Good foliar coverage is necessary for control.

The effectiveness of most foliar treatments will be reduced if rainfall occurs on the day of treatment. Foliar-stem treatments are usually applied only to brush or small trees. Large trees should be treated by another method to improve control and reduce drift potential.

Take precautions against particle drift from the spray to nearby susceptible plants when using the foliar-stem method. Herbicide labels list sensitive species and areas you should avoid spraying. Avoid spraying when the wind velocity is greater than 5 mph or when the wind is blowing toward sensitive crops or ornamentals. Reduce the pressure and use nozzles with larger orifices to apply treatments that do not require coverage with fine spray droplets to achieve good control. Drift-reducing spray additives and equipment are available, but to use them successfully you must adhere closely to the directions. Follow all label precautions and directions to achieve good control and ensure minimum drift.

Table 1. Label Clearances for Common Brush Herbicides

Brush herbicide	Area				Application				Type of brush	
	Pasture	Drainage-ditch bank	Right-of-way	Noncrop	Foliar-stem spray	Cut surface or injection	Basal bark[a]	Soil	Deciduous	Conifer
2,4-D amine	X	X	X	X	X	X			X	
2,4-D ester	X	X	X	X	X	X	X		X	
2,4-DP (dichlorprop)			X	X	X	X	X		X	
Weedone 170 or Weedone CB (2,4-D + dichlorprop)		X	X	X	X	X	X		X	
Banvel + 2,4-D	X	X	X	X	X	X	X[b]		X	X
Banvel 5G or 10G	X	X	X	X				X	X	X
Tordon 10K	X		X	X				X	X	X
Tordon RTU						X			X	X
Tordon + 2,4-D			X	X	X	X			X	X
Crossbow (triclopyr + 2,4-D)			X	X	X	X	X		X	X
2,4-D + mecoprop + dicamba		X	X	X	X				X	
Ammate X	X	X	X	X	X	X			X	X
Krenite		X	X	X	X				X	
Amitrole + T		X	X	X	X				X	
Roundup			X	X	X				X	
Hyvar-X		X[c]	X	X	X			X	X	X
Velpar			X	X	X			X	X	
Spike			X	X				X	X	X

[a] oil-soluble forms only
[b] not for pasture use
[c] soil application only

Basal-bark treatments are oil-soluble herbicides in a carrier of diesel oil or kerosene. They are applied to the lower 18 inches of brush plants that are less than 5 inches in diameter. The spray should thoroughly drench the stem so that runoff soaks the ground line and all exposed roots. The herbicides commonly used for basal-bark treatments can cause injury if the vapor drifts to desirable crops or ornamentals. Although basal-bark treatments can be made throughout the year, treatments made during the dormant season are less likely to produce drift injury. Basal-bark treatments are labor intensive but are useful in selectively removing undesirable species from stands of desirable trees.

Cut-surface treatments are more effective than basal-bark treatments on plants that are greater than 5 inches in diameter or on thick-barked species. The herbicide is applied to the stump of a cut plant or to frills or notches cut around the plant to a depth of at least 1/2 inch into the sapwood. Special injection equipment can be used to cut the plant and apply the herbicide in one operation. The herbicide should be applied to the cut surface before the exposed plant tissue dries, which is usually within 2 or 3 hours after cutting. When treating cut stumps, thoroughly drench the plant so that the runoff covers crown buds and all exposed roots. Most herbicides used for cut-surface treatments volatilize readily. Treatment can be made during the dormant season when the potential for drift injury is low or during any other time of the year.

Soil treatments can be made using certain herbicides that move through the soil to the root zone and then translocate upward to kill the plant. Treatments are applied as sprays within the drip line of the target species or dry as granules or pellets. Exercise care in applying these herbicides to minimize damage to nearby desirable species. Damage can result if there is lateral herbicide movement or if you treat areas where the root zones of desirable and target species overlap.

Most soil treatments can be made throughout the year. They should not be applied to frozen ground. The soil-applied herbicides usually remain active in the soil for several months. For that reason you should not use them where there is a possibility that they might run off into water sources or cropping areas or where they might leach into ground water.

BRUSH HERBICIDES

Phenoxy herbicides used for brush control are 2,4-D and dichlorprop (2,4-DP). Many formulations of these herbicides are available. 2,4-D is labeled for brush control in pastures, drainage-ditch banks, right-of-ways, and noncrop areas. Dichlorprop is labeled for use on right-of-ways and noncrop areas (Table 1). Other herbicides are sometimes combined with 2,4-D or dichlorprop to broaden the spectrum of susceptible plants. Tables 2, 3, 4, and 5 indicate the susceptibility of common brush species to certain herbicide treatments. Much of the information in these tables was taken from Response of Selected Woody Plants in the United States to Herbicides, Agriculture Handbook No. 493, U.S. Department of Agriculture.

The phenoxy herbicides are readily absorbed by plant foliage. Oil-soluble formulations (esters or oil-soluble amines) applied in kerosene or diesel oil will penetrate the bark of most woody plants. The esters are usually more effective than the amines when treating brush and trees with foliar or basal-bark sprays. Amines are preferable for injection and cut-surface treatments.

Minute quantities of phenoxy herbicides may cause injury to highly susceptible nontarget plants such as tomatoes, grapes, cotton, tobacco, cucumber, and ornamentals

whether the method of application is foliar, basal bark, or cut surface. (Foliar treatment may result in greater injury than that caused by the other methods because it requires a greater volume of herbicide.) The vapor from a phenoxy treatment may travel up to 1/2 mile. To reduce vapor drift, use amine rather than ester formulations when possible. If you must use an ester, choose a low-volatile (L.V.) rather than high-volatile (H.V.) formulation. Do not use an ester when the temperature on the day of treatment exceeds 85°F. Do not treat near highly sensitive nontarget plants. Do not apply phenoxys to water intended for domestic use or irrigation.

If possible, do not use phenoxy spray equipment to apply other pesticides to phenoxy-susceptible plants. Some residue may remain even after thorough cleaning. Follow all use restrictions listed on the herbicide label.

Banvel (dicamba) is a translocated selective herbicide that can be absorbed through the roots or the above-ground portions of plants. Banvel is used for foliar, cut-surface, basal-bark, or soil treatments. Foliar sprays can be applied with ground or aerial equipment. The granular or pellet formulations that are available for soil treatments should be applied in spring or early summer. The spectrum of species controlled with Banvel can be broadened by the addition of 2,4-D as recommended on the label.

Banvel is effective in small amounts. Like the phenoxys, it volatilizes readily. Take precautions to prevent drift to sensitive feed and food crops, ornamentals, and conifers. The label tells how long to delay grazing and harvesting after treatment with Banvel and restricts the use of Banvel near soybeans in certain stages of growth. Study the label carefully before applying.

Tordon (picloram) is a translocated selective herbicide that is absorbed by the roots and foliage of plants. Formulations are available for foliar, soil, or cut-surface applications. Liquid formulations may be oil based for foliar treatments or water soluble for cut-surface applications. Mixtures with phenoxy herbicides are available to give broader spectrum weed control.

Soil treatments may be applied as liquids or dry in pellet form. Rainfall is required to wash the dry formulation into the root zone. Broadcast soil treatments are recommended for dense brush. Spot treatments can be made to individual plants or scattered stands of brush.

Picloram moves easily in the soil water and remains active for a long time. A low concentration can cause extensive damage to susceptible species. Avoid applying where runoff or ground water could move the herbicide into the root zone of susceptible nontarget plants such as conifers, or broadleaf ornamentals and crops. Prevent picloram from drifting into water containments and areas where desirable plants are growing. Vapor drift to nontarget species is less injurious if treatment is made during the dormant season.

Tordon is a restricted-use herbicide that can be applied only by certified private or commercial applicators.

Garlon (triclopyr) is a systemic selective herbicide that can be applied as a foliar, basal-bark, or cut-surface treatment. Compared to many brush herbicides, Garlon gives superior control of ash, oak, and certain root-sprouting species. Commercial mixes of triclopyr plus 2,4-D (Crossbow) or triclopyr plus picloram are available to control a broader spectrum of brush species.

Table 2. Foliar Herbicide Treatment, Susceptibility of Common Brush Species[a]

	Foliar spray									
	2,4-D	Dichlorprop	Banvel	Tordon	Hyvar	Garlon	Ammate	Amitrole	Roundup	Krenite
Ash, white (Fraxinus americana)	R	R	S-R	S-R	S-R	S-I	S-I	S	S-I	I
Birch (Betula spp.)	S-I	S	S	S	S	S-I	S	...	S	S
Boxelder (Acer negundo)	S-I	I-R	...	S-I	S	...	...	...	S	...
Brambles--blackberry, raspberry, etc. (Rubus spp.)	I-R	I-R	S-I	S-I	S-I	S-I	I-R	S-I	S-I	S
Cherry, black and choke (Prunus serotina and P. virginiana)	I-R	I-R	S	S-I	S-I	S-I	S	S	S	I
Cottonwood, eastern (Populus deltoides)	S-R	R	R	...	S-I	S-I	S	...	...	S-I
Crabapple (Pyrus ioensis)	S-I	S	S	S	S	...	S	...	S	...
Elderberry (Sambucus canadensis)	S-I	I	S	S	S	S-I	R	...	S	...
Elms, American and slippery (Ulmus spp.)	I	S-I	I	S-I	S-I	S-I	S-I	...	S	S-I
Grapes, wild (Vitis spp.)	S-I	S-I	I-R	S-I	...	...	S-I	...	S	S-I
Greenbrier or catsbriar (Smilax spp.	R	R	R	I-R	R	...	I-R	...	...	...
Hackberry (Celtis spp.)	I-R	I-R	I	S-I	S-I	...	I	...	S	...
Hawthorn (Crataegus spp.)	I-R	R	R	S-I	...	S-I	I	...	S	I
Hedge-apple or osage orange (Maclura pomifera)	I-R	R	I-R	...	...	...	R	...	...	...
Honeylocust (Gleditsia triacanthos)	I-R	I	S-I	S	S	S-I	S-I	...	S	...
Honeysuckle (Lonicera spp.)	S-I	S-I	I	S-I	S	...	I	S-I	S	...
Locust, black (Robinia pseudoacacia)	S-I	S-I	S	S-I	S	S-I	I	S	S	S
Mulberry, red (Morus rubra)	I-R	I-R	S-I	S-I	...	S-I	I-R	...	...	...
Persimmon, eastern (Diospyros virginiana)	I	I-R	S-I	S-I	...	S-I	I	...	...	I
Plum, wild (Prunus spp.)	S-I	I	S-I	S	...	...	I	...	S	S-I
Poison ivy (Rhus radicans)	I	I	S	S	S	...	S	S	S	...
Redcedar, eastern (Juniperus virginiana)	R	R	I-R	S-I	S	...	I	...	S	S
Rose, multiflora (Rosa multiflora)	...	...	...	S	...	...	...	...	S	S-I
Sassafras (Sassafras albidum)	S-I	I	I	S-I	S	S-I	S-I	...	S	I
Sumac (Rhus spp.)	S	S	S	S	S-I	S-I	S-I	S	S	S
Tree-of-heaven (Ailanthus altissima)	S-I	S-I	S-I	S-I	S	...	I	...	S	S-I
Trumpet-creeper (Campsis radicans)	...	...	S-I	...	...	...	...	...	S-I	...
Virginia creeper (Partheno-cissus quinquefolia)	S	S-I	...	...	...	...	R	...	S	...
Willow (Salix spp.)	S	S	S-I	S-I	S	S-I	S-I	...	S	I

[a]S = Susceptible, I = Intermediate, R = Resistant, S-I = Susceptible to Intermediate, S-R = Susceptible to Resistant, I-R = Intermediate to Resistant. Table is adapted from Response of Selected Woody Plants in the United States to Herbicides, Agricultural Handbook No. 493, U.S. Department of Agriculture.

Table 3. Basal-Bark Herbicide Treatment, Susceptibility of Common Brush Species[a]

	Basal-bark spray						
	2,4-D	Dichlorprop	Banvel	Tordon	Hyvar	Ammate	Garlon
Ash, white (Fraxinus americana)	R	R	S-I	S-I	S	S	S
Birch (Betula spp.)	S	...	...	S-I	S	S	S
Boxelder (Acer negundo)	S	S	S	S	S	S-I	...
Brambles--blackberry, raspberry, etc. (Rubus spp.)	I-R	S-R	S	S	S	I-R	S
Cherry, black and choke (Prunus serotina and P. virginiana)	S-R	S	S	S	S-I	S	S
Cottonwood, eastern (Populus deltoides)	...	...	...	...	S	...	S
Crabapple (Pyrus ioensis)	S-I	S-I	S	S	S-I	S	...
Elderberry (Sambucus canadensis)	S-I	S	S	S	S	I	S
Elms, American and slippery (Ulmus spp.)	S-I	S-I	S	S	S-I	S-I	S
Grapes, wild (Vitis spp.)	...	...	...	...	...	I	...
Greenbrier or catsbriar (Smilax spp.)	I	...	R	I-R	R	R	...
Hackberry (Celtis spp.)	S	S	...	S-I	S	S	...
Hawthorn (Crataegus spp.)	I	S-R	S-R	S	S	I	...
Hedge-apple or osage orange (Maclura pomifera)	I	R	...	S	I	I	...
Honeylocust (Gleditsia triacanthos)	I	I	...	S-I	S	S-I	...
Honeysuckle (Lonicera spp.)	S	S	S	S	I-R	R	...
Locust, black (Robinia pseudoacacia)	I	I-R	S-I	S-I	S	I-R	S
Mulberry, red (Morus rubra)	I-R	I-R	S	S	I	I	S
Persimmon, eastern (Diospyros virginiana)	I-R	R	S	S	I	S-I	S
Plum, wild (Prunus spp.)	S-I	S-I	S	S	S	S	...
Poison ivy (Rhus radicans)	I	...	...	...	S	S	...
Redcedar, eastern (Juniperus virginiana)	R	R	S-I	S	S	S	...
Rose, multiflora (Rosa multiflora)	...	...	...	...	...	...	...
Sassafras (Sassafras albidum)	S-I	S-R	S	S	I	S-I	S
Sumac (Rhus spp.)	R	R	S	S	S	R	S
Tree-of-heaven (Ailanthus altissima)	S-R	S-I	S	S	S	I	...
Trumpet-creeper (Campsis radicans)	...	...	...	...	...	...	...
Virginia creeper (Parthenocissus quinquefolia)	...	...	...	...	R	R	...
Willow (Salix spp.)	S	S	...	S-I	S	S	S

[a]S = Susceptible, I = Intermediate, R = Resistant, S-I = Susceptible to Intermediate, S-R = Susceptible to Resistant, I-R = Intermediate to Resistant. Table is adapted from Response of Selected Woody Plants in the United States to Herbicides, Agriculture Handbook No. 493, U.S. Department of Agriculture.

Table 4. Injection/Cut Surface Treatment, Susceptibility of Common Brush Species[a]

	2,4-D	Dichlorprop	Garlon	Banvel	Tordon + 2,4-D	Ammate
Ash, white (*Fraxinus americana*)	I	...	S	S	...	S-I
Birch (*Betula* spp.)	...	S-I	S	S	S-I	S-I
Boxelder (*Acer negundo*)	...	...	...	...	...	...
Brambles--blackberry, raspberry, etc. (*Rubus* spp.)	...	S-I	S	...	...	...
Cherry, black and choke (*Prunus serotina* and *P. virginiana*)	...	S-I	S	...	S-I	...
Cottonwood, eastern (*Populus deltoides*)	S-I	...	S	...	...	...
Crabapple (*Pyrus ioensis*)	...	...	...	...	...	...
Elderberry (*Sambucus canadensis*)	...	...	S	...	...	...
Elms, American and slippery (*Ulmus* spp.)	S-I	...	S	...	S-I	...
Grapes, wild (*Vitis* spp.)	S	...	...	...	...	...
Greenbrier or catsbriar (*Smilax* spp.)	...	...	...	...	...	...
Hackberry (*Celtis* spp.)	S	...	...	...	...	...
Hawthorn (*Crataegus* spp.)	R	...	...	...	S-I	...
Hedge-apple or osage orange (*Maclura pomifera*)	S-I	...	...	...	...	...
Honeylocust (*Gleditsia triacanthos*)	...	...	...	...	...	...
Honeysuckle (*Lonicera* spp.)	...	S-I	...	...	...	...
Locust, black (*Robinia pseudoacacia*)	S	S-I	S	...	...	...
Mulberry, red (*Morus rubra*)	...	...	S	...	...	...
Persimmon, eastern (*Diospyros virginiana*)	I	...	S	S	S-I	...
Plum, wild (*Prunus* spp.)	...	...	...	...	...	...
Poison ivy (*Rhus radicans*)	...	S-I	...	...	...	...
Redcedar, eastern (*Juniperus virginiana*)	R	...	...	S-I	...	...
Rose, multiflora (*Rosa multiflora*)	...	...	...	...	...	...
Sassafras (*Sassafras albidum*)	...	...	S	...	...	...
Sumac (*Rhus* spp.)	...	...	S	...	...	...
Tree-of-heaven (*Ailanthus altissima*)	...	...	...	...	...	...
Trumpet-creeper (*Campsis radicans*)	...	...	...	...	...	...
Virginia creeper (*Parthenocissus quinquefolia*)	...	...	...	...	...	...
Willow (*Salix* spp.)	S	S-I	S	...	...	S-I

[a]S = Susceptible, I = Intermediate, R = Resistant, S-I = Susceptible to Intermediate, S-R = Susceptible to Resistant, I-R = Intermediate to Resistant. Table is adapted from *Response of Selected Woody Plants in the United States to Herbicides*, Agriculture Handbook No. 493, U.S. Department of Agriculture.

Table 5. Soil Herbicide Treatment, Susceptibility of Common Brush Species[a]

	Banvel	Tordon	Hyvar	Velpar	Spike
Ash, white (*Fraxinus americana*)	...	I	S	...	S
Birch (*Betula* spp.)	...	...	S	...	...
Boxelder (*Acer negundo*)	...	...	S	...	S
Brambles--blackberry, raspberry, etc. (*Rubus* spp.)	...	S-I	S	...	S
Cherry, black and choke (*Prunus serotina* and *P. virginiana*)	...	S	S-I	...	S
Cottonwood, eastern (*Populus deltoides*)	...	...	...	...	S
Crabapple (*Pyrus ioensis*)	...	...	I	...	...
Elderberry (*Sambucus canadensis*)	...	S-I	S	...	...
Elms, American and slippery (*Ulmus* spp.)	S-I	S	S	...	S
Grapes, wild (*Vitis* spp.)	...	S-I	...	...	...
Greenbrier or catsbriar (*Smilax* spp.)	R	R	R	...	S
Hackberry (*Celtis* spp.)	...	S	S	...	S
Hawthorn (*Crataegus* spp.)	R	S	S-R	S-I	S
Hedge-apple or osage orange (*Maclura pomifera*)	...	...	R	...	...
Honeylocust (*Gleditsia triacanthos*)	...	S-I	S	...	...
Honeysuckle (*Lonicera* spp.)	...	...	I-R	...	...
Locust, black (*Robinia pseudoacacia*)	...	S-I	S	...	S
Mulberry, red (*Morus rubra*)	...	S-I	I	...	S
Persimmon, eastern (*Diospyros virginiana*)	S	S	I	...	S
Plum, wild (*Prunus* spp.)	...	...	S	...	S
Poison ivy (*Rhus radicans*)	...	...	S	...	...
Redcedar, eastern (*Juniperus virginiana*)	S-I	S-I	S	...	S
Rose, multiflora (*Rosa multiflora*)	...	S-I	...	...	S
Sassafras (*Sassafras albidum*)	...	S-I	I	...	...
Sumac (*Rhus* spp.)	...	S	S	S-I	S
Tree-of-heaven (*Ailanthus altissima*)	...	...	S	...	S
Trumpet-creeper (*Campsis radicans*)	...	...	...	S-I	S
Virginia creeper (*Parthenocissus quinquefolia*)	...	...	R	...	S
Willow (*Salix* spp.)	...	...	S	S-I	S

[a]S = Susceptible, I = Intermediate, R = Resistant, S-I = Susceptible to Intermediate, S-R = Susceptible to Resistant, I-R = Intermediate to Resistant. Table is adapted from *Response of Selected Woody Plants in the United States to Herbicides*, Agriculture Handbook No. 493, U.S. Department of Agriculture.

Take measures to prevent drift of Garlon formulations to susceptible ornamentals, crops, and conifers.

Trimec 352, Brush Killer 875, and certain other commercial mixtures of 2,4-D, mecoprop, and dicamba are designed for foliar applications to give broad-spectrum brush control. A low concentration can damage susceptible species. Take precautions to prevent drift injury.

Ammate X (AMS) is a nonselective herbicide that can be used as a foliar spray or in a cut-surface treatment for brush control. A large concentration and thorough coverage are required to kill plants. A surfactant will aid control.

Since AMS is not volatile, drift should not be a problem, but you should avoid spraying desired plants directly. In pasture or rangeland, spray away from forage plants to avoid suppressing or killing them. The formulation Ammate X-NI can be used on land adjacent to streams and public water supply areas.

Ammate X is corrosive to spray equipment. Clean equipment immediately after use and coat with diesel oil.

Krenite (fosamine) is a contact herbicide that is applied to the foliage of brush during the two-month period prior to fall coloration. No effects are seen until the following spring when treated plants fail to refoliate and subsequently die. Pine species may respond during the season of treatment. Thorough coverage is required for complete control. By carefully directing the application, you can use Krenite to trim woody species without killing the entire plant. A surfactant can be used to improve control.

Krenite should not be applied to desirable plants, brush standing in water, or food crops. Krenite can be slightly corrosive to brass or copper spray equipment. Clean thoroughly after each use to protect the sprayer.

Amitrole is a nonselective translocated herbicide that is especially effective against poison ivy, poison oak, brambles, and honeysuckle. Amitrole can be used only where there is no possibility that residues will remain on food or feed crops (see Table 1). Amitrole is available as a water soluble powder as Amizol and Amino Triazole. It is available with ammonium thiocyanate under the trade names of Amitrol-T and Cytrol Amitrole-T. Amitrole is applied in foliar sprays. All leaves, stems, and suckers should be thoroughly wet to the ground line. The addition of a surfactant might improve control.

Because amitrole gives nonselective control, it should be directed away from desirable species if their loss would be detrimental. Keep amitrole out of aquatic areas if the water is intended for irrigation, drinking, fishing, or other domestic purposes. Keep livestock off treated areas.

Roundup (glyphosate) is a nonselective systemic herbicide that can be used for spot treatments in areas where loss of ground cover is detrimental. Because plants absorb the herbicide through their foliage, application must be made during the season of active growth. Flowering species should be treated when the plants are at or beyond the full-bloom stage of growth. Roundup has no soil activity. Prevent drift to foliage of nontarget species.

Hyvar-X (bromacil) is a nonselective foliage or soil-applied herbicide that is used for the control of a wide spectrum of woody species. Depending upon the formulation, bromacil can be applied dry or in a water spray. Rainfall or irrigation leaches the

herbicide into the root zone. Hyvar-X may be broadcast above the roots of plants just before or during active growth. Spot treatments around the base of woody plants may be appropriate in areas where bare ground is undesirable. Treated plants may not respond until some time after application.

Do not apply Hyvar-X to frozen ground or to brush that is standing in water. Since the undiluted product is combustible, keep it away from heat and open flame. Thoroughly clean all traces of Hyvar-X from spray equipment immediately after use. Do not use aluminum spray nozzles.

Velpar (hexazinone) is a nonselective herbicide that is taken up by the roots and foliage of plants. Velpar is most effective when applied to the soil just before or soon after weed emergence. Velpar also has some contact activity if an appropriate surfactant is added to the spray mix. The recommended rate varies with soil type. Higher rates are recommended when treating hard-to-control species. Velpar gridballs are labeled for some uses.

Avoid application of Velpar to the root zone or foliage of desirable plants. Spot treatment is necessary when bare soil is undesirable. Exceeding the concentration recommended on the label might clog nozzles and result in uneven distribution. Agitate the herbicide mixture for at least ten minutes until Velpar is thoroughly dissolved.

Spike (tebuthiuron) is a soil-applied nonselective herbicide. To achieve the best results, apply the herbicide prior to or during active growth of target plants. Spike can be applied to the soil dry or with a water carrier. The dry application requires rainfall to wash the herbicide into the root zone.

The wettable powder formulation requires continuous agitation. Spike does not leach readily in the soil. Avoid application where runoff can wash the dry herbicide into nontarget areas. Take measures to prevent drift or direct application of Spike to the root zone of desirable plants.

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Chemical Control of Some Aquatic Plants

R.C. Hiltibran

Group and species	Chemical, active ingredient, or free acid equivalent	Rate of application	Remarks
EMERSED PLANTS			
Arrowhead (*Sagittaria* spp.)	Use one of the following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	diquat cation (2 lb./gal.)	1/4 cup/gal.	Wet foliage
Bulrush (*Scripus actus* Muhl.)	Use one of the following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4lb./gal)	1/2 cup/2 gal.	Wet stems
	diquat cation (2 lb./gal.)	2 tbsp./3 gal. and 1 tsp. nonionic wetting agent	Wet foliage to point of run-off
	dichlobenil (aquatic granules 10%)	40 lb./A.	Apply in March to exposed bottom soil
Cattails (*Typha* spp.)	Use one of the following:		
	dalapon	4 oz./gal. and 3 caps detergent	Wet foliage
	amitrole	2 oz./gal. and 3 caps detergent	Wet foliage
	2,4-D ester (4 lb./gal.)	1/2 cup/gal. and 3 caps detergent	Wet foliage
	diquat cation (2 lb./gal.)	2 tbsp./3 gal. and 1 tsp. nonionic wetting agent	
	glyphosate Rodeo (4 lb./gal.)	2 tbsp./1 gal. plus 1/2 to 1 tbsp. of nonionic surfactant	Wet foliage of actively growing plants at bloom stage or later
Creeping water primrose (*Jussiaea repens L.* var. *glabrescens* Ktze.)	Use one of the following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	diquat cation (2 lb./gal.)	1/4 cup/2 gal.	Wet foliage

Group and species	Chemical, active ingredient, or free acid equivalent	Rate of application	Remarks
Phragmites (*Phragmites australis*)	glyphosate Rodeo (4 lb./gal.)	2 tbsp./1 gal. plus 1/2 to 1 tbsp. of non-ionic surfactant	Wet foliage. Full bloom stage or during autumn. Repeat treatments required.
Spatterdock (*Nuphar advena* (Ait.) Ait. f.)	dichlobenil (aquatic granules 10%)	60 lb./A.	Spread on water
	glyphosate Rodeo 4 lb./gal.)	2 tbsp./1 gal. plus 1/2 to 1 tbsp. of nonionic surfactant	Wet foliage. Full bloom stage during summer or fall.
Waterwillow (*Justicia americana* (L.) Vahl)	Use one of the following:		
	2,4-D		
	ester (20% G)	1 lb./440 sq. ft.	Spread on water
	ester (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	amine (4 lb./gal.)	1/4 cup/2 gal.	Wet foliage
	diquat cation (2 lb./gal.)	1/4 cup/2 gal.	Wet foliage
SUBMERSED PLANTS WITH ALTERNATE LEAF ATTACHMENT			
Curlyleaf pondweed (*Potamogeton crispus* L.)	Use one of the following:		
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	0.3 ppm (total or large-scale application) 1.0 ppm (marginal application)	Apply on or below surface
	diquat cation (2 lb./gal.)	0.5 ppm or 1 gal./ surface A.	Same as above
	dichlobenil (aquatic granules 10%)	80 lb./A	Preemergent application
	fenac	See manufacturer's directions	Must be applied to exposed pond bottom
	diquat cation copper-triethanolamine complex	0.25 ppm diquat cation plus an equal volume of copper-triethanolamine complex	Apply on or below water surface
	simazine (80-WP)	0.5 ppm	Apply to total water volume
Leafy pondweed (*P. foliosos* Raf.)	Use one of the following:		
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	0.3 ppm (total or large-scale application) 1.0 ppm (marginal application)	Apply on or below water surface
	diquat cation (2 lb./gal.)	0.5 ppm or 1 gal./ surface A.	Same as above
	dichlobenil (aquatic granules 10%)	120 lb./A.	Preemergent application*

*The preemergent herbicides have not given satisfactory season-long control of leafy pondweed.

Group and species	Chemical, active ingredient, or free acid equivalent	Rate of application	Remarks
Leafy pondweed (continued)	fenac (10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
	simazine (80-WP)	0.5 ppm	Apply to total water volume
Sago pondweed (*P. pectinatus* L.)	Use one of the following:		
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	0.3 ppm (total or large-scale application) 1.0 ppm (marginal application)	Apply on or below water surface
	diquat cation (2 lb./gal.)	0.5 ppm or 1 gal./surface A.	Same as endothall
	dichlobenil (aquatic granules 10%)	40 lb./A.	Preemergent application
	fenac (10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
	simazine (80-WP)	0.5 ppm	Apply to total water volume
Small pondweed (*P. pusillus* L.)	Use one of the following:		
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	0.3 ppm (total or large-scale application) 1.0 ppm (marginal application)	Apply on or below water surface
	diquat cation (2 lb./gal.)	0.5 ppm	Same as above
	dichlobenil (aquatic granules 10%)	80 lb./A.	Preemergent application
	fenac (10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
	simazine (80-WP)	0.5 ppm	Apply to total water volume
Waterstargrass (*Heteranthera dubia* (Jacq.) MacM.)	Use one of the following:		
	diquat cation (2 lb./gal.)	1 ppm or 2 gal./surface A.	Apply on or below water surface
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	5 ppm	Same as above
SUBMERSED AQUATIC PLANTS WITH OPPOSITE LEAF ATTACHMENT			
White buttercup (*Ranunculus trichophyllus* Chaix)	diquat cation (2 lb./gal.)	0.5 ppm	Apply below water surface
Slender naiad (*Najas flexilis* (Willd.) Rostk. & Schmidt)	Use one of the following:		
	copper-ethylene-diamine complex*	0.5-1.0 ppm (copper)	Apply below water surface

*Sold under the trade name of Komeen by the Sandoz Corporation

Group and species	Chemical, active ingredient, or free acid equivalent	Rate of application	Remarks
Slender naiad (continued)	diquat cation (2 lb./ gal.)	1 ppm or 1.5 gal./ surface A.	Apply below water surface
	diquat cation/copper-triethanolamine complex	0.5 ppm diquat cation plus an equal volume of copper-triethanolamine complex	Apply on or below water surface
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	3 ppm (total or large-scale application) 4 ppm (marginal application)	Same as above
	dichlobenil (aquatic granules 10%)	80 lb./A.	Preemergent application
Southern naiad (*N. guadalupensis* (Spreng.) Magnus)	Use one of the following:		
	copper-ethylene-diamine complex*	0.5-1.0 ppm (copper)	Apply below water surface
	diquat cation (2 lb./gal.)	1 ppm or 1.5 gal./ surface A.	Apply below water surface
	diquat cation/copper-triethanolamine complex	0.5 ppm diquat cation plus an equal volume of copper-triethanolamine complex	Apply on or below water surface
	endothall (potassium salt, 4.23 lb./gal. or 10% G)	3 ppm (total or large-scale application) 4 ppm (marginal application)	Same as above
	dichlobenil (aquatic granules 10%)	80 lb./A.	Preemergent application
SUBMERSED AQUATIC PLANTS WITH WHORLED LEAF ATTACHMENT			
Common coontail (*Ceratophyllum demersum l.*)	Use one of the following:		
	endothal (potassium salt, 4.23 lb./gal. or 10% G)	2 ppm	Spread on water
	2,4-D ester (20% G)	2 ppm	Spread on water
	diquat cation (2 lb./gal.)	1 ppm, or 2 gal./ surface A.	Apply below water surface
	diquat cation/copper-triethanolamine complex	0.5 ppm diquat cation plus an equal volume of copper-triethanolamine complex	Apply on or below water surface
Elodea (*Elodea canadensis* Michx.)	Use one of the following:		
	copper-ethylenediamine complex*	0.5-1.0 ppm (copper)	Apply below water surface
	diquat cation (2 lb./gal.)	1 ppm, or 2 gal./ surface A.	Apply below water surface

*Sold under the trade name of Komeen by the Sandoz Corporation.

Group and species	Chemical, active ingredient, or free acid equivalent	Rate of application	Remarks
Elodea (continued)	diquat cation/copper-triethanolamine complex	0.5 ppm diquat cation plus an equal volume of copper-triethanolamine complex	Apply on or below water surface
Watermilfoil (*Myriophyllum* spp.)	Use one of the following:		
	2,4-D ester (20% G)	2 ppm	Spread on water
	endothall (potassium salt, 4.23 lb./gal.	3 ppm	Apply below water surface
	or 10% G)	3 ppm of 10% G	Spread on water
	diquat cation (2 lb./gal.)	1 ppm	Apply below water surface
	dichlobenil (aquatic granules 10%)	100-150 lb./A.	Spread on water
	fenac (10% G)	See manufacturer's directions	Must be applied to exposed pond bottom
FLOATING-LEAVED AQUATIC PLANTS			
American pondweed (*Potamogeton nodosus* Poir.)	Use one of the following:		
	endothall (10% G)	1 ppm	Spread on water
	endothall (potassium salt, 4.23 lb./gal.)	1/2 cup/gal.	Apply to leaves
Waterlilies (*Nymphaea* spp.)	dichlobenil (aquatic granules 10%)	50 lb./A.	Spread on water
	2,4-D (20% G)	200 lb./A.	
FREE-FLOATING AQUATIC PLANTS			
Common duckweed (*Lemna minor* L.)	Use one of the following:		
	endothall (potassium salt, 4.23 lb./gal.)	1 cup/4 gal.	Apply to leaves
	diquat cation (2 lb./gal.)	1 cup/4 gal.	Apply to leaves
	simazine (80-WP)	0.5 ppm	Apply to total water volume
Watermeal (*Wolffia columbiana* Karst.)	simazine (80-WP)	1 ppm	Apply to total water volume
ALGAE			
Chara (has cylindrical, whorled branches and resembles, in form, some of the plants mentioned above) (*Chara* spp.)	Use one of the following:		
	dichlobenil (aquatic granules 10%)	40 lb./A	Preemergent application only
	copper sulfate*	1 ppm	Postemergent application

*Crystalline copper sulfate can be used; however, there are several copper-containing formulations that contain copper-chelating compounds, which prevent the immediate precipitation of copper as copper carbonate. Check the label for instructions concerning their uses and rates of application. A lower rate of application for copper can be used with these latter formulations. Their copper contents may vary.

Group and species	Chemical, active ingredient, or free acid equivalent	Rate of application	Remarks
Chara (continued)	Aquatic Herbicide System M**	15-25 lb./A.	Apply on water surface
Filamentous algae	copper sulfate*	1 ppm	Postemergent
	Aquatic Herbicide System M**	15 lb./A	Spread on water
	simazine (80-WP)	0.5 ppm	Apply to total water volume

*Crystalline copper sulfate can be used; however, there are several copper-containing formulations that contain copper-chelating compounds, which prevent the immediate precipation of copper as copper carbonate. Check the label for instructions concerning their uses and rates of application. A lower rate of application for copper can be used with these latter formulations. Their copper contents may vary.

**A copper-containing formulation developed by the 3M Company and distributed under the trade name of Mariner.

ADDITIONAL INFORMATION

Aquatic Plants and their Control. Fishery Bulletin No. 4, Illinois Department of Conservation, Springfield, IL 61706.

Herbicides, Formulations, and Toxicities

Generic name[a] (producer)	Trade name[b]	Concentration and commercial formulation[c]	Dermal irritation[d]	Acute LD_{50} Oral[e]	Acute LD_{50} Dermal[f]	Signal word
acifluorfen			Moderate	3,330	>2,000	DANGER
(Rohm & Haas)	Blazer	2 S				
(Rhone-Poulenc)	Tackle	2 S				
alachlor			Moderate	1,800	8,000	DANGER
(Monsanto)	Lasso	4 EC, 15 G				
alachlor + glyphosate			Moderate			DANGER
(Monsanto)	Bronco	4 WDL				
alachlor + atrazine	Lasso/ atrazine	4 WDL	Moderate			Warning
ametryn			Moderate	1,750	>10,200	Warning
(CIBA-Geigy)	Evik	80 WP				
amitrole			Mild	24,600	>10,000	Caution
(American Cyanamid)	Amizol	90 WSP				
(Union Carbide)	Weedazol	50 WSP				
amitrole-T			Mild	5,000		Caution
(American Cyanamid)	Cytrol	2 S				
(Union Carbide)	Amitrol-T	2 S				
AMS			Mild	3,900		Caution
(DuPont)	Ammate-X	95 WSP				
asulam			Mild	>8,000	>1,000	Caution
(Rhone-Poulenc)	Asulox	3.34 S				
atrazine			Mild	5,100	9,300	Caution
(CIBA-Geigy)	AAtrex	80 WP, 4 WDL, 90 WDG				
(Shell)	atrazine	80 WP, 4 WDL				
atrazine + propachlor			Moderate			Warning
(Monsanto)	Ramrod/ atrazine	3 + 1 WDL				
benefin			Moderate	5,000		DANGER
(Elanco)	Balan	1.5 EC, 2.5 G				
bensulide			Mild	770	>10,000	Caution
(Stauffer)	Betasan	3.6, 7, & 12.5 G				
	Prefar	4 EC				

[a] Weed Science Society of America approved name, or experimental number.

[b] "Several" indicates many trade names.

[c] EC means emulsifiable concentrate; G, granules; L, liquid; S, water solution; WDG, water-dispersible granule; WDL, water-dispersible liquid; WP, wettable powder; WSP, water-soluble powder; DF, dry flowable; P, pellet; F, flowable. ME means micro-encapsulated. Liquid formulations (EC, L, S, WDL, F) are in pounds per gallon; dry formulations (G, WDG, WP, WSP, DF, P) are in percentages.

[d] Dermal irritation is determined by applying an amount of pesticide onto the skin of shaved test animals. A blank indicates that the information is not available at this time.

[e] LD_{50} means the milligrams of chemical per kilogram of body weight that are lethal to 50 percent of the test animals, usually white rats, when administered in a single, oral dose,

[f] LD_{50} means the milligrams of chemical per kilogram of body weight that are lethal to 50 percent of the test animals, usually rabbits, when administered in a single, dermal dose. A blank indicates that the information is not available at this time.

Generic name[a] (producer)	Trade name[b]	Concentration and commercial formulation[c]	Dermal irritation[d]	Acute LD_{50} Oral[e]	Acute LD_{50} Dermal[f]	Signal word
bentazon (BASF)	Basagran	4 S	Moderate	1,100	>2,450	Caution
bifenox (Rhone-Poulenc)	Modown	4 WDL	Mild	20,800	9,200	DANGER
boron compounds	several	various	Moderate	2,000		Caution
bromacil (DuPont)	Hyvar-X	2 EC, 80 WP, 10 G	Moderate	5,200	>5,000	*DANGER or Warning
bromoxynil (Rhone-Poulenc) (Union Carbide)	Buctril Brominal	2 EC 2 & 4 EC	Moderate	260 to 440	>3,660	Warning
butylate (Stauffer) (PPG Industries)	Sutan+ Genate Plus	6.7 EC, 10 G 6.7 EC	Moderate	3,878	>4,640	Caution
butylate + atrazine (Stauffer)	Sutazine +	4.8 + 1.2 ME 18 + 6 G	Moderate Mild	>5,000	>5,000	DANGER-CORROSIVE Caution
cacodylic acid (several)	several	3.25 & 5.7 L, 65 WSP	Mild	830		Caution
chloramben (Union Carbide)	Amiben	2 S, 10 G, 75 WSP	Mild	5,620	>3,160	Caution
chlorpropham (PPG Industries)	Chloro IPC, Furloe	4 EC, 20 G	Mild	3,700	10,200	Caution
cinmethylin (Shell)	Cinch	7 EC	Moderate	1,600	2,000	Warning
copper sulfate	several	various	Mild	470	>8,000	DANGER
cyanazine (Shell)	Bladex	80 WP, 15 G, 4 WDL	Mild	334	>2,000	Warning
cycloate (Stauffer)	Marathon	6 EC	Moderate	3,160	>4,640	Caution

(See footnotes on first page of table.)
*Varies with the formulation.

Generic name[a] (producer)	Trade name[b]	Concentration and commercial formulation[c]	Dermal irritation[d]	Acute LD_{50} Oral[e]	Dermal[f]	Signal word
dalapon (Vertac)	Dalapon-M	74 WSP	Moderate	7,570		Caution
DCPA (Diamond Shamrock)	Dacthal	75 WP, 5 G, 2.5 G	Mild	>3,000	>10,000	Caution
dicamba (Velsicol)	Banvel	2 & 4 S, 5 G	Moderate	1,028	>2,000	Caution
dichlobenil (Uniroyal)	Casoron	50 WP, 4 & 10 G	Mild	3,160	1,350	Caution
dichlorprop (Union Carbide)	Weedone 2,4-DP	4 EC	Mild	800	1,400	Caution
diclofop-methyl (Hoechst)	Hoelon	3 EC	Moderate	2,176	640	DANGER
dimethazone (FMC)	Command	6 EC	Mild	2,235	>2,000	DANGER-CORROSIVE
dinoseb (DNBP) (Vertac)	several	3 S, 5 EC	Moderate	58	>75	DANGER-POISON
diphenamid (Upjohn)	Enide	90 WP, 50 WP	Mild	970	>6,320	Caution
diquat (Chevron)	Ortho Diquat	2 S	Severe	230	>400	Warning
diuron (DuPont)	Karmex	4 WDL, 80 WP	Mild	3,400		Caution
DPX-F6025 (DuPont)	Classic	75 DF	Mild	>5,000	>2,000	
DPX-Y6202 (DuPont)	Assure	0.8 EC	Mild	>5,000	>2,000	DANGER-CORROSIVE
DSMA (Diamond Shamrock)	several	3 S, various WSP	Moderate	3,630	10,000	Caution
endothall (Pennwalt)	Endothal, Aquathol, Hydrothal	various EC & G	Moderate	182 to 206		DANGER-POISON
EPTC (Stauffer)	Eptam	2.3, 5, & 10 G, 7 EC	Mild	1,652	10,000	Caution
	Eradicane Extra	6 EC				
(PPG Industries)	Genep	7 EC				
ethalfluralin (Elanco)	Sonalan	3 EC	Moderate	>10,000	>2,000	Warning
fenoxaprop (Hoechst)	Whip	1 EC		>3,300	>2,000	Warning

(See footnotes on first page of table.)
*Varies with the formulation.

Generic name[a] (producer)	Trade name[b]	Concentration and commercial formulation[c]	Dermal irritation[d]	Acute LD_{50} Oral[e]	Acute LD_{50} Dermal[f]	Signal word
fenuron TCA (Hopkins)	Dozer	3 L, 25 P	Moderate	4,000		Caution
fluazifop-butyl (ICI Americas)	Fusilade	4 EC	Mild	4,350	>2,000	Warning
fluchloralin (BASF)	Basalin	4 EC	Moderate	1,500		Warning
fosamine (DuPont)	Krenite	4 L	Mild	24,400	>1,683	Warning
glyphosate (Monsanto) (Ortho)	Roundup Kleanup	3 S 0.5 S	Moderate	5,400	>5,000	Warning
haloxyfop (Dow)	Verdict	2 EC	Moderate	2,179	3,536	Warning
hexazinone (DuPont)	Velpar	90 WSP, 2 WDL	Mild	1,690	>5,278	*DANGER or Warning
imazaquin (American Cyanamid)	Scepter	1.5 EC	Mild	>5,000	>2,000	Caution
imidazolinone (American Cyanamid)	AC 263,499	2 EC	Mild	>5,000	>2,000	
linuron (DuPont)	Lorox	4 WDL, 50 WP	Moderate	1,500		Caution
MCPA (Rhone-Poulenc) (Union Carbide)	several several	2 & 4 EC 2 & 4 EC	Mild	800	>1,000	Caution
MCPB (Rhone-Poulenc (Union Carbide)	Can-Trol Thistrol	2 S 2 S	Mild	680		Caution
mecoprop (Rhone-Poulenc)	MCPP, Chipco Turf	2 & 4 EC	Mild	1,060	900	Caution
mefluidide (3M)	Vistar	2 S	Mild	>4,000	>4,000	Caution
metolachlor (CIBA-Geigy)	Dual, Ontrack	8 EC, 25 G	Mild	2,534	>3,000	Warning
metolachlor + atrazine (CIBA-Geigy)	Bicep	2 + 2.5 WDL	Moderate	4,680	>3,000	Caution

(See footnotes on first page of table.)
*Varies with the formulation.

Generic name[a] (producer)	Trade name[b]	Concentration and commercial formulation[c]	Dermal irritation[d]	Acute LD_{50} Oral[e]	Dermal[f]	Signal word
metribuzin			Mild	1,090	>20,000	Caution
(Mobay)	Sencor	50 WP, 4 WDL,				
(DuPont)	Lexone	75 DF				
monuron TCA			Severe	2,300	1,000	Caution
(Hopkins)	Urox	3 EC, 5.5 G				
napropamide			Mild	5,000	>4,640	*DANGER
(Stauffer)	Devrinol	2 EC, 50 WP, 10 G				or Caution
naptalam (NPA)			Mild	1,770		Warning
(Uniroyal)	Alanap	2 EC, 10 G				
naptalam + dinoseb			Mild	232		DANGER
(Uniroyal)	Dyanap	2 + 1 EC				
oryzalin			Mild	10,000	>2,000	Caution
(Elanco)	Surflan	75 WP, 4 WDL				
oxadiazon			Severe	>8,000	8,000	Warning
(Rhone-Poulenc)	Ronstar	2.5 G				
oxyfluorfen			Mild	5,800	>3,000	Warning
(Rohm & Haas)	Goal	2 EC				
paraquat			Moderate	120	>480	DANGER-
(Chevron)	Ortho Paraquat	2 S				POISON
(ICI Americas)	Gramoxone	2 S				
pebulate			Severe	1,390	>4,640	Caution
(Stauffer)	Tillam	6 EC, 10 G				
pendimethalin			Mild	3,380	>5,000	Warning
(American Cyanamid)	Prowl	4 EC				
phenmedipham			Mild	>8,000	>4,000	Caution
(Nor-Am)	Betanal	1.3 EC				
picloram			Mild	8,200	>4,000	*Warning
(Dow)	Tordon	2 EC, 10 G				or Caution
poppenate			Mild	2,748	>2,000	
(Stauffer)	Trophy	4 E, 2 ME				
prometon				2,276	>2,000	*Warning
(CIBA-Geigy)	Pramitol	80 WP	Moderate			or DANGER
		2 EC	Severe			
pronamide			Mild	5,620	>3,160	Caution
(Rohm & Haas)	Kerb	50 WP				
propachlor			Severe	4,700	>3,160	Warning
(Monsanto)	Ramrod	4 F, 20 G				

(See footnotes on first page of table.)
*Varies with the formulation.

Generic name[a] (producer)	Trade name[b]	Concentration and commercial formulation[c]	Dermal irritation[d]	Acute LD_{50} Oral[e]	Dermal[f]	Signal word
propazine (CIBA-Geigy)	Milogard	4 WDL, 80 WP	Mild	5,000	>10,200	Caution
pyrazon (BASF)	Pyramin	80 WP	Mild	3,600		Caution
sethoxydim (BASF)	Poast	1.53 EC	Moderate	2,676		DANGER
siduron (DuPont)	Tupersan	50 WP	Moderate	7,500	>5,500	Caution
simazine (CIBA-Geigy)	Caliber 90	90 WDG	Mild	5,000	10,200	Warning
	Princep	4 WDL, 80 WP, 4 & 10 G				
	Aquazine	80 WP				
sodium chlorate	several	4 L, 99 WSP	Moderate	4,330		DANGER
tebuthiuron (Elanco)	Spike	80 W, 1 & 5 G	Mild	644	>200	Caution
terbacil (DuPont)	Sinbar	80 WP	Mild	>5,000	>5,000	Caution
terbutryn (CIBA-Geigy)	Igran	80 WP	Mild	2,500	>10,200	Warning
triclopyr (Dow)	Garlon	3 & 4 EC	Mild	2,140	>2,000	*Warning or DANGER
tridiphane (Dow)	Tandem	4 EC	Moderate	2,882	5,000	DANGER-CORROSIVE
trifluralin (Elanco)	Treflan	4 EC, 5 G	Mild	3,700	>5,000	Warning
vernolate (Stauffer)	Vernam	7 EC, 10 G	Severe	1,800	10,000	Caution
2,4-D (Dow)	several	various L, G	Moderate	300 to 1,000		*Caution or Warning
2,4-DB (Union Carbide)	Butryac	2 EC	Mild	1,960	>10,000	Caution
(Rhone-Poulenc)	Butoxone	1.75 EC				

(See footnotes on first page of table.)
*Varies with the formulation.

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1986 Condensed Plant Disease Management Guide for FIELD CROPS

You must be certified as a pesticide applicator to use restricted-use pesticides. See your county Extension adviser in agriculture for information.

The best way to ensure the success of a disease management program is to adapt it to the diseases expected and to use integrated disease control measures. Among these measures are the use of resistant varieties, crop rotations, fungicides, nematicides, and suggested agronomic practices. The success of any one or all of these measures may depend on how carefully you scout your crops. Because periodic crop scouting increases the likelihood that disease controls will be applied properly, it can help prevent both loss through disease and unnecessary use of pesticides.

Specific information for the control of the important diseases of corn, soybeans, wheat, and alfalfa can be found in the following issues of *Report on Plant Diseases:*

No. 123: "Winter Wheat Disease Management Program"
No. 212: "Illinois Corn Disease Management Program"
No. 308: "Alfalfa Disease Management Program"
No. 507: "Illinois Soybean Disease Management Program"
No. 1001: "Seed Treatments for Field Crops"

These and other issues of *Report on Plant Diseases* are available from the Department of Plant Pathology, University of Illinois, N533 Turner Hall, 1102 S. Goodwin, Urbana, IL 61801 at a cost of twenty-five cents each.

DISEASES

FEDERAL AND STATE LAWS RESTRICTING PESTICIDE APPLICATION

The U.S. Environmental Protection Agency (EPA) is classifying pesticides for "general" or "restricted" use. Anyone applying a restricted-use pesticide, whether "commercial" or "private," must be certified.

Commercial applicators include not only persons applying restricted-use pesticides for hire but also government personnel, chemical company representatives, and others involved in demonstrational, regulatory, and public health pest control. Certification as a commercial applicator requires passing a written examination administered either by the Illinois Department of Agriculture or the Illinois Department of Public Health.

Private applicators who use restricted-use pesticides "for the purpose of producing any agricultural commodity on property owned or rented by [the applicator] or as exchange labor (no compensation) on the property of another must also be certified, either by attending an educational training program or by passing an examination."

Educational training programs for farmers (private applicators) and commercial pesticide applicators are conducted by the Illinois Cooperative Extension Service to prepare persons for certification. The actual certification and the issuing of permits or licenses are handled by the Illinois State Department of Agriculture.

ALWAYS READ THE LABEL BEFORE USING A PESTICIDE

The chemical names used in this circular may be unfamiliar to you. They are the common, coined chemical names and are not capitalized (for example, benomyl). Trade names are capitalized (for example, Benlate). Common chemical names are used in Table 1, and Table 2 lists both the common names and trade names of fungicides and nematicides.

FUNGICIDE APPLICATION

At present, aircraft are the best vehicles for applying fungicides to agronomic crops. Some aircraft may not be equipped or calibrated to do this job. It is therefore important to select an aerial applicator who is familiar with disease control and whose aircraft has been properly calibrated for uniform, thorough coverage of all above-ground plant parts. With the equipment now available, a reasonable job of applying fungicides requires a minimum of 5 gallons of water carrier per acre. Superior coverage may be obtained with more water, but the cost may be prohibitive. Conversely, a lower volume (under 3 to 4 gallons per acre) gives correspondingly poorer control. Five gallons of water can be applied uniformly using approximately 30 to 70 properly spaced nozzles depending on the aircraft. The nozzles should be D-8 to D-12, hollow cone, with No. 45 or No. 46 cores. The final decision on nozzle number, size, swath width, and placement depends on the air speed, pressure, and volume desired. Droplet size is also important. Ideally, droplets should be 200 to 400 microns in size for thorough and uniform coverage.

ADJUVANTS

When it is compatible with the product label, add a spray adjuvant (surfactant) to the spray mix. Some commonly available surfactants are: Colloidal Products X-77 (liquid, nonionic) Spreader; Colloidal Products Multi-Film L (liquid); Colloidal Products Spray Modifier (liquid, nonionic) spreader sticker; Miller Nu-film-17 liquid spreader sticker; Miller Nu-film-P liquid spreader sticker; Allied Chemical Plyac (liquid) Non Ionic Spreader-Sticker; Rohm & Haas Triton B-1956 (liquid, nonionic) spreader sticker; Triton C-57 spreader binder; and DuPont Spreader Sticker (liquid) spreader sticker.

Adjuvants are suggested for use when you spray corn or small grains. These materials help disperse fungicides and improve coverage.

NEMATICIDE APPLICATION

Granular nematicides/insecticides registered for use on corn and soybeans may be used as in-furrow or band treatments, depending on the product label. In general, band applications have given more consistent control than have in-furrow applications. Follow the manufacturer's suggestions on incorporation.

A more complete list of trade names than that in Table 2 can be found in *Report on Plant Diseases* No. 1001, "Seed Treatments for Field Crops," and No. 1002, "Fungicides, Disinfectants, Grain Preservatives, Surfactants, and Soil-Disinfesting Chemicals." These publications are available from the Department of Plant Pathology, University of Illinois, N-533 Turner Hall, 1102 S. Goodwin, Urbana, IL 61801.

Table 1. Condensed Disease Control Recommendations for Field Crops

Crop	Diseases	Fungicide or nematicide	Comments
Alfalfa	Bacterial wilt, Phytophthora root rot		Resistance should be strongly considered when choosing a variety.
	Leafspots, spring blackstem, and anthracnose		Cut forage in a timely manner to maximize yields and minimize leaf loss. Grow adapted resistant varieties.
	Crown and root rots		Maintain proper fertility and soil pH. Avoid cutting or grazing during the last 5 to 6 weeks of the growing season. Control insect pests.
	Verticillium wilt		Seed treatment with thiram is suggested to prevent seed transmission. Varieties with reported resistance include Apollo II, Trumpeter, WL316, Decathelon, and Funk's G 2640. This disease will only be a problem in stands that are more than 3 years old.
	Seed rots and seedling blights	captan, captan + zineb, or thiram plus metalaxyl	Seed treatment is not usually necessary with high-quality seed.
	Sclerotinia white mold		Spring planting, deep and clean plowing, using 3- to 4-year rotations with nonlegume crops, and avoiding excessively lush growth may help. Chemical controls are not available. The variety Cimarron is reported to be moderately resistant.
Barley	Seed rot, seedling blight, loose smut, and semiloose smut	carboxin + thiram, carboxin (planter-box) plus maneb + HCB or captan + HCB (planter-box), captan + carboxin	Seed treatment is strongly suggested. Carboxin is required for loose smut control.
	Helminthosporium leaf blight, Septoria leaf blotch	mancozeb	Apply when disease conditions warrant. Apply when plants are in the late tillering to jointing stage; repeat at 7- to 10-day intervals. Do not make more than 3 applications. Do not apply within 26 days of harvest.
	Barley yellow dwarf virus		Plant winter barley after the fly-free date and spring barley as early as possible.
Clover	Anthracnose diseases		Grow adapted resistant varieties.
	Crown and root rots		Same as for alfalfa.
	Seed rots and seedling blights		Same as for alfalfa.
Corn	Seed rots and seedling blights	captan, captan + maneb, captan + zineb, captan + HCB + maneb, carboxin, carboxin + thiram, mancozeb, maneb, PCNB + etridiazol, TCMTB, thiram, thiram + maneb	Sow injury-free, plump seed in soils at 50°F or above. Prepare the seedbed properly and place herbicide, fertilizer, insecticide, and seed correctly. Note: fungicide plus insecticide seed treatments are commonly used.

Table 1. (continued)

Crop	Diseases	Fungicide or nematicide	Comments
Corn (cont.)	Helminthosporium leaf blights northern leaf blight northern leaf spot southern leaf blight Helminthosporium leaf blight	zineb, mancozeb	Plant resistant hybrids. Apply 2 to 4 sprays at 10-day intervals starting when disease appears. Fungicide control is justified only when significant disease occurs less than 2 weeks after tasseling. Use a spreader sticker. Fungicide applications are generally economically feasible only in seed production fields. Do not apply within 40 days of harvest. Do not feed fodder or forage to livestock.
	Common rust and southern rust		Same as for Helminthosporium leaf blights.
	Stewart's disease		Plant resistant hybrids and use insecticides to control flea beetles when necessary.
	Goss's bacterial wilt and leaf blight		Plant resistant hybrids. Clean plowdown and 2-year crop rotations also give control. Use clean plowdown only where erosion will not be a problem.
	Anthracnose, Physoderma brown spot, eyespot, gray leaf spot, yellow leaf blight		Plant resistant or tolerant hybrids. Practice crop rotation or clean tillage where soil erosion considerations allow.
	Crazy top and sorghum downy mildew		Plant resistant or tolerant hybrids. Improve drainage in affected area. Control wild cane to reduce sorghum downy mildew inoculum.
	Virus diseases		Plant resistant hybrids. Control johnsongrass to reduce overwintering source of MDMV and MCDV.
	Stalk rots *Diplodia* charcoal *Gibberella* *Nigrospora* *Fusarium* anthracnose		Plant hybrids with good stalk rot resistance and stalk strength. The use of nitripyrin (N-Serve) may be helpful where nitrogen loss is expected. Maintain adequate phosphorus and potassium fertility for the rate of nitrogen used. Control corn borers and corn rootworms. Scout fields at 30- to 40-percent moisture for lodging potential. Walk a zig-zag pattern through the field pushing random plants about 5 inches from the vertical. If more than 10 to 15 percent lodge, schedule the field for early harvest.
	Storage molds *Penicillium* spp. *Aspergillus* spp.	propionic acid, isobutyric acid, acetic acid, or mixtures of these	Grain treated with an acid grain preservative can be used only for animal feed. Store undamaged corn at 15 to 15.5 percent moisture from fall until spring, then dry to 13 percent for long-term storage. Grain damaged by field molds, insects, etc., should be dried to 13 to 13.5 percent moisture at harvest. Watch stored grain for heating, a musty odor, crusting, or other signs of storage mold activity. Control stored grain insects. Make sure combine is adjusted to avoid damage to grain. Remove fines and foreign material before storage.
	Nematodes root-lesion needle dagger spiral lance stubby-root sting stunt	carbofuran, ethoprop, terbufos	Use nematicidal rates of these materials only where soil tests indicate economic populations of nematodes. Use crop rotation where appropriate.
Oats	Seed rots and seedling blights, loose smut and covered smut	captan + HCB, captan + HCB + maneb, carboxin, carboxin + thiram, HCB + maneb, PCNB, TCMTB, captan + carboxin, carboxin + maneb	Seed treatment is strongly suggested for control of smut diseases.
	Barley yellow dwarf		Grow resistant varieties. Plant susceptible varieties as early in the spring as possible.
	Crown rust		Plant resistant varieties. Fungicides applied for *Septoria* and *Helminthosporium* will also aid in crown rust control.
	Helminthosporium leaf spot, Septoria leaf blotch	mancozeb	Spray when disease is present and weather conditions favor disease development. Start applications at tillering to jointing stage. Make a second application 10 days later. A third application is permissible but may be uneconomical. Do not apply within 26 days of harvest.

Table 1. (continued)

Crop	Diseases	Fungicide or nematicide	Comments
Sorghum	Seed rots, seedling blights, and smuts	captan, captan + thiram, captan + zineb, captan + PCNB, HCB + maneb, PCNB + etridiazol, thiram	Fungicide seed treatment is strongly suggested.
	Other diseases		Plant resistant or tolerant hybrids. Diseases other than the smuts have not been important in Illinois.
	Nematodes	aldicarb	
Soybeans	Seed rots and seedling blights (primarily Pythium, Phytophthora, Rhizoctonia)	captan, captan + maneb, captan + thiram, captan + zineb, captan + HCB + maneb, captan + PCNB, HCB + maneb, mancozeb, maneb, PCNB + etridiazol, TCMTB, thiram, Vitavax + thiram, carboxin + captan, Vitavax + metalaxyl, captan + metalaxyl, metalaxyl, thiram + thiabendazole	Plant high-quality seed germinating greater than 70 percent in a cold germination test. Seed treatment is recommended where (1) seed of poor quality due to fungal infection must be planted; (2) delays in emergence are anticipated; (3) seed is planted to produce seed; and (4) reduced seeding rates are used.
	Brown stem rot		Rotate, using 2 years of corn in fields where disease has been damaging. The varieties BSR 301 and BSR 201 have moderate resistance.
	Sclerotinia white mold		Rotate with nonlegume crops. Plant moderately resistant varieties in fields where disease has been present before.
	Phytophthora root rot	metalaxyl	Plant varieties with race-specific or field resistance. Race-specific resistance will provide immunity to specific races. However, in many areas races of the Phytophthora fungus are present that can attack this type of resistance. Varieties with field tolerance are resistant after two sets of trifoliate leaves develop. However, they are very susceptible to the seedling blight phase of the disease. Therefore, varieties with field-tolerance resistance should be protected in the seedling stage with metalaxyl fungicide applied as a seed treatment.
	Soybean cyst nematode	aldicarb, carbofuran, fenamiphos	Rotate to nonhost crops for 3 years and monitor SCN populations by taking soil samples the second and/or third year. One year can be a resistant bean such as Fayette (III), Franklin (IV), CN 210 (II), or CN 290 (II). Nematicides are suggested only where (1) crop rotations are not possible and (2) resistant varieties cannot be used. Aldicarb has given the most consistent control in Illinois; applied in-furrow, it has given control equal to higher rates applied as bands. Both aldicarb and carbofuran can be applied in-furrow. See *Report on Plant Diseases* No. 501 for more information.
	Pod and stem blight, anthracnose, stem canker, Septoria brown spot, Cercospora leaf blight, and purple seed stain	benomyl, thiabendazole, thiophanate-methyl, chlorothalonil	Suggested for use where disease conditions warrant (see Table 2). Two applications are suggested for maximum yield and seed quality. Benomyl, thiophanate-methyl, and thiabendazole have 24c labels for a single late application at higher labeled rates for improved seed quality. Use pod tests to determine the need for late applications.
Wheat	Seed rots, seedling blights, loose smut, and bunt (stinking smut)	carboxin + thiram, carboxin (planter-box) plus maneb + HCB, captan + carboxin, or maneb + thiabendazole	Seed treatment is strongly suggested. Higher labeled rates of carboxin are required for bunt control. Only carboxin controls loose smut.
	Leaf rust, Septoria leaf blotch, Septoria glume blotch, Helminthosporium leaf blight, stem rust, and Pyrenophora tan spot	mancozeb, zineb, triadimefon	Apply fungicide when disease conditions warrant. Begin applications at the jointing stage and repeat at 7-day intervals. Do not make more than 3 applications. Do not apply within 26 days of harvest. Triadimefon is limited to two applications per season. Triadimefon will give excellent control of rust, moderate control of Septoria leaf blotch, and poor control of Septoria glume blotch and tan spot. Do not apply within 21 days of harvest or within 35 days of seeding corn, sorghum, or soybeans. Plant resistant varieties.
	Powdery mildew	triadimefon	Plant resistant varieties. Check with your Extension adviser for chemical control recommendations.

Table 1. (continued)

Crop	Diseases	Fungicide or nematicide	Comments
Wheat (cont.)	Virus diseases wheat streak mosaic wheat soilborne mosaic barley yellow dwarf mosaic wheat spindle streak mosaic		Plant resistant or tolerant varieties. Plant after the fly-free date. Control volunteer wheat in and around production fields.
	Take-all		Plant after the fly-free date. Use ammonium form of nitrogen fertilizer. Use crop rotations of 2 to 3 years between wheat crops where possible.

Table 2. Classification, Common Names, and Trade Names of Pesticides Mentioned in This Report

Common name	Trade name	Use classification
aldicarb	Temik	Unclassified
benomyl	Benlate	Unclassified
captan	Captan, Orthocide, and many others	Unclassified
captan + HCB	Orthocide-HCB, Miller's HCB 4 Flowable, and many others	Unclassified
captan + HCB + maneb	Res Q	Unclassified
captan + PCNB	Stauffer Captan-Terraclor 10-10 and 30-30 Seed Protectant, Orthocide PCNB 10-20 Dust, and many others	Unclassified
captan + zineb	Staples Dithane Seed Treatment Dust	Unclassified
captan + carboxin	Orthocide-Vitavax 20-20, Vitavax-Captan 20-20	Unclassified
carbofuran	Furadan	Restricted-use
carboxin	Vitavax 34	Unclassified
carboxin + captan	Enhance	Unclassified
carboxin + maneb	Enhance Plus	Unclassified
carboxin + thiram	Vitavax 200, Vitavax-T	Unclassified
chlorothalonil	Bravo 500	Unclassified
ethoprop	Mocap	Restricted-use
etridiazol	Terrazole	Unclassified
fenamiphos	Nemacor	Restricted EC formulations: restricted-use.
maneb	Manzate D, Manzate Maneb Fungicide, Dithane M22, M22 Special, and many others	Unclassified
maneb + HCB	Granox NM, Granox Flowable	Unclassified
maneb + thiabendazole	Granox Plus	Unclassified
mancozeb	Manzate 200, Dithane M45	Unclassified
metalaxyl	Apron 2E	Unclassified
PCNB	Terraclor	Unclassified
PCNB + etridiazol	Terraclor Super X, Terra-Coat L21, L205, and SD205 Seed Treatment	Unclassified
TCMTB	Busan, Cover-Up, and Thiogem	Unclassified
terbufos	Counter	Restricted-use
thiabendazole	Mertect 340F	Unclassified
thiophanate-methyl	Topsin M	Unclassified
thiram	Arasan 50-Red, Thiram, Moly-Co-Thi, Stand-up, Thiram 42S, and many others	Unclassified
thiram + thiabendizole	Agrosol	Unclassified
triadimefon	Bayleton	Unclassified
zineb	Dithane Z-78	Unclassified

FUNGICIDE GUIDELINES

Seed Treatments

Fungicide seed treatments will generally increase stands regardless of quality. However, the greatest benefits will be found (1) where low seeding rates are used; (2) where seed must be used that is of poor quality because of fungal infection; and (3) where seed is planted in a seedbed in which delays in germination or emergence are likely.

Fungicide seed treatments are not a substitute for high-quality seed and will not improve the performance of seed that is of low quality due to mechanical damage or physiological factors. Treated seed of low quality will not produce stands and/or yields equal to untreated high-quality seed. Therefore, only high-quality seed should be considered for planting.

The following checklist for soybean seed treatments (Table 3) is designed to assist in determining the need for seed treatments, especially for control of damping-off fungi. Selection of the proper seed treatment is very important because of the specificity of certain fungicides for controlling only Phytophthora and Pythium.

Table 3. Soybean Seed Treatment Checklist for Reducing Early Season Stand Losses Due to Damping-Off

Risk factors	Point value if answer is yes
Rainfall for the 7-day period before planting was:	
Below normal	2
Normal	1
Above normal	4
Seedbed preparation was:	
Conventional tillage	1
Rough surface (conservation tillage)	2
No-till	4
Germination at time of planting is less than 85 percent in a warm test or less than 70 percent in a cold test (such seed should be discarded if at all possible)	3
Previous soybean stand in field was reduced by damping-off or Phytophthora root rot	4
Level of resistance to Phytophthora root rot is:	
Susceptible	2
Tolerant	4
Resistant to one or more races	1
Expected rainfall for 96 hours following planting is:	
Lower than normal	1
Normal	1
Above normal	3
Low areas of field remain flooded for 48 hours following 1 inch of rainfall	4
Seeding rate is less than 55 pounds per acre	3
Field is planted to double crop soybeans	3
TOTAL POINTS AND SUGGESTIONS	
Less than 7 points: seed treatment will probably not be beneficial.	
Seven to 15 points: seed treatment may be beneficial if weather conditions do not favor rapid germination and growth.	
Greater than 15 points: seed treatment will be beneficial to stand development.	

Foliar Treatments

Foliar fungicide treatments may reduce losses from Septoria brown spot, Cercospora leaf blight (purple seed stain), anthracnose, pod and stem blight, and stem canker. These diseases are most damaging when the weather is warm (70° to 80°F) and wet from early pod fill to maturity. Foliar sprays of fungicides may increase yields 10 to 15 percent, increase seed quality, and reduce disease losses when such fields are planted to soybeans the following year. The use of fungicides should be based on expected disease severity. The six diseases just listed will *not* be as severe in cool, dry seasons and where adequate rotations have been used.

Based on seven years of research data, yields have been increased by an average of 4.7 bu/A (range 1.2-13.4) and seed quality has been increased by an average of 10.7 percent (range 0-42.5 percent) by the use of foliar fungicides.

The checklist in Table 4 can be used at early bloom to determine whether fungicide controls for the six diseases mentioned previously should be used. A key factor in this checklist is the presence of black specks (pycnidia) on fallen petioles. Only brown, fallen petioles should be assayed and more than two-thirds to three-

Table 4. Checklist to Determine Whether Foliar Fungicide Application Should Be Made to Soybeans

Risk factors	Point value if answer is yes
Rainfall, dew, and humidity up to early bloom and pod set are:	
Below normal	0
Normal	2
Above normal	4
Soybeans were grown in the field last year	2 to 3
Chisel-plow, disk, or no-till was used	1
Pycnidia (black specks) are visible on fallen petioles and Septoria brown spot is obvious on the lower leaves	2
Early-maturing variety (not full-season)	1 to 2
Soybeans are to be used or sold for seed	6
Yield potential is better than 35 bushels per acre	2
Seed quality at planting time is less than 85 percent germination in a warm test	1
Other conditions that favor disease development (weather forecast with a 30-day period of greater-than-normal rainfall and a field history of disease)	1 to 3

NOTE: If the total point value is 15 or more, application will probably mean increased yields and higher seed quality.

fourths of these petioles should show pycnidia. If growers use the checklist and apply fungicides correctly, maximum benefits should be achieved. Less than optimal benefits will be achieved if fungicides are applied incorrectly or if disease severity does not warrant spraying.

DISEASE REACTIONS OF FIELD CROP VARIETIES RECOMMENDED FOR ILLINOIS

Disease reactions may vary from one locality to another and from year to year, depending on what physiologic races of the pathogens are present. For the latest information on suggested crop varieties, consult your county Extension adviser or the Department of Agronomy, University of Illinois, W-201 Turner Hall, 1102 S. Goodwin, Urbana, IL 61801.

We wish to thank the following for their assistance in preparing the tabular material given below: D.C. Arny, Department of Plant Pathology, University of Wisconsin, Madison; K.L. Athow, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN; R.L. Bernard, USDA-SEA, University of Illinois, Urbana-Champaign; C.M. Brown, Department of Agronomy, University of Illinois, Urbana-Champaign; D.I. Edwards, USDA-SEA, University of Illinois, Urbana-Champaign; D.W. Graffis, Department of Agronomy, University of Illinois, Urbana-Champaign; C.R. Grau, Department of Plant Pathology, University of Wisconsin, Madison; Henryk Jedlinski, USDA-SEA, University of Illinois, Urbana-Champaign; L.J. Michel, USDA-SEA, Iowa State University, Ames; C.D. Nickel, Department of Agronomy, University of Illinois, Urbana-Champaign; E.W. Palm, University of Missouri, Columbia; F.L. Patterson, Department of Agronomy, Purdue University, West Lafayette, IN; G.E. Pepper, Department of Agronomy, University of Illinois, Urbana-Champaign; A.P. Roelfs, USDA-SEA, Cereal Rust Laboratory, University of Minnesota, St. Paul; W.O. Scott, Department of Agronomy, University of Illinois, Urbana-Champaign; G.E. Shaner, Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN; and R.G. Timian, USDA-SEA, North Dakota State University, Fargo.

Wheat

		Recommended area of state[a]	Stem rust	Leaf rust	Loose smut	Septoria	Powdery mildew	Soil-borne mosaic	Barley yellow dwarf	Spot blotch	Pyreno-phora	Wheat streak mosaic	False black chaff	Wheat spindle streak
Spring														
Era		N	R	S[b]	MR	MS	MS			MR	MS			
Olaf		N	MR	MR	S									
Winter	*Type*													
Abe	(Soft)	N,C,S	R	S[b]	MS	S	MS	R	MS				R	MS
Argee	(Soft)	N	R	S	MR		MS	R	MR					
Arthur 71	(Soft)	N,C,S	R	S[b]	MS	MS	MS	R	MS				R	MS
Auburn	(Soft)	N,C,S	R	R	MR	R	MR	R	MS					MS
Beau	(Soft)	N,C,S	R	MS	MS	MR	MS	R	MS				R	MS
Becker	(Soft)	N,C,S		MR		MS	S	MR						R
Caldwell[c]	(Soft)	N,C,S	R	MR	MR	MS	MR	MR	MR		S			MS
Centurk 78	(Hard)	N,C	MR	MS	MR	S	S	MS	MR		MR	S		
Fillmore	(Soft)	N,C,S	R	R	MR	MR	MR	MS	MS					MS
Hart	(Soft)	N,C,S	S	S[b]	R	MR	VS	R	MR					MR
Newton	(Hard)	N,C,S	MR	MR				MR	MS					
Pike	(Soft)	N,C,S	S	S	MR	MS	S	MR	MR					MS
Roland	(Soft)	C,S	R	S[b]	MS	S	MS	R	MS			MS		MR
Rosen	(Soft)	S	R	S		S	S		MS					
Scotty	(Soft)	C,S	R	MR		MR	R	R	MS					
Tyler	(Soft)	S	S	S			R	R	MR					

Note: Several private varieties have high yield potentials and are widely planted. Growers should contact seed company representatives for information on disease resistance.

Note: In this table, average disease reaction is indicated as follows: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; Blank = no information or disease is not important.

[a] Area of Illinois where variety is recommended: N = northern; C = central; S = southern.

[b] Susceptible to new races that are virulent on *Lr* 9 and very common throughout the central United States in 1981 and 1982. Era is susceptible to nearly all leaf rust races as a seedling but has adult plant resistance that normally prevents leaf rust development on the flag leaf.

[c] Moderate resistance to take-all.

Variety	Recommended area of state[a]	Brown leaf spot (blight)	Bacterial blights	Leaf scald	Rust	Seedling disease complex	Northern leaf blight	Anthracnose
Bromegrass, smooth								
Barton	N,C,S					MS		
Baylor	N,C,S	R	MS	MS				
FS Beacon	N,C,S					MS		
Blair	N,C,S	R	MS	MS		MS		
Lincoln	N,C,S	MS	MS	MS		MS		
Southland	S	S	MS	MS				
Orchardgrass								
Able	N,C,S							
Boone	S	MS			MS			
Comet	N,C							
Dart	N,C,S				MS			
Dayton	N	MS			MS			
Hallmark	N,C	MS			MS			
Ina	S							
Jackson	N,S							
Napier	N,C,S	MS			S			
Potomac	N,C	MS			S			
Sudangrass								
Piper	N,C,S						MR	MS
Tall fescue								
Alta	N,C,S				MR			
Fawn	N,C,S				MR			
Kenhy	N,C,S				MR			
Kentucky 31	N,C,S				MR			
Kenwell	N,C,S				MR			
Timothy								
Clair	N,C,S							
Climax	N,C,S							
Itasca	C							
FS 954	N,C							
FS 955	N,C,S							
Pronto	C							
Timfor	N,C,S							
Toro	N,C							
Verdant	C							
Reed canarygrass								
Flare	N,C							
Rise	N,C,S							
Vantage	N,C,S							

Note: In this table, average disease reaction is indicated as follows: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; VS = very susceptible; Blank = no information.

[a] Area of Illinois where variety is recommended: N = northern; C = central; S = southern.

Variety	Suggested area of the state[a]	Phytoph-thora rot[b]	Bacterial pustule	Powdery mildew	Pod and stem blight	Soybean cyst nema-tode	Purple seed stain	Frogeye leaf spot	Downy mildew	Sclerotinia white mold
Amsoy 71	N,C	R	S	VS	S	S	VS	S-2	S	S
Beeson 80	N	R-1-3,7-9	S	MS	S	S	S	R-1,2	S	
Bonus	S	R	S	S	S	S	S	S-2	VS	S
BSR 201[c]	N,C	R								
Calland	C,S	R	S	R	S	S	S	S-2	S	S
Century 84	N,C	R-1-9								
Century	N,C	R-1,2	S		S	S	S	S-2	MS	S
CN 210						R-3				
CN 290						R-3				
Corsoy 79	N,C	R-1-3,7-9	S	VS	S	S	S	S-2	MS	
Crawford	S	S	S		S	S	MR	S-2	S	
Cumberland	C,S	MS	R		MR	S	S	R-1,2	MS	
Cutler 71	S	R	S	R	S	S	S	R-1,2	S	
Dare	S	S	R		MS	S	S	R-1,2	MR	
DeSoto	C,S	S	S		S	S	S	S-2	S	S
Dyer	S		R		S	R-3				
Egyptian	S					R-3,4				
Elf	C,S	S	R	S		S	S	MR-2	S	VS
Elgin	N,C	S	R				S	S		
Essex	S	S	R	MR	S	S	MS	S-2	MS	
Fayette	C,S	S	R		S	R-3,4	S	S		
Forrest[d]	S	MR	R			R-3				
Franklin	S	R	R		S	R-3	S		S	S
Gnome	N,C	S	R		S	S				S
Hack	N,C	R-1,2,10-19,24								
Harcor	N	R-1,2	S		S	S		S-2		S
Hark	N	S	S	VS	S	S	S	S-2	S	
Harper	C,S	T	R				MR	MS-2		
Hobbit	C	S	R							
Hodgson 78	N	R-1,2			S	S	S	S-2		MR
Lawrence	S	S	R			S				
Nathan[e]	S					R-3,4				
Nebsoy	N,C	R-1,2	S		MR	S		S-2		S
Oakland	C,S	R-1,2	S	R	MR	S	S	S-2	MS	
Pella	C,S	R-1,2	S		S	S	S	S-2	S	S
Pixie	S	S			S	S	S			S
Sprite	S	S			S	S	S			S
Union	S	R	R	R	MS	S	S	S-2	R	MR
Wayne	C,S	MS	R	MR	S	S	S	R-1,MR-2	VS	MR
Wells II	N,C	R-1-3,6-9	S	VS	S	S	S	R-2	MS	
Will	C,S	S	R		MS	S	S	S	S	
Williams 82	C,S	R-1-9	R			S	S	S-2	S	

Note: Growers should contact individual seed companies for information on disease resistance of private varieties.

Note: In this table, average disease reaction is indicated as follows: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; T = field tolerance; VS = very susceptible; Blank = no information. Designations such as S-1,2 or R-1,2 indicate susceptible (S) or resistant (R) to the pathogens indicated by the race numbers.

[a] Area of Illinois where variety is suggested: N = northern; C = central; S = southern.

[b] Races 1 and 2, except where other races are indicated.

[c] BSR 201 is resistant to brown stem rot.

[d] Forrest is also highly resistant to wildfire, target spot, reniform nematode, and root-knot nematode.

[e] Nathan is also resistant to root-knot nematode.

Barley

Variety	Recommended area of state[a]	Stem rust	Leaf rust	Loose smut	Covered smut	Septoria	Powdery mildew	Barley yellow dwarf	Barley stripe mosaic	Spot blotch	Net blotch	Helminthosporium stripe	Scald
Spring													
Larker	N	MR	S	S	S	S	S	MS	S	S	MS		S
Manker	N	MR	S	S	S	S	S	MS	S	MR	MR		S
Winter													
Barsoy	C,S	MS	S	S			MR	S	S		MS	S	S
Paoli	C,S	MS	MS	MS			MR	S	S		MR	MR	MR
Pike	C,S	MS	S	S			MR	S	S		MR	MR	S

Note: In this table, average disease reaction is indicated as follows: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; VS = very susceptible; Blank = no information.

[a] Area of Illinois where variety is recommended: N = northern; C = central; S = southern.

Oats

Variety	Recommended area of state[a]	Stem rust	Crown rust	Smuts	Barley yellow dwarf	Septoria
Spring						
Clintford	N,C	S	VS	R	MS	MS
Dal	N	MS	MR	MR	MS	MS
Froker	N	MR	MS	S[b]	S	MR
Lang	N,C,S	MS	S	MS[b]	MR	MS
Larry	N,C,S	MS	S	MS	MR	MS
Noble	N,C,S	MS	S	R	MR	MS
Ogle	N,C	MS	S	MS	MR	MS
Otee	N,C,S	MS	S	MS	R	MS
Wright	N	MS	S	MS[b]	MS	MS
Winter						
Compact	S	S	S	MR	S	MS
Norline	S	S	S	MR	MS	MS
Walken	S	S	S	MR	S	MS

Note: In this table, average disease reaction is indicated as follows: R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; VS = very susceptible; Blank = no information.

[a] Area of Illinois where variety is recommended: N = northern; C = central; and S = southern.

[b] Susceptible to new races of smut fungi.

Red Clover

Variety	Recommended area of state[a]	Powdery mildew	Northern anthracnose	Southern anthracnose	Viruses
Arlington	N,C	R	R		MR
E-688	C,S	R	T	R	
Florex	N	R	R		R
Florie	N,C,S	R	R	R	R

Variety	Recommended area of state[a]	Powdery mildew	Northern anthracnose	Southern anthracnose	Viruses
Ruby	N,C,S	R	R	T	
Kenland	C,S	S	S	R	S
Kenstar	C,S	S	S	R	MR
Lakeland	N	R	R	S	MR
Mega	N,C,S	R	R	R	
Redland	C,S	R	MR	R	S
Redland II	C,S	R	R	R	
Redman	N,C,S	S	R	MR	S

Note: In this table, average disease reaction is indicated as follows: R = resistant; MR = moderately resistant; T = tolerant; S = susceptible; Blank = no information.

[a] Area of Illinois where variety is recommended: N = northern; C = central; S = southern.

Variety	Verticillium wilt	Bacterial wilt	Common leaf spot	Lepto leaf spot	Spring black stem	Anthracnose	Phytophthora root rot	Winter hardiness[a]
Acclaim[b]	MR	R	MR			MR	MR	H
Advantage		R				MR	R	MH
Answer		R				MR	VR	MH
Apollo II	MR	R				MR	R	H
Armor		R				MR	R	MH
Arrow[b]	R	R				R	R	H
Baker		R	MR			MS	S	H
Blazer		R				S	R	
Cimarron		MR	MR			R	R	MH
Conquest		R						
Dart[b]	R	R				R	R	MH
Defender		R				MR	MR	MH
DeKalb Brand 120		R					R	
DeKalb Brand 130		R				MR	S	MH
Discovery		R	MS				S	H
Dominor		R					S	H
Drummor			R			MR	R	H
Duke		R				MR	R	MH
Epic		R				S	R	
Expo		R				MR	R	MH
Futura		R				MR	MR	H
Glory		R	R					H
G-2815		R				MR	MS	MH
G-7730		R				MS	R	
Hi-phy		R					R	
Honeoye		MR	MS	MS	MS	S	S	H
Jubilee[b]		R				R-MR	R	H
Magnum		R					MR	
Marathon		MR	MS	MS		S	S	MH
Mercury		R				MR	R	H
Olympic		R	MR			R	S	H
Oneida		R					R	H
Pacer		R	MR	MR	MS	S	MS	H
Peak		R				MS	R	
Perry		R				MR	S	H
Phytor		R	MR				R	H
Pioneer Brand 520		R	MS	MS	MS	MS	S	H
Pioneer Brand 521		R	MS	MS	MS	MS	S	H
Pioneer Brand 524		VR	MS			S	S	H
Pioneer Brand 526		R				MS	MS	H
Pioneer Brand 531		R				MS	S	
Pioneer Brand 532		R				MS	S	
Pioneer Brand 555		R				MR	S	MH
Pride Polar II		R					R	H
Pride Preserve[b]		MR	R			MS	MR	H
Primal		R						H
Raidor		R				MR	S	MH
Riley		VR				R	S	MH
Saranac AR		MR	MR	MS	MS	R	S	H
Shenandoah[b]		R				R	R	MH
Spredor 2		R				S	S	H
Sunrise		R						MH
Tempo		MR	MR	MS	MS	S	S	H
Thunder		R				MR	R	H
Trident		R					VR	H
Trumpeter	MR	MR				R	S	H

Alfalfa (continued)

Variety	Verticillium wilt	Bacterial wilt	Common leaf spot	Lepto leaf spot	Spring black stem	Anthracnose	Phytophthora root rot	Winter hardiness[a]
Valor		R	MS	MR	MR	MS	S	H
Vancor		R				R	MR	H
Vernal		R	MS	MS	MS	S	S	H
Voris A-77		VR				R	MS	H
Weevlcheck		VR	MR	MS	MS	S	S	H
WL-215		R	MS	MS	MS	S	MS	H
WL-219		R	MR	MS	MS	MS	MS	H
WL-220		R	R			MS	R	H
WL-221		R				MR	S	H
WL-311		R	MS	MS	MS	MR	MS	H
WL-312		R				MR	MR	H
WL-313		R				MR	S	H
WL-315[b]		R				MR	MR	H
WL-316	R	MR				R	S	H
WL-318		MR	MS	MS	MS	MR	MR	MH
WL-320[b]	MR	R				MR	R	MH
Wrangler[b]	R	R					R	H

NOTE: In the table, average disease reaction is indicated as follows: VR = very resistant; R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; Blank = no information.

[a] Winter hardiness is based primarily on autumn growth ratings: VH = very hardy; H = hardy; MH = moderately hardy; MS = winter hardiness is questionable.

[b] Fusarium wilt resistant.

This circular was prepared by B.J. Jacobsen, M.C. Shurtleff, H.W. Kirby, and T.A. Melton, Extension Plant Pathologists with the Department of Plant Pathology, University of Illinois at Urbana-Champaign. The suggestions given in this circular are revised annually.

The Soybean Cyst Nematode Problem

T.A. Melton, B.J. Jacobsen, D.I. Edwards, and G.R. Noel

Soybeans severely infected with the soybean cyst nematode (Heterodera glycines Ichinohe, 1952) become stunted and yellow or chlorotic and may even be killed. The damage is usually most severe on lighter, sandy soils, but drastic losses have been observed on the heavy soils typical of much of the soybean acreage in Illinois. Yield losses can range from 10 to 80 percent, depending on rainfall, soil fertility, the presence of other diseases, and the population of the nematode.

The damage caused by soybean cyst nematodes can be greatly accentuated if the infected soybean plants are exposed to drouthy periods and root-rotting fungi. Rotating to nonhost plants such as corn or sorghum, eliminating weed hosts, and using a nematicide will tend to delay or perhaps prevent soybean cyst nematode populations from increasing to damaging levels.

The soybean cyst nematode has been identified in most counties in the southern half of Illinois, as well as in several counties in the northern half of the state (Figure 1). Undetected infestations are probably present in most other counties. An awareness of the problem will help in efforts to spot new and potentially devastating infestations.

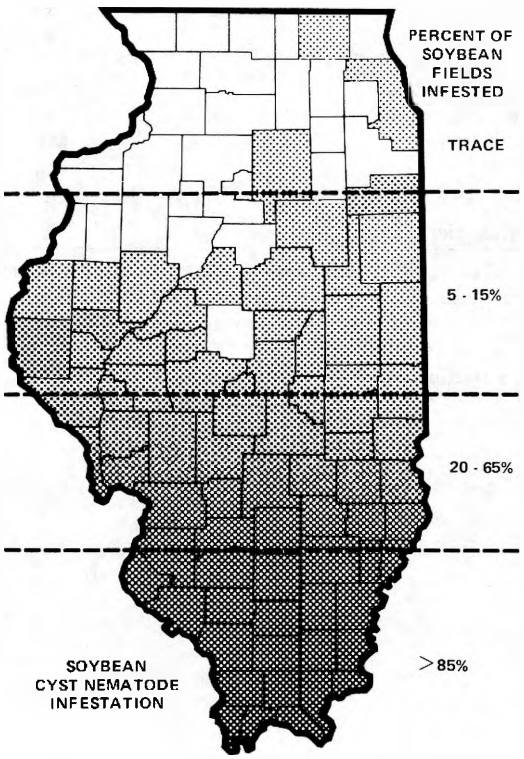

Figure 1. Illinois counties with known infestations of the soybean cyst nematode as of September 1, 1985.

Symptoms and Identification

Unfortunately, the aboveground symptoms of damage on individual plants and the appearance of infested fields are usually not specific enough to allow positive identification. However, some symptoms are quite suggestive of infection by this nematode. Heavily infected plants are stunted and may be yellow and chlorotic, particularly in soils of low fertility or during drouth conditions. Badly infested portions of a field may be oval to somewhat rectangular in outline. These portions may have a general yellowish cast and show the most severe damage in the center, with less damage toward the margin.

Often these symptoms are not apparent. Because slight to moderate stunting is difficult to detect, the grower is often unaware of SCN presence in a field. Yellowing of plants will not be apparent with low to moderate nematode populations

unless plants are stressed by drouthy conditions. This explains reports of the sudden explosion of soybean cyst nematodes in new counties and fields in drouthy years such as 1984.

Many other conditions may cause the same or similar symptoms. Therefore, identification cannot be made entirely on the basis of aboveground symptoms alone. Growers should notify their county extension adviser at once if they see the conditions described above in their soybean fields, or they should contact an extension plant pathologist at the University of Illinois, Urbana, IL 61801 (Telephones: (217)333-7515 and 333-1845). Special arrangements must be made for collecting and shipping samples (see Report on Plant Diseases No. 1100, "Collecting and Shipping Soil Samples for Nematode Analysis"). Final identification cannot always be made with the unaided eye. The nematodes must be recovered from infested soil or plant roots and identified under a microscope or with a hand lens.

Field diagnosis can be done by digging up plants on the margins of suspected damaged areas and gently washing and tapping the soil from the roots. The presence of white to brown, lemon-shaped cysts on the soybean roots provides positive diagnosis. The absence of cysts, however, does not mean that the soybean cyst nematode is not involved. The absence of cysts is not uncommon where plants are severely stressed toward the end of the growing season. Soil samples should be submitted in such cases.

The Nematode and Its Life History

Soybeans are infected by the second-stage larva--a microscopic (1/60-inch-long), colorless worm (Figure 2). Larvae penetrate the soybean by puncturing the roots with a spearlike feeding structure, the stylet. Once inside the root, they migrate toward food-conducting tissues, where they feed and mature. Feeding alters the internal root structure, thereby interfering with normal root functions and ultimately causing plant damage. In approximately three weeks, under optimum conditions (soil temperatures at 27° to 29°C or 80° to 84°F), egg-bearing females develop from the larvae. At 32°C (90°F) and above nematode development is slower and numbers reaching maturity are reduced.

The females enlarge greatly as they develop, becoming lemon shaped. They break through the root surface while remaining attached to the root by the head. The females lay some eggs in a jellylike mass attached to the posterior end but retain most of the eggs within their swollen bodies. If an infected plant is dug at this stage, the attached females can be seen with the unaided eye as shiny, white, spherical bodies about the size of the period at the end of this sentence. This is the so-called white female stage.

After death, the white female stage changes from yellow to brown--the brown cyst stage. By the time brown cysts are formed, the cyst (the altered female body wall) has become a protective structure containing an average of 100 to 400 eggs. The cyst wall protects the eggs from drying, chemical action, predators, and parasites. For these reasons, the brown cyst stage is best suited for the spread of the nematode to new areas. One female can produce up to 600 eggs, and as many as five generations can be completed in a single growing season. Thus, if one cyst containing 400 eggs is introduced into a soybean field in the spring, over 10 trillion cysts could be produced in one growing season. Thus, the introduction of even a single cyst into a field represents a potentially high nematode population that could cause noticeable damage within a short time.

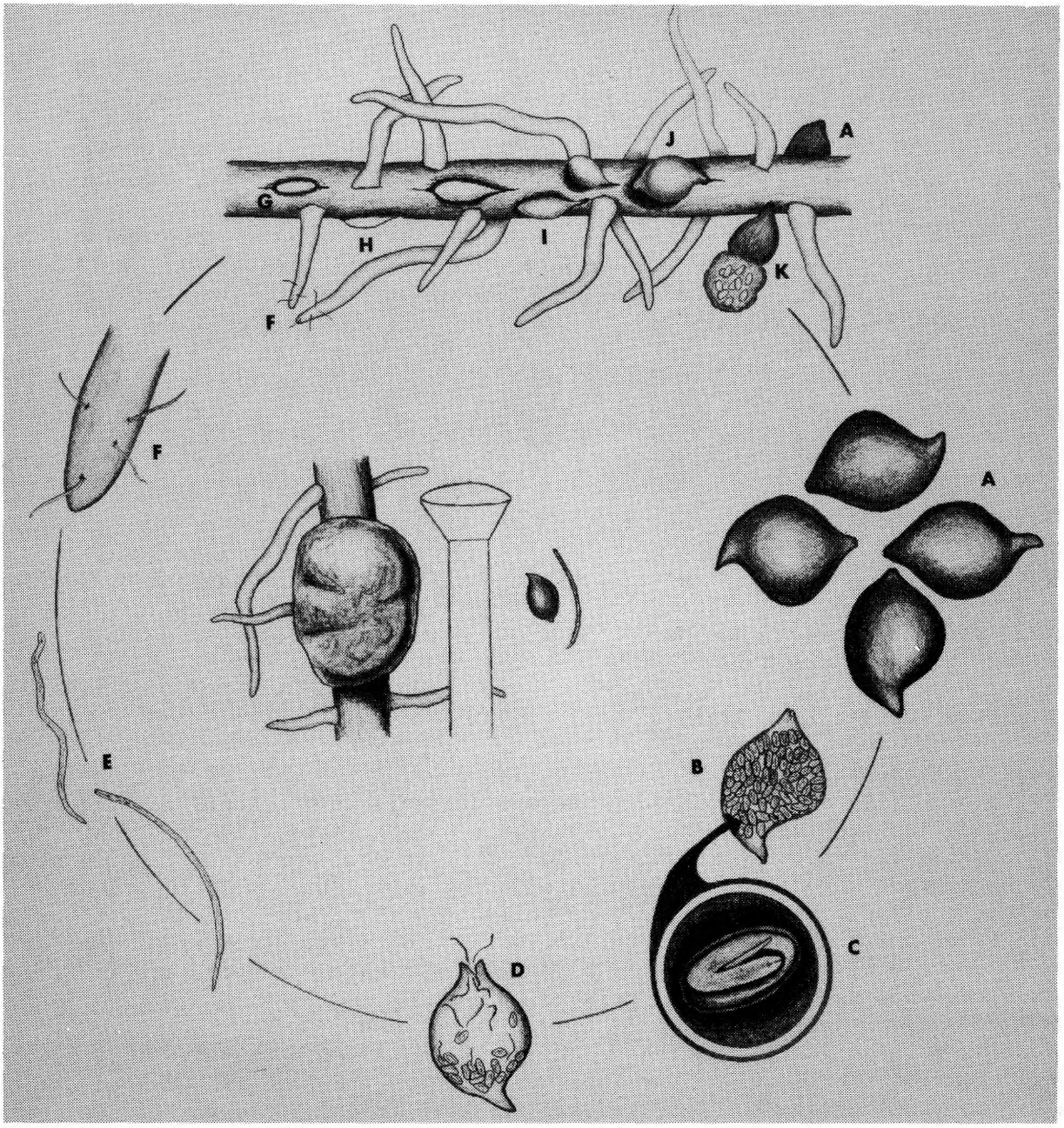

Figure 2. Disease cycle of the soybean cyst nematode. Brown, lemon-shaped cysts (A) overwinter in the soil. The cysts are filled with eggs (B). Each viable egg contains a fully developed second-stage larva (C). When temperature and moisture are favorable, the larvae hatch and emerge from the cysts (D). The larvae (E) move about freely in the soil before invading young roots by direct penetration (F). About 9 to 12 days after infection, the females become flask-shaped and split the root surface (G). They are pearly white at first (H), and turn pale yellow to yellowish brown as they mature (I). The females finally become almost entirely exposed through the root surface (J). A jellylike mass, in which some eggs are deposited, is extruded (K). The eggs in the matrix may hatch immediately with the emerging second-stage larvae ready to cause new infections. The cycle is completed when the female carcass, containing most of the 200 to 600 eggs, turns into a tough brown cyst (A) that may persist in the soil for many years. Approximately 21 to 24 days are required for the completion of the life cycle. To show the degree of magnification, a nodule of nitrogen-fixing bacteria, the head of a common pin, a cyst, and an adult male nematode are shown in the center.

The five described races of the soybean cyst nematode are designated 1, 2, 3, 4, and 5. These races are characterized by their ability to reproduce on certain soybean varieties (Table 1). Race 3 is the most common one found in Illinois. If the population is not race 3, it usually is race 1 or 4. Races 1 and 5 have been detected.

Table 1. Characterization of the Known Races of the Soybean Cyst Nematode in the United States

Race[a]	Reproduction on key varieties				
	Franklin	Peking	P.I. 88788	P.I. 90763	Susceptible[b]
1	No	No	Yes	No	Yes
2	Yes	Yes	Yes	No	Yes
3	No	No	No	No	Yes
4	Yes	Yes	No[c]	Yes	Yes
5	Yes	No	Yes	No	Yes

[a]The numerical designation is based on chronological order of recognition, with race 5 being the latest discovery.
[b]Any standard susceptible variety.
[c]Moderately resistant.

Soybean varieties resistant to race 3 can be grown without appreciable losses in the presence of race 3 (see the section on resistant varieties). Race 4, found first in Arkansas and later in Missouri and Tennessee, causes severe damage on varieties resistant only to race 3. Damaging levels of race 4 have occurred in a number of central and southern Illinois counties and may be present in other areas of the state. Race 3 and 4 resistant varieties can be used for control. In a few southern Illinois counties, populations have caused severe damage on varieties resistant to races 3 and 4. Some of these populations have been identified as different from races 3 and 4. In central and southern Illinois races 1 and 5 have caused severe damage on race 3 and 4 resistant varieties such as Fayette. Procedures have been developed for determining the races of the soybean cyst nematode. Race determinations are made available as a grower service by the University of Illinois at Urbana-Champaign. For information, contact your county Extension adviser in agriculture.

Experienced personnel can determine the most prevalent race present in a field by planting one or several small areas (two to three rows 5 to 10 feet long in areas of the field where SCN populations are high) to three varieties. The first variety is selected from line A of Table 2 (races 1 and 3 resistant), the second from line B (races 3 and 4 resistant), and the third variety is a susceptible one normally used by the grower. After six to eight weeks roots are dug, gently washed in buckets of water, and examined for cyst development. After determining which varieties that SCN developed on, the results are compared with Table 2 to determine which race is present and which varieties are resistant to it.

Race 3 resistant varieties can be grown and combined with crop rotation for control if only race 3 is detected. If race 4 is detected by growers in the southern tip of the state, they should consider growing varieties such as Nathan, Bedford, or Fayettee, which are resistant to races 3 and 4. Bedford and Nathan are late-maturing varieties (Maturity Group V) and are only adaptable to far southern Illinois. If race 4 is detected in the central portion of the state, growers should

Table 2. Race Determination of SCN Based on the Use of Commercial Varieties as Differentials

Variety	SCN development			
A. Franklin, Forrest, CN210, CN290 (Resistant to races 1, 3)	no	no	yes	yes
B. Bedford, Fayette, Nathan, Egyptian (Resistant to races 3, 4)	yes	no	no	yes
C. Susceptible	yes	yes	yes	yes
Race designation	1	3	4	unclassified

plant the Fayette variety, which is resistant to races 3 and 4. If race 1 is detected, Franklin (IV) or Forrest (V) may be used. Currently there are no race 1 resistant varieties in maturity groups earlier than 4. In all situations, growers should use rotation with nonhost crops since continuous planting to a resistant variety is likely to lead to the selection of a soybean cyst nematode race that can attack the resistant variety used. In one research plot where the variety Franklin was planted for three years, a new race was detected by the end of the third year.

Host Plants

The host range of the soybean cyst nematode includes leguminous field crops plus some ornamental plants and certain weed species that are susceptible and will increase nematode populations. Highly susceptible hosts are shown in capital letters in Table 3. Other plants listed allow cyst production but are not often associated with soybean production in Illinois.

How Nematodes Spread

Cysts occur throughout the root zone in the soil. Some accumulate on the soil surface. From there, they can easily be transported alone or with soil by man and by natural agents. Cysts may be found in the mud adhering to farm implements, machines, vehicles, tools, shoes, or other mud-carrying items. The cysts also can adhere to boxes, crates, cartons, and bags and can be moved in this way whether or not mud is present. Nursery stock, transplants, bulbs, corms, and root crops may carry cysts in adhering soil, even though the plants themselves are not being attacked by the nematodes. Hay, straw, grain, or seed crops that carry dust or soil peds may also serve as carriers. Basically, anything that moves through an infested field in contact with the soil is capable of picking up and transporting cysts, although equipment and contaminated soybean seed that has not been thoroughly cleaned appear to be the most important means of spreading soybean cyst nematodes in Illinois.

Natural agents may also be important in the spread of the soybean cyst nematode. Wind, runoff water, livestock, and wildlife can carry cysts into clean areas. Even waterfowl and other birds feeding in infested fields may pick them up and carry them considerable distances.

Control: An Integrated Approach

An ideal program to control soybean cyst nematodes (SCN) should integrate the following: detection, crop rotation, resistant varieties, nematicides, soil fertility, sanitation, and soil analysis.

Detection

Identifying the problem is the first step in control. Soybean producers should be familiar with SCN symptoms and should suspect SCN where yields are reduced without explanation.

After a SCN infestation is identified, the predominant race present should be determined using the procedure described earlier. After the race has been determined, an economic analysis of control alternatives should be made to determine the best control strategies for a particular farm.

Table 3. Host Plants of the Soybean Cyst Nematode That Grow in Illinois

Crop and ornamental plants	Weeds
SOYBEANS, CULTIVATED AND WILD	HENBIT (Lamium amplexicaule)
BEANS, GREEN (SNAP), BUSH, KIDNEY, OR LIMA	HOP CLOVERS (Trifolium spp.)
LESPEDEZAS	CHICKWEED, COMMON (Stellaria media)
VETCH, COMMON, HAIRY, OR WINTER	CHICKWEED, MOUSEEAR (Cerastium vulgatum)
LUPINES, WHITE (ORNAMENTAL SPECIES)	MULLEIN, COMMON (Verbascum thapsus)
Clovers, crimson, scarlet, or alsike	SICKLEPOD (Cassia obtusifolia)
Sweetclover	Digitalis penstemon (Penstemon digitalis)
Birdsfoot-trefoil	Pokeweed (Phytolacca americana)
Crownvetch	Purslane (Portulaca oleracea)
Pea, garden	Bittercress (Cardamine sp.)
Cowpea or black-eyed pea	Rocky Mountain beeplant (Cleome serrulata)
Locust, black	Spotted geranium (Geranium maculatum)
Bells of Ireland	Toadflax, old-field (Linaria canadensis)
Borage (Borago)	Pigweed, winged (Cycloloma atriplicifolium)
Canarybirdflower	Vetch, American, Carolina, or wood (Vicia micrantha)
Caraway	Burclover or toothed medic (Medicago sp.)
Chinese lanternplant	Dalea (Dalea alopecuroides)
Coralbells	Milkvetch, Canadian (Astragalus canadensis)
Cup-flower	Beggars weed or tick clover (Desmodium nudiflorum, D. marilandicum, D. viridiflorum)
Delphinium	Corn cockle (Agrostemma githago)
Foxglove	Hogpeanut (Amphicarpa bracteata)
Geranium	Milkpea (Galactia volubilis)
Geum	Wildbean (Strophostyles helvola)
Horehound, common (Marrubium vulgare)	
Poppy	
Sage	
Snapdragon	
Sweet basil	
Sweet pea	
Verbena	

Entries in capital letters indicate highly susceptible hosts.

Crop Rotation

Crop rotation is a powerful tool for controlling SCN and other diseases. The effect of crop rotation is shown in Table 4. The data show that after three years in a nonhost crop, SCN populations were low enough at the Fayette County research location to safely plant a susceptible variety. SCN populations were reduced between 50 to 90 percent each year a nonhost crop was planted.

Table 4. Effect of Crop Rotation on Soybean Cyst Nematode (SCN) and Yield of Soybeans Resistant and Susceptible to SCN

Rotation by year[a]				Rotation by host for Race 3[b]				SCN per 100 cc. of soil, 1980		Yield, 1980
1977	1978	1979	1980	1977	1978	1979	1980	Cysts	Viable eggs and larvae	(bu/A)
soy(S)	soy(S)	soy(S)	soy(S)	H	H	H	H	57.5	256.9	20.4
soy(S)	corn	soy(S)	soy(S)	H	NH	H	H	31.6	315.9	25.6
soy(S)	corn	corn	soy(S)	H	NH	NH	H	12.4	212.5	26.2
soy(S)	soy(R)	soy(R)	soy(R)	H	NH	NH	NH	3.4	1.4	24.3
soy(S)	corn	soy(R)	soy(R)	H	NH	NH	NH	1.4	18.7	27.2
soy(S)	corn	corn	soy(R)	H	NH	NH	NH	5.3	0	24.1

[a](S) = SCN-susceptible variety Union. (R) = SCN-resistant variety Franklin.
[b]H = SCN host. NH = Not a SCN host.
Data: Fayette County, 1980, Jacobsen, Pepper, Hirrel, and Melton.

Rotations with nonhost crops such as corn, sorghum, wheat, red clover, alfalfa, and sunflower and with SCN-resistant soybeans are effective because SCN larvae hatch from eggs as long as soils are between 60 to 90°F (16 to 32°C). Optimum hatch occurs at 72°F (23°C). The second-stage larvae have food reserves to last seven to fourteen days, depending on soil temperature, after which time they must establish a feeding site in a host plant. Thus, if no host plant is available, data indicate that between 50 to 90 percent of the SCN population is eliminated by starvation each year. Even greater reductions may occur where eggs or larvae are attacked by parasites and predators such as fungi and mites.

Four crop rotations are suggested below that should minimize and may eliminate yield losses to SCN. Note that resistant varieties should not be used alone since experience has shown that this practice will lead to the development of high populations of a SCN race that can attack the resistant variety.

1. Crop Rotation #1
   Year 0--identification of a problem with race 3
   Year 1--nonhost crop (e.g., corn, sorghum, wheat, sunflower, alfalfa, and red clover)
   Year 2--adapted race 3 resistant soybean variety
   Year 3--nonhost crop
   Year 4--susceptible soybean variety if soil analysis shows SCN populations are below threshold level; otherwise, plant a nonhost crop and repeat soil sampling
   Year 5--repeat rotation

2. Crop Rotation #2
   Year 0--identification of a problem with race 3 or 4
   Year 1--nonhost crop (e.g., corn, sorghum, wheat, sunflower, alfalfa, and red clover)
   Year 2--adapted race 3 and 4 resistant soybean variety
   Year 3--nonhost crop
   Year 4--susceptible soybean variety if soil analysis shows SCN populations are below threshold level; otherwise, plant a nonhost crop and repeat soil sampling

3. Crop Rotation #3, for use where resistant varieties are not adapted or available
   Year 0--identification of a SCN problem
   Year 1--nonhost crop (e.g., corn, sorghum, wheat, sunflower, alfalfa, and red clover)
   Year 2--nonhost crop (e.g., corn, sorghum, wheat, sunflower, alfalfa, and red clover)
   Year 3--nonhost crop (e.g., corn, sorghum, wheat, sunflower, alfalfa, and red clover)
   Year 4--susceptible soybean variety if soil analysis shows SCN populations are below threshold level; otherwise, plant a nonhost crop and repeat soil sampling

4. Crop Rotation #4, for use where continuous soybeans are planted. This is the least desirable rotation plan because of the potential buildup of new races of SCN and other diseases under continuous soybean culture.
   Year 0--identification of a problem with race 3
   Year 1--race 3 resistant variety
   Year 2--race 3 and 4 resistant variety
   Year 3--race 3 and 4 resistant variety
   Year 4--susceptible soybean variety if soil analysis shows SCN populations are below threshold level; otherwise, plant a nonhost crop and repeat soil sampling

Ideally, a nonhost crop should be planted after a SCN problem is identified because SCN exists naturally as a mixture of races and a nonhost crop will reduce the population of all races. If a resistant variety is planted immediately, that part of the native population able to attack the resistant variety will increase.

The value of crop rotation should not be underestimated. A grower will achieve higher yields on all crops involved in the rotation than on any one crop that is planted continuously. This result is well illustrated by a long-term study on several agronomy research fields located throughout Illinois. In this study, yields were compared in fields where soybeans and corn were planted continuously and where corn and soybeans were planted in rotation. Soybeans planted in rotation yielded, on the average, approximately 5 bu/A more than continuous soybeans, and corn planted in rotation yielded approximately 12.5 bu/A more than continuous corn. These studies, conducted in the absence of SCN, show the positive economic impact of rotation. Therefore, growers should compare the yields and the economic return of rotated crops versus the yields and returns of continuous soybeans. An

example of such a comparison is given below. The example is based on the following assumptions:

Average corn yields	125 bu/A	@ $2.70	$134.00/A direct costs
Average soybean yields	40 bu/A	@ $6.40	$ 72.00/A direct costs

	Corn-Soybean Rotation		Continuous Soybeans	
	Yield (bu/A)	Net return/A	Yield (bu/A)	Net return/A
Yield 1	125 bu corn	$ 203.50	40 bu	$ 184.00
2	40 bu soybeans	184.00	35 bu	142.00
3	125 bu corn	203.50	35 bu	142.00
4	40 bu soybeans	184.00	35 bu	142.00
5	125 bu corn	203.50	35 bu	142.00
		$ 978.50		$ 752.00

In this example, the grower made $226 more per acre over 5 years with rotation. Added benefits of rotation are the better weed control achieved by rotating herbicides and corn rootworm control. Growers should do this comparison with their average yields and expected crop prices. With rotation a SCN problem is less likely to develop and is easier to manage if it does develop.

Resistant Varieties

SCN-resistant varieties are an excellent control tool for use in a SCN management program. However, high-yielding resistant varieties are not available for all areas.

The data given in Table 5 reflect the yields of high-yielding susceptible varieties and SCN-resistant varieties in the presence and absence of SCN. At the present time, no SCN-resistant variety will yield as much as high-yielding susceptible varieties when SCN is not present, although the variety Fayette is within 5 percent of commonly susceptible varieties. The varieties CN 290 and CN 210 are somewhat lower yielding relative to susceptible varieties in the absence of SCN. Therefore, they should be used only where SCN problems exist and not in noninfested fields where susceptible varieties will likely out-yield them. Therefore, growers should plant resistant varieties only where an SCN problem exists. Also, planting a SCN resistant variety unnecessarily could lead to the selection of a race of SCN that could attack that variety, eliminating it as a control tool. Table 6 lists the public soybean varieties resistant to SCN, the type and source of resistance, and the maturity group. There are several private varieties available with resistance to one or more races of SCN.

Table 5. Comparison of Yields of Soybean Varieties Resistant and Susceptible to Soybean Cyst Nematode in Illinois[a]

Variety	Yield (bu/A) in soybean cyst nematode infested test locations			Yield (bu/A) in test locations not infested with soybean cyst nematode		
	Yale, Jasper Co.	Mt. Vernon, Jefferson Co.	Sidney, Champaign Co.	Eldorado, Gallatin Co.	Belleville, St. Clair Co.	Urbana, Champaign Co.
Williams 82	9.5	25.8	...	48.4	56.4	51.3
Cumberland	5.6	30.6	...	50.6	57.5	56.3
Pella	8.1	23.1	...	50.2	55.7	53.1
Century	4.2	...	...	45.9	49.3	56.1
Union	15.5	29.2	...	50.9	...	...
Fayette	31.7	34.8	52.0	46.5	50.8	50.2
Franklin	26.0	30.6	...	42.0	...	...
Wells II	...	...	44.7			
Williams 79	...	...	44.6			
CN 290	35.7	...	40.8[b]	...	...	51.7
CN 210	30.1	...	39.5[b]	...	...	48.5
Corsoy 79	6.4	...	38.2[b]	...	...	50.1

[a]Data from Dr. R.L. Bernard, Dr. G.R. Noel, and Dr. D.I. Edwards, USDA, 1981.
[b]Data from Dr. R.L. Bernard, Dr. G.R. Noel, and Dr. D.I. Edwards, USDA, 1982.

Table 6. Public Soybean Varieties Resistant to Races of the Soybean Cyst Nematode

Variety	Maturity group	Source of resistance	Race resistance
CN 290	II	Peking	1 and 3
CN 210	II	Peking	1 and 3
Fayette	III	PI 88788	3 and 4*
Franklin	IV	Peking	1 and 3
Custer	IV	Peking	1 and 3
Egyptian	IV	Peking and PI 88788	3 and 4*
Forrest	V	Peking	1 and 3
Bedford	V	Peking and PI 88788	3 and 4*
Nathan	V	Peking and PI 88788	3 and 4*

*Moderate resistance to race 4.

Nematicides

The nematicides Mocap 15G, Nemacur 15G, Nemacur 3E, Furadan 15G, and Temik 15G are labeled for SCN control. These chemicals are applied in bands over the row at planting. Furadan 15G and Temik 15G are also labeled for in-furrow application. The data in Table 7 are the average yields of SCN-susceptible soybean varieties treated and untreated with nematicides and the average yields of SCN-resistant soybean varieties. Over the years, Temik 15G has given the most consistent increase in yield, but resistant varieties have produced higher yields than the best nematicide treat-

ment at the Franklin County research site. However, the best nematicide treatment produced higher yields than the best resistant variety at the Vermilion County research site. On sandy soils, products with high water solubilities should be avoided. In general, nematicide use should be considered only where adapted resistant varieties are unavailable or where susceptible varieties are planted when SCN populations are above the threshold level.

Soil Fertility

The data in Table 8 show that high fertility is required to achieve optimal yields of the SCN-resistant variety Franklin. It also should be noted that the susceptible variety Union did not have yields as high as the SCN-resistant variety Franklin. Therefore, fertility alone will not eliminate yield losses from SCN. The data given in Table 9 show that high fertility is required to realize the full potential of Temik nematicide treatment. Therefore, soybean growers should make sure that adequate levels of phosphorus and potash are present before initiating a SCN control program.

Sanitation

Since SCN moves with infested soil, soybean producers with SCN-infested fields can reduce the likelihood of spread to other fields by washing soil from equipment used in infested fields before moving the equipment to noninfested fields.

Since SCN is often carried in soil peds, seed produced on infested ground should be thoroughly cleaned to remove soil peds before planting. Seed purchased from infested areas should have been cleaned by a spiral cleaner before planting.

Table 7. Performance of Registered Nematicides against the Soybean Cyst Nematode in Illinois, 1968-1981

Chemical and location	Product (lb/A)	Years tested	Average yield (bu/A)		
			Treated[a]	Untreated[a]	Resistant varieties[a]
FURADAN 10G					
Franklin Co.	20 band	1975, 1980	32.4	25.4	37.0
MOCAP 10G					
Franklin Co.	25, 30 band	1968, 1976	23.4	22.4	27.7
NEMACUR 15G					
Franklin Co.	7.3 band	1977, 1978	22.6	20.9	30.4
Vermilion Co.	7.3 band	1977, 1978	41.9	37.2	...
Franklin Co.	14.5 band	1975, 1978, 1979, 1980	30.6	27.9	33.8
Vermilion Co.	14.5 band	1977, 1978, 1979, 1980	35.4	31.7	33.0 (36.4)[b]
Franklin Co.	29 band	1974, 1975, 1979, 1980	29.7	26.1	35.2
Vermilion Co.	29 band	1979, 1980	32.4	28.9	33.0 (36.4)[b]

(Continued)

Table 7. (Continued)

Chemical and location	Product (lb/A)	Years tested	Average yield (bu/A) Treated[a]	Untreated[a]	Resistant varieties[a]
TEMIK 15G					
Franklin Co.	7 in-furrow	1980, 1981	31.3	27.2	...
Vermilion Co.	7 in-furrow	1980	35.3	26.6	...
Franklin Co.	10 band	1978, 1979, 1980	28.6	25.0	28.9
Vermilion Co.	10 band	1978, 1979, 1980	37.1	30.3	33.0 (36.4)[b]
Franklin Co.	14 band	1977, 1978, 1979, 1980	30.4	26.4	31.3
Vermilion Co.	14 band	1978, 1979, 1980	40.3	30.3	33.0 (36.4)[b]
Franklin Co.	20 band	1976, 1977 1979, 1980	35.7	29.0	31.6
Vermilion Co.	20 band	1977, 1979, 1980	41.6	33.0	33.0 (36.4)[b]

[a]Treated and untreated varieties for Franklin County tests were Clark 63 (1968-1974), Williams (1977-1978), Cutler 71 (1975-1976), and Mitchell (1979-1980). Resistant varieties for Franklin County tests were Custer (1968-1977) and Franklin (1977-present).
Treated and untreated varieties for Vermilion County tests were Amsoy 71 (1977-1979) and Wells II (1980). The resistant variety used in Vermilion County tests was Franklin.
[b]The yield of CN 290.
Data: D.I. Edwards, USDA.

Table 8. Effect of High and Low Fertility on Average Yields of the Soybean Varieties Franklin and Union in the Presence of Race 3 Soybean Cyst Nematode

Variety	Yield (bu/A) High fertility	Low fertility
Franklin (resistant to race 3)	26.3	19.5
Union (susceptible to race 3)	21.5	14.1

Data: Fayette Co., 1978-1980, Jacobsen, Pepper, Hirrel, and Melton.

Table 9. Effect of Temik Nematicide on Union and Franklin Soybean Yields under High and Low Fertility

Variety	Yield (bu/A) with high fertility[a]		Yield (bu/A) with low fertility[b]	
	Temik[c]	No Temik	Temik[c]	No Temik
Franklin	31.0	28.7	24.4	22.3
Union	26.1	21.8	24.4	12.0

Data: Fayette Co., 1978-1980, Jacobsen, Pepper, Hirrel, and Melton.
[a]High fertility: P_1 Bray = 51; K = 263; pH = 6.2.
[b]Low fertility: P_1 Bray = 28; K = 94; pH = 6.5.
[c]Temik 15G at 14.0 lb of product per acre.

Another common source of SCN contamination is second-hand farm equipment. Such equipment should be washed free of all adhering soil before it is used.

Soil Analysis for SCN

Soil analysis for SCN should always be done before a susceptible variety is planted without nematicide protection. At the present time, a soil population below 20 viable eggs and larvae per 100 cc. of soil is considered to be the population at which a susceptible variety can be planted without significant damage. Growers who want to plant a susceptible variety as soon as possible in the rotation should sample each nonhost crop in the fall to determine the remaining population. If populations increase after cropping to a resistant variety, the buildup of a new race should be suspected.

Soil samples should be collected to a depth of 6 inches. Approximately 10 or more subsamples per 5 acres should be taken. Subsamples should be mixed and a composite sample should be sent to the University of Illinois Plant Clinic, St. Mary's Rd., Urbana, IL 61801, for analysis. A nominal charge will be made for processing samples.

Soybean Cyst Nematode in Snap Beans, Kidney Beans, Lima Beans, and Peas

These crops are all good-to-excellent hosts for the soybean cyst nematode. SCN can reduce the yields of these crops, although populations higher than those on soybeans are needed to cause losses equal to those on soybeans. At present, crop rotations and soil sampling appear to be the best method of control on these crops. Research is now in progress to determine sources of resistance, the economic threshold, and possible interactions with other diseases organisms.

Snap bean lines with usable resistance to races 3 and 4 include Wisconsin (RRR) (root rot resistant) lines 36 and 46. Many commercial varieties are as good hosts as soybeans.

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1986 Disease Management Guide for Commercial Vegetable Growers

THE SUCCESSFUL CONTROL OF VEGETABLE DISEASES requires an integrated program that includes the use of resistant varieties, disease certification programs, crop rotation, balanced soil fertility, weed and insect control, and proper crop culture as well as the selective application of fungicides, bactericides, or nematicides. Economical control depends on establishing an overall disease management system for the entire farm. Keeping careful records of the crops that have been planted, the problems encountered, and the pesticides used is important.

The information in this circular is updated annually. The grower should also consult the current versions of Circular 897, *Insect Pest Management Guide: Commerical Vegetable Crops and Greenhouse Vegetables,* and Circular 907, *Weed Management Guide for Commercial Vegetable Growers,* as well as Circular 1174, *Vegetable Varieties for Commercial Growers,* which contains information on disease resistance. Those circulars are revised each year.

Because many disease problems originate with seeds or transplants, growers should follow the seed treatment recommendations given in this circular or be sure to obtain planting material that is certified free of disease.

This publication presents the vegetable fungicide tolerances and application intervals for various crops as approved by the Food and Drug Administration (FDA) and the U.S. Environmental Protection Agency (EPA) as of October 1, 1985. The tables on the next two pages give the number of days between the last application at the normal rate and the harvest as well as other restrictions that will keep residues within the tolerances set by the FDA.

The listing of a chemical as approved for use on a particular crop does not mean that the Illinois Cooperative Extension Service or Agricultural Experiment Station recommends the use of the chemical for that crop. Our specific recommendations for disease control are given in the table entitled "Condensed Recommendations on Disease Management . . ."

In some instances a tolerance has been set but a definite interval has not been established. The absence of an interval for a particular crop in the listings does not necessarily mean that the fungicide may not be used on that crop. To ensure that the crop produced does not exceed the tolerance, the use of the fungicide would require a restriction such as "do not apply after first blooms appear" or "do not apply after edible parts form." This information appears on the product label.

In a few cases the interval and dosage have been established but the allowable residue concentration has not been determined. Again, this does not mean that the fungicide may not be used on the crops for which it is labeled. It does mean, however, that until the tolerance is established it must be considered as zero. These cases are reviewed each year, and some are cancelled when the chemical manufacturer supplies the EPA with additional data.

Growers must follow a program of disease control that will assure that the vegetables produced do not contain excessive fungicide residues. Vegetables marketed with residues exceeding the FDA tolerances may be injurious to consumers, may be confiscated, and may cause the grower to be brought to court.

Growers have nothing to fear from the law as long as they use fungicides and other pesticides according to the current label and only on the crops specified, in the amounts specified, and at the time specified. The prudent grower keeps a record of the products and trade names used, the percentage of active ingredients, dilutions, rates of application per acre, and dates of application. The record sheet at the end of this circular provides a convenient place to record such information.

This circular is revised each year. Be sure you are using the most recent copy.

Prepared by Barry Jacobsen and Tom Melton, Department of Plant Pathology

Circular 1184

LIMITATIONS ON DAYS BETWEEN APPLICATION AND HARVEST AND OTHER RESTRICTIONS WHEN USING FUNGICIDES ON VEGETABLES IN ILLINOIS

Crop	Benlate[a]	Captan (D)	Bravo	Di-folatan	Dyrene	maneb[b]	mancozeb[c]	Phaltan	zineb
Asparagus	..	root dip	..	..	..	A	A	..	A
Beans (dry, lima, snap)	14, 28 on lima, B	pp, 0	7, B (snap only)	..	..	0, 4 on limas or snap	..	..	7
Beet, garden	..	0, pp	..	..	..	..	..	..	7
Broccoli	..	pp	0	..	..	7, or trim and wash, 3	..	..	7
Brussels sprouts	..	pp	0	..	..	7	..	..	7
Cabbage	..	pp	0	..	..	7	..	..	7
Cantaloupe (muskmelon and honeydew melon)	0	0, ph, pp	0	0	0	5	5	0	5
Carrot	4	0	0	..	..	0	7, B (tops)	..	7 (tops)
Cauliflower	..	pp	0	..	..	7	..	..	7
Celery	7	0, pb	7	..	0	14, strip and wash	14	7	14
Chinese cabbage	..	..	..	..	..	..	..	..	7
Corn, sweet and pop	..	10, B, pp	14, B[d]	..	..	0, B, C	7, B	..	0, B, C
Cucumber	0	0, ph, pp	0	0	0	5	7	0	5
Eggplant	..	0, ph, pb	..	..	..	0	..	..	0
Endive, escarole	..	..	..	..	..	10, and wash	..	..	10
Fennel	..	..	..	..	..	..	7	..	..
Kale, collard	..	pp	..	..	..	10, and wash	..	..	7, collard 10,kale
Kohlrabi	..	pp	..	..	..	7	..	..	halfgrown
Leek	..	..	..	..	0	..	..	0	..
Lettuce	..	0	..	..	..	10, strip and wash	..	0	10
Mustard greens	..	pp	..	..	..	10, and wash	..	..	10
Onion	..	0, ph	green, 14; dry, 7	0	0	0	7, D	0	7
Parsley	..	..	..	..	..	..	..	..	..
Parsnip	..	..	..	..	..	..	..	..	..
Peas	..	pp	..	..	..	..	..	..	10
Pepper	..	0, pb, pp	..	..	..	0	..	..	0
Potato, Irish	..	0, ph	0	0	0	0, C	0	..	0 and seed, C, pp
Pumpkin	0	0, pp	0	..	0	5	..	0	0
Radish	..	..	..	..	..	..	..	..	0
Rhubarb (greenhouse)	..	0	..	..	..	0	..	..	..
Shallots	..	..	..	..	0	..	..	0	..
Spinach	..	0, pp	..	..	..	10, and wash	..	..	10
Squash	0	0, pp	0	..	0	5	5	0	5
Sugar beet	21	0	..	..	..	14, B, C	14, B	..	..
Swiss chard	..	0	..	..	..	..	..	..	10
Tomato	0	0, pp	0	0[e]	0	5, F	5	0	5
Turnip, rutabaga	..	pp	..	..	..	7, and wash	..	..	7 (tops)
Watermelon	0	0, pp	0	0	0	5	5	0	5

NOTE: Numbers in the table indicate number of days between last application and harvest; 0 = up to harvest. Dots in a column indicate that the fungicide is not registered for use on that particular vegetable. Other abbreviations used in the table are as follows:

A = Postharvest application to ferns only or to young plantings that will not be harvested.
B = Do not feed treated tops or forage to livestock.
C = Do not use treated seed or seed pieces for feed or food.
D = Do not apply to exposed bulbs.
E = Do not apply after fruit buds form.
F = To avoid damage, do not use on tender young plants.
pb = Plant bed treatment.
ph = Postharvest spray or dip.
pp = Preplant soil treatment.

[a] Do not apply Benlate alone; always use in combination with mancozeb or other labelled protective fungicide such as Captan, Bravo, Dyrene, or maneb. Do not mix with Mertect or Topsin-M.
[b] Maneb is sold as Manex, Maneb 80, Dithane M22, and Manzate. Maneb with zinc salt is sold as Dithane M22 Special, Manzate D, Dithane Flowable, and Manzate Flowable Fungicide.
[c] Mancozeb is sold as Dithane M-45 and Manzate 200.
[d] Do not apply if the crop will be used for processing.
[e] Machine harvest only.

LABEL INFORMATION ON FUNGICIDES OF LESS GENERAL USE

Fungicide (tolerance)	Crops and use restrictions
Botran	**Beans** (snap) — white mold, 2 days to harvest. Do not feed forage to livestock. **Greenhouse tomato** — to harvest. Do not drench seedlings or newly set transplants. **Carrot** — postharvest dip or spray, see label. **Garlic, onion** — soil application before seeding or spray to soil around sets or bulbs. *Do not plant spinach* as a followup crop in treated soil. **Leaf lettuce** (greenhouse) — 14 days[a] (do not apply to wilted plants or seedlings). **Head lettuce** — 14 days. **Celery** — 7 days. **Cucumber** (greenhouse) — see label. **Rhubarb** (greenhouse) — 3 days. **Potato** — 14 days (do *not* feed to livestock). **Sweet potato** — root dip and plant bed treatment. **Note:** Do not plant tomatoes as followup in treated soil. Don't use spent roots for food or feed. Postharvest spray or dip as directed. **Tomato** (greenhouse) — 3 days.
carbofuran (Furadan 10G)	**Corn** (sweet and pop) — nematodes. Apply in band or furrow at planting. **Cucumber, melon, squash, pumpkin** — apply in band at planting.
chloroneb (Demosan)	**Beans** — seedling diseases. Seed treatment or in-furrow spray at planting.
Copper fungicides[b]	**Bean, beet, broccoli, Brussels sprouts, cabbage, cantaloupe, carrot, cauliflower, celery, cucumber, eggplant, honeydew melon, lettuce, muskmelon, onion, pea, potato, pumpkin, radish, spinach, squash, tomato, watermelon.**
tribasic copper sulfate (many trade names)	
copper sulfate (many)	**Bean, broccoli, cabbage, cantaloupe, cassaba melon, cauliflower, celery, cucumber, honeydew melon, muskmelon, Persian melon, potato, pumpkin, radish, squash, tomato, watermelon.**
copper resinate (Citcop 4E, Cop-O-Cide, Emulsifiable Liquid Copper Fungicide)	**Bean, broccoli, cantaloupe, cauliflower, chinese cabbage, carrot, celery, cucumber, honeydew melon, lettuce, muskmelon, onion, pepper, pumpkin, squash, tomato, turnip, watermelon.**
copper ammonium carbonate (Copper-Count N)	**Bean, cabbage, carrot, crenshaw melon, celery, cantaloupe, cassaba melon, cucumber, honeydew melon, lettuce, muskmelon, pepper, Persian melon, potato, squash, tomato, watermelon.**
copper hydroxide (Kocide 101 and 404)	**Bean, broccoli, Brussels sprouts, cabbage, cantaloupe, carrot, celery, cucumber, honeydew melon, muskmelon, pepper, potato, pumpkin, squash, tomato, watermelon.**
copper oxychloride sulfate (COCS, Copro 50 and 53)	**Bean, beet, broccoli, Brussels sprouts, cabbage, cantaloupe, carrot, cassaba melon, cauliflower, celery, crenshaw melon, cucumber, eggplant, honeydew melon, lettuce, muskmelon, onion, pea, Persian melon, potato, pumpkin, spinach, squash, tomato, watermelon.**
Bordeaux mixture (many trade names)	**Asparagus, beans, beets, broccoli, Brussels sprouts, cabbage, carrot, cassaba melon, celery, collards, crenshaw melon, honeydew melon, horseradish, kale, mustard, pepper, rape, rutabaga, spinach, cress, cucumber, eggplant, honeydew melon, muskmelon, Persian melon, potato, pumpkin, radish, squash, tomato, turnip, watermelon.**
dinocap (Karathane)	**Cantaloupe (muskmelon), cucumber, honeydew melon, pumpkin, squash, watermelon** — 7 days. For control of powdery mildew only.
etridiazol (Terrazole, Truban)	Seed treatment: **Beans, peas, sugar beets.**
Iprodione (Rovral)	**Head lettuce** — lettuce drop and bottom rot, no more than 3 treatments. **Garlic** — white rot. Root crops, cereal grains, soybeans, and tomatoes may be planted the next year. Garlic and leafy vegetables may be planted following treated lettuce.
metalaxyl (Apron 2E)	Seed treatment for control of Pythium and Phytophthora root rot on **sweet corn, popcorn, peas, snap and dry beans.**
(Ridomil 2E)	**Tomatoes, cucumbers, melons, squash** — Pythium damping off. Apply 2-4 tablespoons in 2 gal water per 150 square feet before or at the time of seeding. Follow with ½ inch water to incorporate.
(Ridomil MZ58)	**Cucumber, melon** — 5 days, no more than 20 lb/A/yr. **Onion** — 7 days, no more than 12.5 lb/A/yr. **Potato** — 7 days, no more than 22.5 lb/A/yr. **Tomato** — 5 days. Use only where downy mildew or late blight disease problems exist. Corn, root crops, or the aforementioned crops may be planted the year following use; other crops may not be planted until 18 months after treatment.
metiram (Polyram)	**Potato, sugar beet** — no time limitations. **Celery** — 14 days. **Cantaloupe, cucumber, tomato** — 5 days. Do *not* feed **sugar beet** tops to meat or dairy animals. **Celery** — strip, trim, and wash — 14 days. Postharvest application to **asparagus ferns. Corn** — fresh market only.
oxymal (Vydate)	**Potatoes** — nematodes. Apply before or at planting.
PCNB (Terraclor, Brassicol, Fungiclor)	**Beans** — base of plants *before* blossoming, soil and seed treatment at planting, or foliar spray. Do *not* feed treated **Bean** vines to livestock. Do *not* apply after first bloom. **Broccoli, Brussels sprouts, cabbage, cauliflower** — transplant solution (¾ pint per plant) or row treatment before transplanting. **Pepper, potato, tomato** — soil treatment at or before planting. **Tomato** (greenhouse) — transplant solution (½ pt. of 0.2% per plant). **Garlic** — soil and seed treatment at planting.
streptomycin	**Celery, pepper, tomato** — plant beds only (200 ppm spray); **Potato** — seedpiece treatment only (100 ppm dip or dust). Soak cut seed pieces less than 30 min. **Beans** — seed treatment for halo blight control. Do not use treated seed for food or feed.
sulfur, lime, and lime-sulfur	Exempt when used with good agricultural practices. See label.
terbufos (Counter 15G)	**Corn** (sweet and pop) — Apply in band or furrow at planting.
thiabendazole (Mertect)	**Sweet potato** — "seed" root treatment. Do not use treated pieces for food or feed. **Potato** — "seed" tubers only (1,500 ppm-20 sec. dip). Storage rot control.
thiophanate methyl (Topsin-M)	**Beans** — white mold and gray mold. Snap or dry beans, 14 days. Lima, 28 days. **Celery** — early and late blight, 7 days, limit of 4 applications per year.
(TOPS 2.5D)	**Potato** — seed piece treatment.
thiram, TMTD	**Onion** — Furrow treatment. **Celery** — 7 days (strip, trim, and wash). **Sweet potato** — preplant root dip. **Tomato** — 0 days, for leaf spots and fruit rots. Seed treatment: **Beans, beets, broccoli, Brussels sprouts, cabbage, cantaloupe, carrot, cauliflower, collard, corn, cucumber, eggplant, endive, kale, kohlrabi, lettuce, okra, onion** (bulb, seed, and set), **peas, pepper, pumpkin, radish, spinach, squash, Swiss chard, tomato, turnip, watermelon.** WARNING: Do not use treated seed for food, feed, or oil — 7 days.
triadimefon (Bayleton)	**Cantaloupe (muskmelon), cucumber, honeydew melon, pumpkin, squash, watermelon** — powdery mildew. May apply a maximum of 1 lb./A/yr. of 50% wp.
triphenyltin (Du-Ter)	**Carrot** — Alternaria leaf spot and late blight — 14 days. **Potato** — early and late blight. May be applied through irrigation systems (solid set or center pivot only).
vinclozolin	**Head lettuce** only. Sclerotinia drop (Ronalin). No more than 3 treatments. Limit of 28 days to harvest.
ziram	**Cucumber, melon** — 0 days. **Beans** (snap and lima) — 4 days. **Tomato** — 7 days.

[a] Number of days between last application and harvest.

[b] There are many other copper materials, but these are most widely available and labeled for use on vegetable crops. Exempt from tolerance if used with good agricultural practices; not exempt if used at the time of harvest or after harvest. See label.

CONDENSED RECOMMENDATIONS ON DISEASE MANAGEMENT FOR DISEASES OF COMMERCIAL VEGETABLE CROPS FOR 1986

Vegetable	Disease management practices
Asparagus	
Crown or root rots, Seedling blights, and wilt	No resistant varieties are available for control of these diseases. Treating the crowns with captan or mancozeb may aid in control. These diseases are best managed by good asparagus culture. Provide optimal soil fertility, and weed, insect and rust control. Avoid excessive cutting.
Rust, other leaf and branchlet blights	Grow rust-resistant varieties. Apply zineb, maneb, mancozeb, or Polyram to nonharvested fields up to August 15 and to harvested fields after harvest only. Applications should be made on 7- to 10-day intervals.
Beans (snap, dry, wax, and lima)	
Most diseases	When possible, use rotations of 2-3 years between bean crops.
Seed decay, damping-off, seed-borne stem blights, and root rots	Plant only western-grown, certified seed in a seed bed that is warm (60°-65° F.) and well-prepared. Seed treatment with metalaxyl, thiram, captan, captan plus fenaminosulf, Terrazole, or chloroneb plus insecticide is suggested. In-furrow sprays of chloroneb or seed treatment with metalaxyl may be helpful for early season root-rot control.
Root rots	Maintain optimal soil fertility. Utilize crop rotations of 2-3 years.
Bacterial blights	Plant only western-grown, certified seed. Utilize crop rotations of 2 to 3 years. Avoid cultivating when beans are wet. Streptomycin may be added to seed treatment fungicide/insecticide. Field applications of 2-3 pounds of fixed copper per acre will provide good control of brown spot and halo blight, only moderate control of common or fuscous blight.
Downy mildew and syringe blight (brown spot) on lima beans	Make early and weekly applications of maneb plus fixed copper. Eliminate lilac and wild cherry from field borders.
Rust, anthracnose, and other fungal leaf, pod, and stem diseases	Utilize crop rotations of 2-3 years. Apply maneb, zineb, or Bravo at 7- to 10-day intervals. Rust-resistant varieties are available for some types of beans. Sulfur can also be used but may be phytotoxic at high temperatures.
White mold, gray mold	Apply Benlate, Botran, or Topsin-M first at initial to 25 percent bloom and again at full bloom. Botran may be used on snap beans only.
Virus diseases	Plant varieties with resistance to bean common mosaic, NY15 strain of common mosaic, and bean yellow mosaic.
Soybean cyst nematode	Rotate 2-3 years with corn, small grains, alfalfa, red clover, or other nonhost crop. Do not include soybeans in the rotation.
Beets (garden and sugar), Swiss chard	
Seed rot, damping-off, and seed-borne leaf spot	Sow in a well-prepared seed bed. Treat seed with captan or thiram. Make sure boron levels are adequate.
Cercospora leaf spot	Apply zineb or fixed copper weekly at the first sign of disease.
Crucifer crops (broccoli, Brussels sprouts, cauliflower, cabbage, chinese cabbage, collards, kale, kohlrabi, mustard, radish, rutabaga)	
Seed rot, damping-off, black rot, blackleg	Sow only western-grown, hot water-treated seed. Seed also should be treated with thiram or captan. Place seed beds where no crucifer has grown for 4 years or more and where water will not drain from fields recently planted to crucifers.
Wirestem (*Rhizoctonia*)	Incorporate PCNB-captan in upper 3 inches of soil before planting or drench after planting.
Clubroot	Apply PCNB (Terraclor 75) in transplant water.
Black rot and blackleg	Use a crop rotation of 3-4 years or more. Use only hot water-treated seed. Use care in the selection of plant bed sites. Be sure no drainage occurs to seed bed from old plantings. Control wild mustard and other cruciferous weeds. Purchase only certified, disease-free transplants. Do not dip transplants before planting. Sprays of fixed copper may help control black rot. Bravo applied to control downy mildew may also help control blackleg. Some cabbage varieties resistant to black rot are available. Losses are generally lower where direct seeding is used.
Downy mildew, Alternaria leaf spot, and other fungal leaf diseases	Apply maneb, zineb, or Bravo on weekly intervals. Start applications in seed bed or when plants are young.
Tipburn	Plant resistant varieties.
Fusarium yellows	Plant yellows-resistant varieties.
Radish black root	Plant resistant varieties.
Carrots, Parsnips	
Seed rot, damping-off	Treat seed with captan or thiram.
Cercospora leaf spot, Alternaria leaf blight	Apply maneb, mancozeb, zineb, or Bravo on 7-10 day interval.
Aster yellows	Use insecticides to control leafhoppers that transmit the mycoplasma. Excellent early season leafhopper control is essential. Control must occur *before* leafhoppers feed.
Root-knot nematode	Fumigate mineral soils with D-D, Telone, or Vorlex, *or* practice a 3-year rotation with corn or some other nonhost crop with which broadleaf weed hosts will be controlled.
Parsnip canker	Spray with fixed copper at a 10-day interval in late season (August) until the tops die. Ridge soil over the shoulders.

CONDENSED RECOMMENDATIONS ON DISEASE MANAGEMENT (continued)

Vegetable	Disease management practices
Celery, Parsley	
Seed rot, damping-off, seed-borne leaf blights	Treat plant seed with hot water, then captan or thiram. If damping-off starts, spray 2-3 times, 5-7 days apart with zineb. Seed 2-3 years old is free of late blight.
Leaf blights and spots (celery only)	Spray maneb, zineb, Benlate, Topsin-M, Dyrene, Bravo, or mancozeb at 7-10 day intervals.
Aster yellows and Root-knot nematode	(See the section on Carrots and Parsnips)
Corn (sweet and pop)	
Seed rot, seedling blights, seed-borne diseases	Plant seed treated with captan, thiram, metalaxyl plus captan, or Vitavax-thiram and insecticide.
Goss' bacterial wilt	Use 2 to 3 year crop rotations when using susceptible corn (dent or sweet) varieties.
Stewart's disease	Control flea beetles with insecticide, or plant tolerant hybrids.
Smut	Plant tolerant hybrids.
Maize dwarf mosaic, Wheat streak mosaic	Control Johnsongrass and volunteer wheat. Plant wheat after the fly-free date. Some hybrids tolerate maize dwarf better than others, but no hybrids are highly resistant.
Helminthosporium leaf blights, anthracnose leaf blight	Spray mancozeb, zineb, maneb, Polyram, or Bravo when disease first appears. Crop rotation and clean tillage will help reduce disease risk.
Rust	Spray the same as for Helminthosporium blights or plant resistant varieties.
Nematodes	Apply carbofuran or terbufos at the time of planting.
Vine Crops (cucumbers, muskmelons (cantaloupe), pumpkins, squash, and watermelons)	
General	Use a crop rotation of 3-4 years. Grow resistant varieties whenever possible.
Seed rot, damping-off, seed-borne diseases	Plant only certified, western-grown seed treated with captan or thiram. Damping-off can be treated with a captan or Ridomil bed drench.
Bacterial wilt	Provide season-long control of striped and spotted cucumber beetles. Start as the plants emerge. Planting-time treatment with Furadan will provide moderate control for 3-4 weeks. Supplemental insecticide use will be necessary.
Anthracnose, scab, blossom blights, gummy stem blight, or black rot	Grow resistant varieties whenever possible. Spray weekly with maneb, zineb, Bravo, Dyrene, Difolatan, or Benlate.
Downy mildew, Alternaria leaf blight	Grow resistant varieties whenever possible. Maintain ample but *not* excessive nitrogen fertility. Apply maneb, zineb, mancozeb, Dyrene, Bravo, or Difolatan on a weekly schedule.
Fruit spots and rots	Maintain fungicide schedule as for anthracnose through the season. Avoid harvest injuries.
Fusarium wilt	Grow resistant varieties.
Angular leaf spot	Apply fixed copper sprays in combination with zineb, maneb, or mancozeb. Start applications early in the season. Practice crop rotations of 3-4 years. Resistant cucumber varieties are available.
Powdery mildew	Apply Bayleton or Karathane WD at the first sign of disease and again 10 days later for Karathane (10-14 days later for Bayleton). Where Benlate or Bravo is applied to control other diseases, mildew will be controlled well. Plant resistant varieties where possible.
Mosaics	Control aphids and beetles in the field. Control broadleaf weeds around field borders. Plant only mosaic-resistant cucumbers.
Root-knot nematode	Fumigate with Vapam or Vorlex in the fall before planting or use Furadan at planting.
Eggplant	
Seed rot, damping-off, seed-borne diseases	Plant hot water-treated seed when possible. Treat the seed with captan or thiram. Damping-off can be controlled with a captan drench.
Phomopsis blight, Alternaria leaf spot, Cercospora leaf spot, and anthracnose	Spray plants weekly with maneb, zineb, or captan at first sign of disease or when first fruits are half sized.
Verticillium wilt, nematodes	Fumigate the soil with Vapam, Vorlex, or methyl bromide plus chloropicrin. Planting in black plastic mulch will help reduce disease severity.
Horseradish	
Leaf spots	Apply fixed-copper fungicides. Start when conditions are wet or dews are heavy. Continue until a killing frost occurs.
Brittleroot	Plant clean sets. Control leafhoppers.
Verticillium wilt	Fumigate the soil before planting with Telone C.
Lettuce, Endive	
Seed rot, damping-off, Gray mold	Treat seed with captan. In the field or seed bed, work Botran into the soil before planting and spray Botran after thinning or transplanting and again as necessary. Ferbam or zineb can be used as drenches to control damping-off.
Aster yellows	Control leafhoppers throughout the season. Early season control is most important.
Rhizoctonia bottom rot, Sclerotinia drop	Plant on beds and deep plow when possible. Apply Rovral at 3-leaf stage and again 10 days later. A third application may be made 10 days later if disease conditions warrant. Botran applications as previously described may help. Ronalin should be applied 2 days after thinning, 14 days later, and 14 days after the second spray. Use 100 gallons of water carrier per acre.
Gray mold, white rust, downy mildew	Apply ferbam, maneb, or zineb at 5- to 7-day intervals.

CONDENSED RECOMMENDATIONS ON DISEASE MANAGEMENT (continued)

Vegetable	Disease management practices
Okra	
Seed rot, damping-off	Treat seed with captan or thiram.
Fusarium wilt or Verticillium wilt	Fumigate soil with Vorlex, Vapam, or methyl bromide plus chloropicrin.
Onions, garlic, leek, chives	
Smut, seed rot, damping-off	Treat the seed with captan or thiram. Use Methocel sticker to pellet the fungicide with seed. Use 1 pound of active ingredient to 20 pounds of seed for set onions; 6 pounds of active ingredient to 8 pounds of seed for bulb onions.
Blast, downy mildew, Alternaria purple blotch, Botrytis neck rot	Apply maneb, zineb, mancozeb, Difolatan, Dyrene, Phaltan, or Bravo on a weekly schedule. Begin spraying with first ozone alert. Continue until harvest. Bravo has given superior control in research trials.
Bulb and stem nematode, Root-knot nematode	Fumigate with Telone or DD.
White rot of garlic	Apply Rovral on cloves and furrow covering soil.
Fusarium basal rot	Avoid heavily infested fields. Grow resistant varieties.
Storage decays	Maintain excellent control of leaf diseases in the field. Maintain dry storage conditions.
Yellow dwarf mosaic	Control aphids. Keep old and new plantings as far apart as possible.
Peas	
Seed rot, seedling and seed-borne diseases	Plant western-grown seed treated with captan, thiram, or zineb plus insecticide. Graphite at 1 ounce per bushel may be added to reduce friction in the drill.
Root rot	Index production fields. Avoid planting in fields with an index of 75 or higher. In fields with a lower root rot index, dinoseb (Premerge 3) or trifluralin applied preplant incorporated will provide good to excellent control.
Fusarium wilt, near wilt, and virus diseases	Grow resistant varieties.
Powdery mildew	Apply lime-sulfur dust (4:6 ratio) at 30 pounds per acre when mildew first appears and temperatures are less than 80° F. Two applications a week apart will provide good control.
Fungal leaf spots and blights	Apply zineb weekly when necessary.
Peppers	
Seed rot, damping-off, and seed-borne diseases	Treat seed with hot water or a sodium hypochlorite (household bleach) soak, then use captan or thiram. The sodium hypochlorite soak will control seedborne bacterial spot. Use 1 part bleach to 3 parts water, soak 1 to 2 minutes. Use 1 gallon of bleach-water solution to 1 pound of seed. Rinse thoroughly before treating with fungicide.
Bacterial spot	Use crop rotations of 2-3 years, excluding small grains and tomatoes. Control broadleaf weeds in field borders. Apply copper plus streptomycin to seedlings. After transplanting, apply fixed copper plus maneb or mancozeb, on a 5- to 7-day interval. Purchase only certified, disease-free transplants. Planting peppers in narrow strips between early planted corn may help reduce spread during severe rain and wind storms.
Anthracnose, Cercospora leaf spot, other fungal leaf spots, and fruit rots	Apply maneb or zineb after first fruits form on a 5- to 7-day interval.
Verticillium wilt	Fumigate soil with Vapam, Vorlex, or methyl bromide plus chloropicrin.
Virus diseases	Grow resistant varieties. Control aphids and broadleaf weeds in and around fields. Plant only healthy transplants.
Potatoes (Irish)	
General	Purchase only certified seed. Seed-production fields should be inspected for virus, nematode, or fungal disease problems.
Seedpiece decay, seed-borne diseases, Verticillium wilt, and Blackleg	Treat seed with captan, maneb, mancozeb, or with TOPS 2.5D (Topsin plus Douglas fir bark). Keep seed storage at approximately 40° F. during the winter. In the spring, warm the seed to 60°-70° F. for 1.5-2 weeks before cutting. Streptomycin may be added to fungicide dusts to improve the control of bacterial diseases. Avoid bruising seed during handling.
Scab	Plant resistant varieties. Do *not* apply manure or other organic matter immediately before the potato crop. Working PCNB into the top 4-6 inches of the soil at or before planting may help.
Storage rots	Store healthy, sound, unbruised potatoes. Maintain a proper storage environment. Apply Mertect 340F as a spray to unwashed tubers before storage. This will help control Fusarium dry rot.
Rhizoctonia	Use a Terraclor EC soil treatment.
Verticillium wilt	Practice crop rotation, use only seed free of Verticillium. Control root-knot and root-lesion nematodes. Soil fumigation with Vapam or Vorlex may be practical.
Nematodes	Where soil samples indicate damaging levels of nematodes, apply Temik or Vydate, or fumigate with Vapam, Vorlex, D-D, or Telone C.
Early blight and late blight	Apply maneb, mancozeb, Difolatan, Bravo, Polyram, Du-Ter, or Dyrene on 7- to 10-day schedule. Maintain an adequate supply of nitrogen throughout the season to provide good control of early blight. Use Ridomil MZ58 only where late blight infection is present.
Virus diseases and Purple-top wilt (Aster yellows)	Plant certified seed only. Control aphids and leafhoppers with insecticides.
Rhubarb (greenhouse only)	
Botrytis leaf rot	Apply maneb or copper after budding and at weekly intervals until harvest.

CONDENSED RECOMMENDATIONS ON DISEASE MANAGEMENT (concluded)

Vegetable	Disease management practices
Crown and root rots	Plant only in well-drained soil. Maintain optimal soil fertility. Drench the crowns with fixed copper at 3 pounds per acre in the early spring and after harvest if crown rot is a problem.
Spinach	
Seed rot and damping-off	Treat seed with captan or thiram.
Downy mildew or blue mold, White rust, anthracnose, and other fungal leaf diseases	Grow resistant varieties or spray with captan, maneb, or zineb on a 5- to 7-day schedule starting before the plants begin to rosette.
Cucumber mosaic virus or blight	Grow resistant varieties.
Sweet potatoes	
Black rot, foot rot, Fusarium wilt and scurf	Grow resistant varieties. Plant disease-free roots and use crop rotations of 3-4 years. Dip the roots or sprouts in Botran or Mertect 340F.
Storage rots	Fumigate storage crates and houses with formaldehyde. Use Botran as a postharvest dip. Store only healthy, blemish-free roots.
Nematodes	Plant resistant varieties. Use crop rotation. Temik, Mocap, or Dasanit may be used for chemical control.
Tomatoes (field)	
Seed decay, damping-off, and seed-borne diseases	Plant hot-water- or sodium-hypochlorite-soaked seed that has been treated with captan or thiram. See treatment for pepper seed. Use Ridomil bed drench for Pythium damping off.
Bacterial spot and bacterial speck	Purchase certified, disease-free plants. Use crop rotations of 2-3 years, excluding small grains. In the seed bed, spray with fixed copper plus streptomycin. After transplanting, spray with fixed copper plus mancozeb. Once established, bacterial spot is difficult to control.
Septoria blight, early blight, buckeye rot, gray leaf spot, and leaf mold	Apply maneb, mancozeb, Polyram, zineb, Dyrene, Bravo, or Difolatan on a 7- to 10-day schedule after the first sign of disease or after the first fruits form. Difolatan may be used only on machine-harvested fruit. A soil surface spray of Difolatan or maneb after the last cultivation will improve anthracnose control. Benlate may be used for Botrytis and Septoria control.
Blossom-end rot	Mulch plants or maintain uniform soil moisture. Applications of calcium nitrate starting when the fruits are grape size may reduce losses.
Verticillium wilt and Fusarium wilt	Grow resistant varieties.
Viruses	Take care to avoid infesting the seedlings. Start with virus-free seed. Control insects and broad leaf weeds in and around fields. See greenhouse tomatoes below.
Tomatoes (greenhouse)	
Virus diseases	Start with hot water-treated seed. Do not allow the use of tobacco on the premises. Smokers should wash their hands with soap and hot water before working with plants. If possible, plant TMV-resistant hybrids. Control insects. Remove infected plants if possible.
Botrytis gray mold, leaf mold, and gray leaf spot	Avoid excessive humidity by heating and venting, especially at night during the late fall, early winter, and early spring. Spray weekly with Benlate, mancozeb, or Bravo *or* fumigate with Exotherm Termil.
Nematodes, root rots, and soil-borne TMV	Steam the plant beds.

GENERAL SUGGESTIONS ON FUNGICIDE APPLICATION

1. Cover the foliage uniformly. *Ground equipment* — Apply 75 to 125 gallons per acre at approximately 400 pounds per square inch of pressure. Lowering volumes and/or pressures may provide adequate coverage, but high-volume, high-pressure applications provide ideal coverage. Make sure the sprayer is functioning properly. Check the nozzles for cleanliness and wear. Boom, height, accuracy of pressure gauge, agitation, and calibration should also be checked. *Aerial application* — Apply recommended amounts of pesticide per acre in 3 to 5 gallons of water. Make sure nozzles are properly aligned and clean, so uniform application is achieved. Cover a swath no wider than is reasonable for the aircraft and boom being used. Spray only those fields which are suitable for aerial application. Avoid fields of irregular shape or topography, particularly if they are bounded by power lines, trees, or other obstructions.

2. Whenever possible spray when the air is still or when wind velocity is not excessive (less than 10 to 12 mph).

3. Avoid situations where pesticide drift may cause needless problems.

4. When it is compatible with the product label, use a spray adjuvant (surfactant). Some commonly available surfactants are: Colloidal Products X77 (liquid, non-ionic) spreader activator; Colloidal Products Multifilm L. (liquid); Colloidal Products Spray Modifier (liquid, non-ionic) spreader sticker; Millers Nufilm 17 liquid spreader sticker; Millers Nufilm P liquid spreader sticker; Allied Chemical Plyac (liquid) sticker; Rohm and Haas Triton B — 1956 (liquid, non-ionic) spreader sticker; Triton CS7, spreader-binder; and Du Pont Spreader Sticker (liquid) spreader sticker.

GENERAL SUGGESTIONS ON SOIL FUMIGATION

Follow the manufacturer's directions exactly. Fumigants work best in light, loose soils that are free of trash, clods, and lumps. Avoid recontaminating treated soil. It is best to apply fumigants during the fall before planting. In general, the soil temperature must be at least 55° F. at the 6-inch depth, with a time lapse of 21-28 days between treating and seeding. Some require gas-tight plastic covers.

1985 ILLINOIS COMMERCIAL SPRAY SCHEDULE

Apples, Peaches, Nectarines, Apricots, Plums, Pears, and Cherries

D. B. Meador, Extension Specialist in Horticulture
Roscoe Randell, Extension Specialist in Entomology
Stephen M. Ries, Associate Professor of Plant Pathology
Malcolm C. Shurtleff, Extension Specialist in Plant Pathology

CIRCULAR 1151 S SUPPLEMENT TO CIRCULAR 1151

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER FOR DILUTE SPRAYS	SPECIAL SUGGESTIONS
DORMANT TO GREEN TIP		
Scale insects, aphids, and red mites	SUPERIOR OIL, 2 gal.	Thorough coverage is the most important factor. Varieties susceptible to powdery mildew should be sprayed in dormancy so that a mildewcide can be used in ½-inch stage.
Scab	DIFOLATAN 4F, 3 qt. or 5 qt.	Application at the 5-qt. rate during silver tip but before ¼-inch green should control scab until calyx (or about 6 weeks, depending on rainfall). Difolatan will not control mildew or the rust diseases; therefore, these diseases on susceptible varieties will need additional control measures beginning at pink bud. On these cultivars the 3-qt. rate or an alternate fungicide (see green tip) is suggested. Application later than ¼-inch green tip will produce severe leaf injury.
Fire blight, black rot, and blotch	COPPER SULFATE, 4 lb., or 8-8-100 BORDEAUX	Mostly for varieties susceptible to fire blight. Use the copper sulfate during dormancy; the bordeaux-oil is best at silver tip. Difolatan and bordeaux are compatible with superior oil at this time of year. Do not apply oil after a Difolatan spray.
GREEN TIP THROUGH TIGHT CLUSTER		
Aphids	Systemic phosphate insecticide — plus —	Pests tolerant to currently used pesticides are appearing. Therefore we recommend alternating pesticides during the spray program and using labelled pesticide mixes.
Scab, powdery mildew	DODINE 65W (Cyprex), ⅜ to ½ lb. — or — DODINE 65W (Cyprex), ¼ lb., and Microfine wettable SULFUR, 5 lb.	On varieties susceptible to powdery mildew use Dikar, benomyl-captan, or include sulfur with dodine. It is important to provide trees with protective fungicides at 7- to 10-day intervals throughout this period. Scab and mildew control must begin at green tip.
	— or — DIKAR, 2 lb., and TRITON B1956, 3 oz.	Wetting agents increase the effectiveness of Dikar against powdery mildew.
	— or — BENOMYL 50W (Benlate), 2 to 3 oz., or THIOPHANATE-METHYL 70W (Topsin M), 2 to 3 oz., and CAPTAN 50W, 1 lb.	Use 2 oz. of benomyl for normal conditions and 3 oz. during severe scab pressure to deactivate scab. Never use benomyl alone. When benomyl is applied to deactivate scab lesions, combine it with protectant fungicides. Topsin M (thiophanate-methyl) can be substituted for benomyl. Topsin M is formulated as a wettable powder and will control the same diseases as benomyl.
	— or — TRIFORINE 18EC (Funginex), 1 pt.	Use triforine for "kick-back" action up to 96 hours after a scab infection period.
PINK BUD		
Scab, powdery mildew, cedar-apple rust	DIKAR, 2 lb., and TRITON B1956, 3 oz.	If the 3-qt. rate of Difolatan was used, now is the time to apply additional scab sprays.
	— or — BENOMYL 50W (Benlate), 2 to 3 oz., or THIOPHANATE-METHYL 70W (Topsin M), 2 to 3 oz., and MANCOZEB 80W, 12 oz., or POLYRAM 80W, 12 oz.	Rust control must start in this spray. Mancozeb (Manzate 200, Dithane M-45), Polyram, zineb, and ferbam are all good rust fungicides. Ferbam may affect fruit finish of Golden Delicious if used after calyx.
	— or — DODINE 65W (Cyprex), ¼ lb., and Microfine wettable SULFUR, 5 lb., and a rust fungicide	
	— or — BAYLETON 50W, 1 oz.	Bayleton, a new product, is very effective against rust diseases and powdery mildew but weak against scab. If scab is a problem, combine Bayleton with a good scab fungicide.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER FOR DILUTE SPRAYS	SPECIAL SUGGESTIONS
PINK BUD (continued)		
Curculio, leaf roller	AZINPHOSMETHYL 50W (Guthion), ⅝ lb.	Only necessary if curculio or leaf roller is severe or if other chewing insects are present. If fruit dimpling caused by tarnished plant bug is a problem, use a carbamate insecticide such as methomyl or Sevin. Pydrin or permethrin is effective in the pink bud stage. The control of white apple leaf hoppers and leaf miners is most effective at petal-fall.
For fertilizing	SOLUBOR, 1 lb.	This prevents a deficiency of boron, which affects pollen germination. If ground applications of boron are made, eliminate foliar application. See Circular 1151.
EARLY BLOOM		
Fire blight	STREPTOMYCIN, 50 or 100 ppm	On susceptible varieties start streptomycin at pink. Continue at 3-day intervals through bloom. Above 65° F. use 50 ppm; below 65° F., or when mixed with fungicides, use 100 ppm. Streptomycin uptake is enhanced by applying it as a dilute spray and by using spreader activators, such as glyodin, Regulaid, or glycerin, at 1 to 2 pints per 100 gal. Resistance to streptomycin is suspected in southwestern Illinois. Spray at recommended rates until petal-fall.
Scab, powdery mildew, and cedar-apple rust	Same as for PINK BUD	Fungicide applications are not recommended at full bloom as many injure pollen and may interfere with fruit set. During prolonged bloom, however, scab, mildew, and cedar-apple rust must be controlled. When simultaneous application of a fungicide and streptomycin is necessary, benomyl, captan, or glyodin should be used. Rust diseases have been extremely severe for the past few years. Maintain a strict schedule from pink bud to third cover.
CALYX AND FIRST COVER		
Codling moth, leaf roller, curculio, aphids	PHOSMET 50W (Imidan), 1½ lb., or AZINPHOSMETHYL 50W (Guthion), ⅝ lb.	Apply calyx spray when ¾ of the petals have fallen, and first cover, 7 to 10 days later. Imidan may be weak for leaf roller control. For leaf hopper and leaf miner control, apply a phosphate insecticide such as Lorsban that has had little or no past usage in the orchard or use a carbamate insecticide such as methomyl or Pydrin at a low dosage. Sevin and Vydate may thin fruit. Methomyl is safest on predatory mites. Vydate will also kill mites and leaf miners.
Scab, cedar-apple rust, blotch, powdery mildew, frog-eye, quince rust	— plus either —	
	POLYRAM 80W, 2 lb.	If the 5-qt. rate of Difolatan was used earlier, scab control fungicides must now be applied.
	— or —	
	DIKAR, 2 lb., and TRITON B1956, 3 oz.	Since Polyram will not control powdery mildew, choose another fungicide on mildew-susceptible varieties or combine a mildewcide (benomyl, sulfur, or dinocap (Karathane)) with Polyram. Thiophanate-methyl can be substituted for benomyl.
	— or —	
	BENOMYL 50W (Benlate), 2 or 3 oz., and MANCOZEB 80W, 12 oz., or POLYRAM 80W, 12 oz.	If quince rust has been a problem and the weather is wet, increase the rust fungicide to the full label rate.
Fire blight	STREPTOMYCIN, 100 ppm	Control blight in secondary bloom on susceptible varieties. The use of streptomycin after bloom for twig blight control is of limited value and is not recommended.
For thinning	See Circular 1151.	Summer varieties are best thinned at petal-fall. Fall and winter varieties are best thinned according to fruit size, preferably when king fruit is 10 to 11 millimeters in diameter.
For fertilizing	SOLUBOR, 1 lb.	Add to the calyx spray if there is no ground application of boron. See Circular 1151.
	UREA (45 percent N), 2 to 5 lb.	Use as needed in the first and third cover sprays. Do not use on Golden Delicious.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER FOR DILUTE SPRAYS	SPECIAL SUGGESTIONS
COVER SPRAYS (remainder of the season)		
All insects, diseases, and mites	AZINPHOSMETHYL 50W (Guthion), ⅝ lb. — plus either — POLYRAM 80W, 1½ lb. — or — DIKAR, 2 lb., and TRITON B1956, 3 oz. — or — BENOMYL 50W (Benlate), 2 oz., and CAPTAN 50W, 1 lb. — or — CAPTAN 50W, 1 lb., and ZINEB 75W, 1 lb.	As needed at 10- to 14-day intervals after the first cover. Alternate phosphate insecticides are phosmet (Imidan), phosalone (Zolone), malathion, parathion, or diazinon. Parathion and diazinon are outstanding for San Jose scale and spotted tentiform leaf miner. Red mites may need suppression through this period. Northern Illinois growers should be aware of apple maggot in late August. If cicadas are laying eggs, spray with carbaryl 50W, 2 lb. per 100 gal. water, every 7 days. Also use carbaryl for young grasshoppers in or near young orchards. Rust and powdery mildew control should continue through third cover. Folpet (Phaltan), 1½ to 2 lb. per 100 gal., should start at fifth cover if Botryosphaeria is serious.
Bitter pit and Jonathan spot	CALCIUM CHLORIDE, 2 lb. or 3 lb.	On Jonathan and Red Delicious add 2 lb. calcium chloride per 100 gal. in the third, fourth, and fifth cover sprays, 3 lb. in later sprays. Limit applications of calcium chloride on Golden Delicious to a trial basis. For low-volume sprays apply 4 lb. per acre in the third, fourth, and fifth cover sprays and 6 lb. per acre in later sprays. Add the calcium chloride last when preparing sprays. See Circular 1151.
GROWTH REGULATOR SPRAYS		
To increase "typeness" of Red Delicious	PROMOLIN, 1-1½ pt.	Apply 100 gal. of solution per acre when the kings are in full bloom or split the application, making one application at half rate when the kings are in full bloom plus another at half rate at petal-fall. The split application is preferred.
To increase red color of Jonathan, McIntosh	ALAR, 1 lb. and PROMOLIN, 1 pt.	Apply 100 gal. of solution per acre 60 to 85 days before normal harvest date.
To delay harvest, increase firmness and color	ALAR, 1 lb.	Apply 60 to 85 days before normal ripening date to McIntosh, Jonathan, and later varieties.
To advance harvest	ETHREL, 1 pint, and NAA, 10 ppm, and 2,4,5-TP, 10 ppm	Apply one to two weeks before desired harvest date to Jonathan and spur-type Red Delicious. Apply as a dilute spray with thorough coverage. Stop-drop materials must be applied with Ethrel. Works well on apples previously treated with Alar.
To prevent preharvest drop	See Circular 1151.	Alar applied to delay harvest acts as a stop-drop preventative. NAA and 2,4,5-TP may be applied when apples start to drop.

PEACHES, NECTARINES, APRICOTS

DORMANT		
Scale insects, red mites, leaf curl	SUPERIOR OIL, 2 gal., and 6-6-100 BORDEAUX — or — FERBAM 76W, 2 lb. — or — BRAVO 500, 1½-2 pt.	The oil controls scale and mites; the fungicide prevents the development of leaf curl. Thorough coverage in the fall or BEFORE buds start to swell in the spring is critically important for control of leaf curl. Dichlone 50W, 1 lb., is also effective against leaf curl, but it is not compatible with oil. Bravo is not compatible with spray oils. Do not apply oil after a Bravo spray.
PINK BUD		
Tarnished plant bug, curculio, oriental fruit moth	AZINPHOSMETHYL 50W (Guthion), ⅝ lb., or CARBARYL 50W (Sevin), 2 lb., or METHOMYL L (Lannate, Nudrin), 1½ pt.	Apply when buds show pink. *Must not be applied when any blossoms are open, as this will kill honey bees.* Azinphosmethyl is best for curculio. Pydrin or permethrin is good for control of tarnished plant bug and stink bug.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER FOR DILUTE SPRAYS	SPECIAL SUGGESTIONS
EARLY TO FULL BLOOM		
Brown rot blossom blight	BENOMYL 50W (Benlate), 4 oz., or THIOPHANATE-METHYL 70W (Topsin M), 4 oz., plus CAPTAN 50W, 1 lb.	Try to make two applications, one in early bloom and one in full bloom. *Do not use insecticides after first blossoms open.*
	— or —	Thiophanate-methyl 70W (Topsin M) is a relatively new fungicide in Illinois. Its spectrum of activity is identical to that of benomyl and it therefore should be used with the same precautions as benomyl (see below).
	Microfine wettable SULFUR, 3 lb., and DICHLONE 50W (Phygon), ¼ lb.	Fungi tolerant to currently used fungicides (benomyl and thiophanate-methyl) are appearing. We therefore recommend alternating fungicides in the spray program and using suggested fungicide mixes. Never use benomyl or thiophanate-methyl alone or in combination with each other. Always combine them with protectant fungicides.
	— or —	
	FUNGINEX 18EC, ¾-1 pt.	
PETAL-FALL THROUGH COVER SPRAYS		
Curculio, oriental fruit moth, stink bugs, red-banded leaf roller, and catfacing insects	AZINPHOSMETHYL 50W (Guthion), ⅝ lb., or PHOSMET 50W (Imidan), 1½ lb.	Parathion and diazinon are alternative insecticides and are especially effective against San Jose scale. For terrapin scale control, either add Systox to the regular spray when needed or use diazinon.
Brown rot and peach scab	— plus —	Where peach scab has been a problem, use sulfur, benomyl, thiophanate-methyl, or Bravo (chlorothalonil). Discontinue using Bravo at shuck-split, and substitute another scab control fungicide until 40 days before harvest.
	Microfine wettable SULFUR, 6 lb.	
	— or —	**A complete application is needed about every 14 days through this period. Normally, insecticides are not used after the first 2nd-brood curculio spray. Watch harvest restrictions. See borer control section.**
	BRAVO 4F, 1½-2 pt.	
Bacterial spot	MYCOSHIELD 17W, 150 ppm	**Mycoshield (oxytetracycline) should be applied on a strict 7-day schedule beginning at shuck-split and continuing until 3 weeks before harvest.**
	CAPTAN 50W, 1 lb., and DODINE 65W (Cyprex), ½ lb.	When warm, rainy weather prevails during early to mid-summer, bacterial spot may become serious. The combination of captan and dodine added to the cover sprays may help alleviate the problem.
To advance harvest	ALAR, 1½-2 lb.	**Apply as a dilute spray with full coverage just before pit hardening, when the peaches loosen and can be mechanically thinned. Alar advances harvest 3 to 5 days and promotes uniform ripening.**
PREHARVEST AND POSTHARVEST FUNGICIDES		
Brown rot	BENOMYL 50W (Benlate), 4 oz., or THIOPHANATE-METHYL 70W (Topsin M), 8 oz., plus CAPTAN 50W, 1 lb.	Brown rot becomes increasingly important as fruit begins to ripen; therefore, begin a 7-day spray schedule starting 4 weeks prior to harvest. Benomyl, captan, Funginex, dichlone, and sulfur all control this disease. During hot weather, sulfur applied just before harvest may reduce fruit finish. Alternate fungicides and observe harvest restrictions.
	— or —	
	TRIFORINE 18EC (Funginex), ¾-1 pt.	Do not use more than three applications of Funginex to control fruit rot.
***Rhizopus* rot**	— or —	**Botran is specific for *Rhizopus* rot and is best added to the hydrocooler water as a postharvest dip.**
	CAPTAN 50W, 2 lb., plus **BOTRAN 50W, 2 lb.**	

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER FOR DILUTE SPRAYS	SPECIAL SUGGESTIONS
BORER CONTROL		
Peach borer, lesser peach borer, American plum borer	ENDOSULFAN 50W (Thiodan) 1½ lb., or AZINPHOSMETHYL 50W (Guthion), ⅝ lb., or CHLORPYRIFOS 4E (Lorsban), 1½-2 pt.	Make two to four applications but adhere to harvest restrictions on the different varieties. July and August are the critical months. Thorough coverage of all wounds and gummy areas of all major branches is essential. This spray *must* be applied with a hand gun instead of the mist-blower type sprayer. Chlorpyrifos (Lorsban) should be applied to peach tree trunks up to scaffold limbs.
	PLUMS	
DELAYED DORMANT		
Scale insects, red mites, black knot	SUPERIOR OIL, 2 gal.	Apply before buds begin to open. The oil controls scale and mites. Prune out and burn all black knots during the dormant period.
PETAL-FALL THROUGH SECOND COVER		
Curculio, brown rot	AZINPHOSMETHYL 50W (Guthion), ⅝ lb. — plus — BENOMYL 50W (Benlate), 4 oz., plus CAPTAN 50W, 1 lb. — or — CAPTAN 50W, 2 lb.	Apply a spray every 10 to 14 days for three times, starting at petal-fall. Add a miticide if needed. For borer control follow the suggestions given under peaches. Alternate fungicides during the spray program. Dichlone (Phygon, Quintar) will provide excellent control of brown rot blossom blight. Thiophanate-methyl 70W (Topsin M) can be substituted for the benomyl but should be used in combination with captan or dichlone.
ADDITIONAL COVERS		
Brown rot	BENOMYL 50W (Benlate), 4 oz., plus CAPTAN 50W, 1 lb. — or — CAPTAN 50W, 2 lb.	Start these sprays about 3 weeks before harvest and apply about every 7 days. Alternate fungicides during the spray program.
	PEARS	
DELAYED DORMANT		
Pear psylla, scale insects, leaf spot	SUPERIOR OIL, 2 gal., and FERBAM 76W, 2 lb.	Apply just before buds begin to open.
BLOOM		
Fire blight	STREPTOMYCIN, 100 ppm	Three sprays 3 days apart, starting with the first blossoms. May be applied during the day for effective control. Be sure to continue on late blossoms. See early bloom section under apples.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER FOR DILUTE SPRAYS	SPECIAL SUGGESTIONS
CALYX THROUGH COVER SPRAYS		
Codling moth, curculio, leaf spot, scab	AZINPHOSMETHYL 50W (Guthion), ⅝ lb. — plus either — CAPTAN 50W, 1½ lb., or FERBAM 76W, 1½ lb.	Start calyx spray as soon as the petals have fallen and continue at 12- to 14-day intervals for at least 3 covers. Later, apply azinphosmethyl alone if psylla nymphs are visible on water sprouts.

CHERRIES

DORMANT		
Scale insects	SUPERIOR OIL, 2 gal.	Apply before the buds open.
FIRST AND SECOND COVER SPRAYS		
Brown rot, cherry leaf spot, curculio, slugs	AZINPHOSMETHYL 50W (Guthion), ⅝ lb. — plus either — CAPTAN 50W, 2 lb. — or — WETTABLE SULFUR, 6 lb. — or — DICHLONE 50W, ½ lb.	Start right after the shucks have fallen with the first cover. Apply a second cover spray 10 days later.
ADDITIONAL SPRAYS		
Cherry leaf spot	DODINE 65W (Cyprex), ½ lb., or CAPTAN 50W, 2 lb.	Apply immediately after harvest. One or two sprays should be adequate. Spray more if there is evidence of leaf spot. A phosphate insecticide may be needed if insects attack leaves. Borers should be controlled as suggested for peaches.

See the section on peaches, nectarines, and apricots for suggested borer sprays.

MITE CONTROL: It is important to avoid using insecticides that are toxic to predatory mites. If phosphate insecticides will kill plant-feeding mites, they will also kill predaceous mites. Miticides, however, may be more selective, and the following miticides can be used without killing predatory mites: DICOFOL (Kelthane), OMITE, OVEX, PLICTRAN, TETRADIFON (Tedion), and VENDEX. The miticide OXYMAL (Vydate) will kill all mites. Some fungicides, such as DIKAR and DINOCAP (Karathane), give mite suppression and allow good predatory mite survival. BENOMYL (Benlate) suppresses both types of mites. Where red mites have been a problem, use oil in the dormant spray.

RESTRICTIONS ON PESTICIDES USED ON TREE FRUITS: The following restrictions are those in effect as of December 1, 1984. Growers are urged to follow directions on the manufacturer's current label at all times. When mixing several pesticides in the same tank, use the time restriction with the longest interval.

Pesticide	Number of days between last application and harvest				
	Apples	Pears	Cherries	Peaches	Plums
Ambush, Pounce (permethrin)	J	14D	...	7	...
Bayleton	0	...	...	...	...
Benlate (benomyl)	0	0	0	0	0
Bordeaux	0	0	0	0	0
Botran	...	...	1H	1H	8
Bravo	...	...	...	K	...
Captan	0	0	0	0	0
Copper sulfate	0	0	...	...	...
Cyprex	7	7	0	15	...
Diazinon	14	14	10	20	10
Difolatan	A	A	...	...	...
Dikar	30	21	...	...	...
Dithane M-45 (mancozeb)	30	21	...	...	...
Ferbam	7	7	0	21	7
Funginex (triforine)	J	...	...	0	...
Glyodin	0	0	7	...	...
Guthion (azinphosmethyl)	15	15	15	21	15
Imidan	7	7	7	14	7
Karathane	21	21	...	45	...
Kelthane	7	7	7	14	7
Lannate, Nudrin (methamyl)	8	...	...	4	...
Lime sulfur	0	0	0	0	0
Lorsban	28	A	...	14	A
Malathion	3	3	3	7	3
Manzate 200 (mancozeb)	30	15	...	...	...
Mesurol	...	...	7D	21E	...
Mycoshield (oxytetracycline)	...	...	...	21	...
Omite	7D	7D	...	14C	28C
Ovex	...	...	...	7	...
Parathion	14	14	14	14	14
Phaltan (folpet)	0	...	...	...	...
Phosphamidon	30	...	...	...	...
Phygon (dichlone)	1	...	3	7	3
Plictran	14E	14E	...	E	E
Polyram	30	...	...	...	...
Pydrin	21F	A	...	14G	...
Quintar (dichlone)	1	...	B	7	...
Sevin	1	1	1	1	1
Streptomycin	50	30	...	...	...
Sulfur	0	0	0	0	0
Systox	21	21	...	30	30
Tedion	0,E	0,E	0,C	0,C	0,C
Thiodan	...	...	21C	30C	7C
Thiram (thylate)	0	...	...	7	...
Topsin M (thiophonate-methyl)	0	...	1	1	1
Trithion	30	30	...	...	...
Vendex	14D	14D	...	...	...
Vydate	14	...	...	...	...
Zineb	30	7	...	...	30

... Not recommended.
A. Dormant application up until ¼-inch green.
B. Do not apply when fruit is present — apply prebloom or postharvest.
C. Not more than 2 applications to fruit.
D. Not more than 3 applications to fruit.
E. Not more than 4 applications to fruit.
F. Not more than 2.1 lb. active ingredient per acre per season.
G. Not more than 1.5 lb. active ingredient per acre per season.
H. Can be used as a fruit dip.
J. Do not apply after petal-fall.
K. Do not apply after shuck-split.

Spray Chart for Some Important Diseases of Woody Ornamentals in Illinois

M.C. Shurtleff and H.W. Kirby

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
ALDER			
Powdery mildew	benomyl, 50% WP[2]	½	Spray 2 or more times, 7 to 10 days apart, starting when disease first appears.
	sulfur, 95% WP	2-3	
ALMOND - See Cherry			
AMELANCHIER (Shadbush, Serviceberry, Juneberry)			
Cedar rusts	ferbam, 76% WP	2	Spray 3 times at 10-day intervals, starting when new growth appears in the spring.
	thiram, 65-75% WP	1½-2	
	zineb, 75% WP	1½-2	
	mancozeb, 80% WP	1½-2	
Powdery mildew	Karathane, 22.5% WP	½	Spray when disease first appears or as leaves start to expand. Repeat 2 or 3 times 10 days apart.
	benomyl, 50% WP	½-1	
	sulfur, 95% WP	2-3	
	Bayleton, 25% WP	2-4 oz.	
APPLE - See Crabapple			
ARBORVITAE			
Phomopsis needle and twig blight	benomyl, 50% WP	1	Only new growth is susceptible. Spray whenever new growth appears and after shearing or wet weather. Spray at budbreak and then repeat at 10- to 14-day intervals until new growth has matured.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Root rot	Banrot, 40% WP	6-12 oz.	Apply in 100 gallons of water to 400 square feet of bed (or ½ pint per pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
ASH			
Anthracnose, Fungus leaf spots	copper[3]	See label	Apply when buds begin to open. Repeat 10 to 14 days later. Zineb, maneb, and mancozeb also control rust.
	zineb, 75% WP	1½-2	
	maneb, 80% WP	1½-2	
	benomyl, 50% WP	½-1	
	mancozeb, 80% WP	1½-2	
AZALEA - See Rhododendron			
BARBERRY			
Bacterial leaf spot and twig blight, Fungus leaf spot, blotch, and anthracnose	copper	See label	Spray 2 or 3 times, 10 days apart, beginning when new leaves appear in spring.
BASSWOOD - See Linden			
BEECH			
Fungus leaf spot	copper	See label	If severe, spray twice, 10 days apart, starting as the leaves begin to unfold.
Powdery mildew	Karathane, 22.5% WP	½	If severe, spray twice, 10 days apart, starting when mildew is first seen.
	benomyl, 50% WP	½-1	
	sulfur, 95% WP	2-3	
BIRCH			
Leaf blister	copper	See label	Spray once *before* buds swell in early spring.
	liquid lime-sulfur	2 gal.	
Anthracnose	benomyl, 50% WP	1	Spray twice, 10 to 14 days apart, starting at budbreak.
	zineb, 75% WP	1½-2	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Rust	zineb, 75% WP	2	Spray several times 10 days apart. Start about a week before rust normally appears.
	mancozeb, 80% WP	1½-2	
	Bayleton, 25% WP	2-4 oz.	
BITTERSWEET			
Powdery mildew	benomyl, 50% WP	½-1	If severe, spray 2 or 3 times at 10-day intervals, starting when mildew first appears.
	Karathane, 22.5% WP	½	
Fungus leaf spots	copper	See label	Spray twice, 10 days apart, starting as leaves unfold.
BOSTON IVY - See Ivy			
BOXELDER - See Maple			
BOXWOOD			
Canker or stem blight, Fungus leaf blights or spots	copper	See label	Spray 4 times: (1) while dormant after old leaves have been cleaned up and *before* new growth starts; (2) 10 to 14 days later; (3) when growth is half complete; and (4) in autumn when fall growth has ceased.
	liquid lime-sulfur	2 gal.	
Phytophthora root rot	etridiazol (Truban)	See label	Apply as drench around plants to saturate the soil. Repeat at 4- to 12-week intervals in spring and autumn.
	fenaminosulf (Lesan)	See label	
	metalaxyl (Subdue)	See label	
	Banrot, 40% WP	6-12 oz.	
BUCKEYE - See Horsechestnut			
BUSH HONEYSUCKLE			
Fungus leaf spots	copper	See label	Spray twice, 10 days apart, starting as the leaves unfold.
Powdery mildew	benomyl, 50% WP	½-1	Spray 2 or 3 times, 10 days apart. Start when mildew first appears.
	Karathane, 22.5% WP	½-1	

Plant and disease	Suggested fungicide	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
BUTTERNUT - See Walnut			
BUTTONBUSH			
Powdery mildew	benomyl, 50% WP	½-1	Make several weekly sprays. Start when disease first appears.
	sulfur, 95% WP	2-3	
	Karathane, 22.5% WP	½	
BUTTONWOOD - See Sycamore			
CATALPA			
Powdery mildew	benomyl, 50% WP	½-1	Spray when disease first appears. Repeat 10 and 20 days later.
	Karathane, 22.5% WP	½	
Fungus leaf spots	copper	See label	If severe, spray when leaves are unfolding, when leaves reach full size, and 2 weeks later.
CHERRY, PEACH (NECTARINE), PLUM, ALMOND, MAYDAY-TREE, CHERRY PLUM, CHERRY-LAUREL			
Black Knot	dodine, 65% WP	½-1	Spray as buds begin to swell. Repeat at pink bud, at full bloom, and 2 to 3 weeks later. Sanitation is important.
	zineb, 75% WP	1½-2	
	maneb, 80% WP	1½-2	
	benomyl, 50% WP	1	
	mancozeb, 80% WP	1½-2	
	Topsin-M	See label	
Brown rot, blossom and twig blight	benomyl, 50% WP	½-1	Spray when first blossoms open, during full bloom, and again at petal-fall. Thorough coverage is required.
	sulfur, 95% WP	5-10	
	captan, 50% WP	2	
	captafol (Difolatan 4F)	2	
	triforine (Funginex)	See label	
	Topsin-M	See label	
Leaf blister or curl, Plum pockets, Witches'-broom	captan, 50% WP	2	Spray once in late fall or *just before* buds swell in early spring.
	liquid lime-sulfur	2 gal.	
	ferbam, 76% WP	2	
	dodine, 65% WP	½-1	
	copper	See label	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Coccomyces leaf spot, blight, or shot-hole	folpet (Phaltan), 50% WP benomyl, 50% WP dodine, 65% WP captan, 50% WP Acti-dione PM Topsin-M	2 ½-1 ½-1 2 See label See label	Spray 4 times, 2 weeks apart. Start as buds are opening. Use Acti-dione *only* on non-bearing trees.
Perennial or Valsa canker	ferbam, 76% WP benomyl, 50% WP	2 ½-1	Delay pruning until buds open in spring. Spray just after pruning.
Powdery mildew	benomyl, 50% WP Karathane, 22.5% WP sulfur, 95% WP Acti-dione PM Topsin-M	½-1 ½ 1½-2 See label See label	Spray when mildew first appears. Repeat once or twice at 7- to 10-day intervals. Use Acti-dione *only* on non-bearing trees.
Rust	ferbam, 76% WP zineb, 75% WP sulfur, 95% WP	2 1½-2 4-6	Spray several times, about 10 days apart. Start about 2 weeks after petal-fall.
Scab, Shot-hole, Fungus leaf spots	benomyl, 50% WP sulfur, 95% WP captan, 50% WP Topsin-M zineb, 75% WP	½-1 3-6 2 See label 1½-2	Spray 3 to 5 times, 10 to 14 days apart, starting at petal-fall.
CONIFERS - See Pine			
COTONEASTER Fire blight	streptomycin formulations bordeaux mixture	See label 2-6-100	Apply during bloom at 5- to 7-day intervals. Do *not* use streptomycin on *C. racemifolia*; you may substitute bordeaux if temperature is above 65° F.
Scab	benomyl, 50% WP dodine, 65% WP	½-1 ½-1	Apply in spring as buds start to swell and repeat 2 to 3 weeks later.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Fungus leaf spots	benomyl, 50% WP	½-1	Spray several times 10 to 14 days apart. Commence at budbreak.
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
CRABAPPLE, APPLE, PEAR			
Cedar rusts (apple, hawthorn, quince)	chlorothalonil	See label	Spray as new growth appears and flower buds start to open. Repeat 3 or 4 or more times at 10-day intervals. (Also, see under Juniper).
	Zyban, 75% WP	1½-2	
	ferbam, 76% WP	2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	Bayleton, 25% WP	2-4 oz.	
	zineb, 75% WP	1½-2	
	Polyram, 80% WP	1½-2	
Scab, Fungus leaf spots and fruit rots, Sooty blotch and flyspeck	zineb, 75% WP	1½-2	Spray when growth first appears. Repeat 4 more times, 7 to 10 days apart until two weeks after petal fall. Thorough coverage of new growth is essential. Captafol (Difolatan 4F) is applied as a single application before bloom for control of primary apple scab. See label.
	benomyl, 50% WP	1	
	dodine, 65% WP	½-1	
	captan, 50% WP	2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	Polyram, 80% WP	1½-2	
	folpet, 50% WP	1½-2	
	Dikar, 76.7% WP	2	
	captafol (Difolatan 4F)	1½-2 pts.	
	Zyban, 75% WP	1½-2	
Fire blight	streptomycin formulations	See label	Spray when 20 percent of blossoms are open and repeat at 5- to 7-day intervals during bloom. Then apply weekly for 5 or 6 weeks. Best control obtained when spraying at night.
	copper	See label	
Powdery mildew	benomyl, 50% WP	½-1	Spray when disease first appears or as leaves start to expand. Repeat 2 or 3 times, 10 days apart.
	sulfur, 95% WP	6-8	
	Karathane, 22.5% WP	½	
	Dikar, 76.7% WP	2	
	Bayleton, 25% WP	2-4 oz.	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
CURRANT, ALPINE			
Anthracnose, Fungus leaf spots	benomyl, 50% WP	½-1	Spray 2 or 3 times, 10 to 14 days apart. Start at leaf emergence or when leaves are nearly expanded.
	ferbam, 76% WP	2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
DOGWOOD			
Fungus leaf spots, Leaf blotch, Anthracnose, Spot anthracnose, Flower and leaf blights	chlorothalonil	See label	Spray just before flower bracts are fully expanded. In wet years, repeat 2 or 3 more times 10 to 14 days apart.
	benomyl, 50% WP	1	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
	captan, 50% WP	2	
	folpet, 50% WP	2	
	Zyban, 75% WP	1½-2	
Powdery mildew	benomyl, 50% WP	½-1	Spray when mildew first appears. Repeat 7 to 10 days later if needed.
	Bayleton, 25% WP	2-4 oz.	
	Karathane, 22.5% WP	½-1	
ELM			
Anthracnose, Black leaf spot, other fungus leaf spots, Twig blight	sulfur, 95% WP	2-3	Spray 3 times, 10 to 14 days apart. Start when the leaf buds break open. Sanitary measures are important.
	copper	See label	
	zineb, 75% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	ferbam, 76% WP	2	
Dutch elm disease	metam or SMDC (Vapam Soil Fumigant)	See label	Soil treatment when disease first appears to prevent transmission by root grafts. Follow label directions.
	methoxychlor	See label	Apply just before budbreak to prevent inoculation by elm bark beetles.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Dutch elm disease (*continued*)	Arbotect 20-S[4]	See label	For *protective* treatment. Should be injected into elms more than 5 inches in diameter by a trained arborist *before* elms contract the disease or when trees are newly infected, and wilt symptoms are *less* than 5 percent. Apply before the removal of diseased branches and when leaves approach full size.
	or		
	MBC-phosphate-carbendazin[4] (formerly Lignasan BLP, now sold as Hopkins Correx Fungicide, Agway Elmosan, Pratt Elm Tree Noculate, Arboral Fungicide, and Lily/Miller Ulmasan)	See label	
EUONYMUS			
Fungus leaf spots, Anthracnose, scab	benomyl, 50% WP	½-1	Apply at budbreak or at first sign of disease. Spray 2 or 3 times at 7- to 10-day intervals. Sanitary measures are important.
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
	copper	See label	
Powdery mildew	Acti-dione PM	See label	Apply at first evidence of disease. Repeat at 7- to 10-day intervals. Follow label directions.
	Karathane, 22.5% WP	½-1	
	Bayleton, 25% WP	2-4 oz.	
	benomyl, 50% WP	½-1	
	triforine (Funginex)	See label	
Root rot	Banrot, 40% WP	6-12 oz.	Apply 100 gallons to 400 square feet of bed (or ½ pint per 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
EVERGREENS - See Fir, Juniper, Pine, Yew			
FIR			
Needle and twig blights, leaf casts	copper	See label	Spray 2 or 3 times, 15 to 30 days apart, starting when new needles are half grown.
Rusts	sulfur, 95% WP	3-5	Spray 2 or 3 times, 7 to 10 days apart. Start a week before rust usually appears.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Root rot	Banrot, 40% WP	6-12 oz.	Apply 100 gallons to 400 square feet of bed (or ½ pint per 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
FIRETHORN - See Pyracantha			
FORSYTHIA			
Fungus leaf spots	mancozeb, 80% WP	1½-2	Apply at budbreak and repeat at 7- to 10-day intervals as needed to keep foliage protected in damp weather.
	maneb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
	copper	See label	
HAWTHORN, RED HAW			
Leaf blight, scab, other fungus leaf spots	Polyram, 80% WP	1½-2	Apply 3 or 4 sprays at 7- to 10-day intervals, starting in early June. Extend the schedule during rainy seasons. Sanitation is important. Paul's Scarlet and English hawthorns are very susceptible. Maneb, chlorothalonil, mancozeb, zineb, and Polyram will also control rusts.
	captan, 50% WP	2	
	benomyl, 50% WP	1	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
	dodine, 65% WP	3/4	
	chlorothalonil	See label	
Cedar rusts	ferbam, 76% WP	2	Spray as new growth appears and flower buds start to open. Repeat 3 or 4 times at 7- to 10-day intervals.
	Bayleton, 25% WP	2-4 oz.	
	zineb, 75% WP	1½-2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	chlorothalonil	See label	
Fire blight	streptomycin formulations	See label	Spray when 20 percent of blossoms are open and at 5- to 7-day intervals during bloom. Do not use streptomycin on *C. mollis*.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Powdery mildew	Karathane, 22.5% WP	½-1	Spray twice, 10 days apart, starting when mildew first appears.
	benomyl, 50% WP	½-1	
	Bayleton, 25% WP	2-4 oz.	
HICKORY			
Anthracnose, Fungus leaf spot or blotch, scab, Spot anthracnose	benomyl, 50% WP	½-1	Spray 3 or 4 times, 7 to 10 days apart, starting as the buds break open. Sanitation is important.
	zineb, 75% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
HOLLY			
Fungus leaf spots, Tar spot, Anthracnose, Spot anthracnose	benomyl, 50% WP	½-1	Apply 3 or 4 sprays at 10- to 14-day intervals. Start as leaves begin to unfold. Sanitary measures are important.
	zineb, 75% WP	1½-2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	ferbam, 76% WP	2	
Leaf and twig blight, algae	copper	See label	Spray 3 or 4 times, 10 days apart. Start with the first autumn rains.
	zineb, 75% WP	1½-2	
Powdery mildew	sulfur, 95% WP	4-5	Apply at first disease appearance. Repeat at 7-day intervals as needed.
	benomyl, 50% WP	½-1	
	Karathane, 22.5% WP	½-1	
Root rot	Banrot, 40% WP	6-12 oz.	Apply 100 gallons to 400 square feet of bed (or ½ pint per 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
HONEYSUCKLE			
Herpobasidium leaf blight	copper	See label	Apply several sprays 7 to 10 days apart. Start when new growth appears. Only young leaves are infected.
	mancozeb, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
Powdery mildew	benomyl, 50% WP	½-1	Spray 2 or more times at weekly intervals. Start when disease first appears.
	sulfur, 95% WP	4-5	
	Acti-dione PM	See label	
	Karathane, 22.5% WP	½-1	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
HORSECHESTNUT, BUCKEYE			
Leaf blotch, Fungus leaf spot or blotch, Anthracnose, Spot anthracnose	benomyl, 50% WP zineb, 75% WP mancozeb, 80% WP maneb, 80% WP dodine, 65% WP chlorothalonil	½-1 1½-2 1½-2 1½-2 1-2 See label	Spray 3 or 4 times, 10 to 14 days apart, starting as the buds begin to open. Thorough coverage is required for control. Resistant species are available.
HYDRANGEA			
Fungus leaf spots, Rust	zineb, 75% WP chlorothalonil	1½ See label	Spray 3 times, 7 to 10 days apart. Start when new growth appears. Benomyl will *not* control rust.
Botrytis leaf and flower blight (gray-mold)	benomyl, 50% WP Botran, 50% WP chlorothalonil Ornalin, 50% WP	½-1 1-1½ See label 1-1½	Spray when symptoms first appear. Repeat twice weekly during rainy periods. Or apply Exotherm Termil dust in storage.
Root and stem rots (potted plants)	Banrot, 40% WP Lesan, 35% WP *or* Truban, *plus* benomyl, 50% WP	6-12 oz. ¼ See label 1	Drench established plants with mixture. Avoid overwatering.
Powdery mildew	benomyl, 50% WP Karathane, 22.5% WP	½-1 ½	Spray several times, 7 to 10 days apart. Start when disease first appears.
IVY, ENGLISH - See Flower diseases			
IVY (BOSTON, VIRGINIA CREEPER)			
Powdery mildew	benomyl, 50% WP	½-1	Spray several times at 7- to 10-day intervals. Start when disease first appears.
Leaf spots	ferbam, 76% WP	1½-2	Spray 3 times at weekly intervals. Start as new growth appears.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
JUNEBERRY - See Amelanchier			
JUNIPER, REDCEDAR			
Rusts	zineb, 75% WP	1½-2	Spray susceptible junipers 4 times, 10 to 20 days apart, starting in early July.
	ferbam, 76% WP	2	
	Polyram, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
Phomopsis twig blight	benomyl, 50% WP	1	Spray several times at 2-week intervals. Keep new flushes of growth protected. See Arborvitae.
Cercospora needle blight	copper	See label	Spray when disease first appears or after June 1; repeat at 7- to 10-day intervals.
Root rot	Banrot, 40% WP	6-12 oz.	Apply 100 gallons to 400 square feet of bed (or ½ pint per 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
LILAC			
Powdery mildew	benomyl, 50% WP	½-1	Spray several times at 2-week intervals. Start when disease first appears (usually in July).
	Karathane, 22.5% WP	½-1	
	triforine (Funginex)	See label	
	Bayleton, 25% WP	2-4 oz.	
Bacterial and Phytophthora blights	copper	See label	Spray 2 or 3 times at 7- to 10-day intervals. Start when new growth appears in spring.
LINDEN, BASSWOOD			
Anthracnose, Fungus leaf spots, Leaf blight, Spot anthracnose	copper	See label	Spray just after budbreak and again 10 and 20 days later. Sanitary measures are important.
	benomyl, 50% WP	1	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Powdery mildew	benomyl, 50% WP	½-1	Spray when mildew first appears. Repeat 10 days later.
	sulfur, 95% WP	4-6	
MAGNOLIA			
Powdery mildew	benomyl, 50% WP	½-1	Spray 2 or 3 times, 7 to 10 days apart. Start when disease first appears.
	Acti-dione PM	See label	
	Karathane, 22.5% WP	½-1	
Fungus leaf spot, Leaf blight	copper	See label	Spray twice, 10 days apart. Start as buds break open.
	plus		
	benomyl, 50% WP	½-1	
MAPLE, BOXELDER			
Anthracnose, Fungus leaf spots, Leaf blight or blotch, leaf scab, Tar spot, leaf blister	zineb, 75% WP	1½-2	Spray 3 or 4 times, 10 days apart, starting as the buds *begin* to open. For tar spot, spray just *before* buds swell in early spring. Sanitation is important.
	mancozeb, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
	benomyl, 50% WP	1	
MAYDAY-TREE - See Cherry			
MOUNTAIN-ASH			
Leaf blight, scab, Fungus leaf spots	benomyl, 50% WP	½-1	Spray 2 to 4 times, 10 days apart, starting as the leaf buds open.
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	
	maneb, 80% WP	1½-2	
	chlorothalonil	See label	
Rusts	zineb, 75% WP	1½-2	Apply 4 or 5 sprays, 10 days apart. Start as flower buds begin to open.
	mancozeb, 80% WP	1½-2	
Fire blight	streptomycin formulations	See label	Spray when 20 to 25 percent of blossoms are open and again at full bloom.
	copper	See label	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
MULBERRY			
Bacterial blight or leaf spot, Fungus leaf spot, False mildew	bordeaux mixture fixed copper	5-5-100 See label	Apply at budbreak and repeat at 7-day intervals during moist periods. If severe, spray twice, 10 days apart, starting as the leaves unfold.
Powdery mildew	benomyl, 50% WP Karathane, 22.5% WP	½-1 ½-1	Spray twice, 10 days apart. Start when mildew is first seen.
NECTARINE - See Cherry			
OAK			
Anthracnose, Fungus leaf spots and blights, Spot anthracnose, Leaf blotch, Leaf blister	chlorothalonil copper zineb, 75% WP benomyl, 50% WP dodine, 65% WP mancozeb, 80% WP maneb, 80% WP	See label See label 1½-2 1 1 1½-2 1½-2	Spray 3 times: just *before* buds open, when leaves are half grown, and 10 to 14 days later. Follow label directions. Sanitary measures are important.
Oak wilt	2,4,5-T[5]	4 lb. a.i. /gal. oil	Apply to deep girdle and axe cuts in roots to the point of runoff before 50 percent wilt of tree develops. Treatment kills infected trees; prevents spread to healthy oaks.
	metam or SMDC (Vapam Soil Fumigant)	See label	Soil treatment when disease first appears to prevent transmission to nearby healthy oaks through root grafts. Follow label directions.
PEACH - See Cherry			

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
PECAN			
Scab, fungus leaf spots, Leaf blotch and scorch, Spot anthracnose, Anthracnose	benomyl, 50% WP maneb, 80% WP mancozeb, 80% WP dodine, 65% WP Polyram, 80% WP Du-Ter, 47.5% WP	½-1 1½-2 1½-2 ½-1 2 ½	Apply 4 to 6 sprays, 10 to 14 days apart. Start when buds begin to open. Thorough coverage is required. Follow manufacturer's directions.
Powdery mildew	benomyl, 50% WP Du-Ter, 47.5% WP Karathane, 22.5% WP	½-1 ¼-½ ½-1	Spray when mildew is first seen. Repeat at 10- to 14-day intervals.
PHOTINIA			
Powdery mildew, Entomosporium leaf spot	benomyl, 50% WP sulfur, 95% WP triforine (Funginex) Bayleton, 25% WP	½-1 4-6 See label 2-4 oz.	Spray several times at 10- to 14-day intervals. Start when new leaf growth or disease first appears.
PINE			
Dothistroma needle blight	copper	See label	Spray twice: when new needles are just emerging and when new needles are fully expanded (6 to 8 weeks later).
Scirrhia brown spot and needle blight	copper mancozeb, 80% WP maneb, 80% WP chlorothalonil	See label 1½-2 1½-2 See label	Spray once or twice, 30 days apart, starting when new needles are half grown. If period is rainy, spray at 2-week intervals.
Lophodermium needle cast or blight	mancozeb, 80% WP maneb, 80% WP chlorothalonil benomyl, 50% WP	1½-2 1½-2 See label 1½-2	Spray 4 times, 2 weeks apart, starting in early July when the new needles are fully grown.
Diplodia tip blight or dieback	copper benomyl, 50% WP	See label 1	Spray 3 or 4 times, 10 to 14 days apart. Start just before budbreak.

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Scleroderris or Gremmeniella canker	chlorothalonil, 500	1½ qts.	Spray as new growth appears in spring. Repeat at 2-week intervals until early July, then monthly until early September.
Annosus root and butt rot	borax, 100% (dry, powdered)	1 lb./50 sq. ft. of stump surface	Cover fresh-cut stump surface immediately after felling tree. Sprinkle liberally and evenly.
Cylindrocladium blight	benomyl, 50% WP	½	Apply as a soil drench to seedling beds at 2- to 4-week intervals.
	ferbam, 76% WP	2	
Damping-off, root rot, Rhizoctonia needle blight	etridiazol (Truban)	See label	Drench around plants in nursery beds at 2- to 12-week intervals. See labels.
	Banrot, 40% WP	6-12 oz.	
	PCNB (Terraclor) *plus* metalaxyl (Subdue) (1:16 ratio)	See labels	Apply to nursery beds prior to seeding.
PLANETREE - See Sycamore			
PLUM - See Cherry			
POPLAR			
Leaf rusts	triforine (Funginex)	See label	Spray in early summer about a week before rust is expected and again 10 to 14 days later.
	zineb, 75% WP	2	
	mancozeb, 80% WP	2	
	maneb, 80% WP	2	
	sulfur, 95% WP	4-6	
Yellow leaf blister	zineb, 75% WP	2	Apply several weekly sprays when spots first appear on the lower leaves.
	mancozeb, 80% WP	2	
	maneb, 80% WP	2	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Powdery mildew	sulfur, 95% WP	4½-5½	Apply at first sign of disease. Repeat 2 or 3 times at 5- to 10-day intervals.
	benomyl, 50% WP	1	
PRIVET			
Anthracnose, Fungus leaf spot, Twig blight	ferbam, 76% WP	2	Spray several times at 10-day intervals, starting in midspring.
	benomyl, 50% WP	1	
Powdery mildew	Bayleton, 25% WP	2-4 oz.	Spray twice, 10 days apart. Start when mildew appears.
	benomyl, 50% WP	½-1	
	Karathane, 22.5% WP	½-1	
Root rot	Banrot, 40% WP	6-12 oz.	Apply 100 gallons to 400 square feet of bed (or ½ pint per 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
PYRACANTHA (Firethorn)			
Fire blight	streptomycin formulations	See label	Spray when 20 to 25 percent of blossoms are open and repeat at 5- to 7-day intervals during bloom.
	copper	See label	
Scab	benomyl, 50% WP	1	Spray 4 times: at budbreak, just before blossoms open, at petalfall, and 2 weeks later. Add a spreader-sticker to the spray mix.
	chlorothalonil	See label	
	mancozeb, 80% WP	1½-2	
QUINCE			
Fire blight	bordeaux mixture	2-6-100	Spray when 20 percent of blossoms are open; repeat when 75 percent are open. Do *not* use streptomycin on quince.
Rust, Scab, Fungus leaf spots	maneb, 80% WP	1½-2	Apply several sprays at 10-day intervals starting at budbreak.
	mancozeb, 80% WP	1½-2	
	zineb, 75% WP	1½-2	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
REDBUD			
Cercospora and other fungus leaf spots	copper	See label	If serious, apply at budbreak and repeat several times at 10-day intervals during the spring rainy period.
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
Botryosphaeria canker	benomyl, 50% WP		Treat wounds and pruning scars with ½ t benomyl in 1 gallon of tree-wound dressing.
REDCEDAR - See Juniper			
RED HAW - See Hawthorn			
RHODODENDRON, AZALEA			
Ovulinia petal or flower blight of azalea	Zyban, 75% WP	1½	Spray as flowers begin to open. Then apply benomyl at 5-day intervals; or apply zineb or mancozeb 3 times weekly during bloom. See labels.
	benomyl, 50% WP	1	
	zineb, 75% WP	1	
	mancozeb, 80% WP	1½	
	chlorothalonil	See label	
	Bayleton, 25% WP	¼-½	
Powdery mildew	benomyl, 50% WP	½-1	Spray several times at 7- to 14-day intervals. Start when disease first appears.
	Karathane, 22.5% WP	½-1	
	Bayleton, 25% WP	2-4 oz.	
Fungus leaf spots, Rusts, Leaf, flower, and stem galls	zineb, 75% WP	1½-2	Spray several times at 10-day intervals. Start at budbreak. Benomyl is *not* effective against rusts.
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	benomyl, 50% WP	½-1	
	ferbam, 76% WP	2	
	chlorothalonil	See label	
Bud and twig blight, Dieback	copper	See label	Make 3 sprays, 7 to 10 days apart, starting at budbreak.
	chlorothalonil	See label	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
Root and crown rot or dieback, wilt (*Phytophthora cinnamomi* and other fungi)	etridiazol (Truban)	See label	Apply as a drench around plants to saturate the soil. Repeat at 4- to 12-week intervals in spring and autumn. Follow label directions.
	fenaminosulf (Lesan)	See label	
	Banrot, 40% WP	6-12 oz.	
	metalaxyl (Subdue)	See label	
Cutting rot or dieback, Cylindrocladium root rot	benomyl, 50% WP	See remarks	Mix 1 part benomyl with 39 parts of root-inducing hormone powder by weight. Treat cut ends with mixture before "sticking" in rooting medium. Then drench soil as for root and crown rot or wilt.
	etridiazol (Truban)	See label	Apply as for root and crown rot or wilt.
ROSE			
Botrytis blight	benomyl, 50% WP	½	Mist flowers at 7- to 10-day intervals in moist weather. Do not apply Ornalin immediately after yearly cutback.
	Botran, 50% WP	See label	
	zineb, 75% WP	1	
	Ornalin, 50% WP	1-1½	
Black spot, Cane blight, Cankers, Spot anthracnose, Anthracnose, Fungus leaf spots	triforine (Funginex)	See label	Spray at 7- to 10-day intervals starting when new growth appears. Shorten spray interval to 5 or 7 days in rainy weather. Maneb, mancozeb, Polyram, triforine, and chlorothalonil also control rusts.
	chlorothalonil	See label	
	folpet, 50% WP	1½-2	
	maneb, 80% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	Polyram, 80% WP	1½-2	
	benomyl, 50% WP	1	
	zineb, 75% WP	1½-2	
	Zyban, 75% WP	1½	
	Topsin-M	See label	
Powdery mildew	benomyl, 50% WP	1	Spray at 7- to 14-day intervals, starting when new growth appears. Thorough coverage is required. Follow label directions.
	Karathane, 22.5% WP	½-1	
	Bayleton, 25% WP	2-4 oz.	
	Milban, 39% EC	32 oz.	
	Acti-dione PM	See label	
	triforine (Funginex)	See label	
	Zyban, 75% WP	1½	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
RUSSIAN-OLIVE			
Fungus leaf spots	copper	See label	Spray twice, 10 days apart, starting as leaves unfold.
	Bayleton, 25% WP	2-4 oz.	
SERVICEBERRY, SHADBUSH - See Amelanchier			
SPRUCE - See Pine			
SUMAC			
Fungus leaf spots	maneb, 80% WP	1½-2	Apply when disease is first seen. Repeat as needed at 7- to 10-day intervals during rainy spring periods.
	sulfur, 95% WP	4-6	
SYCAMORE, PLANETREE, BUTTONWOOD			
Anthracnose,[6] Fungus leaf spots, Leaf blight	chlorothalonil	See label	Spray 3 times: just before buds break open, at budbreak, and when leaves are expanded (10 to 20 days later). Thorough coverage is required.
	benomyl, 50% WP	1	
	copper	See label	
	mancozeb, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
	dodine, 65% WP	1	
	captafol (Difolatan 4F)	2 pt.	
	zineb, 75% WP	1½-2	
Powdery mildew	benomyl, 50% WP	½-1	Spray 2 or 3 times, 7 to 10 days apart, starting when disease first appears.
	sulfur, 95% WP	4-6	
	Bayleton, 25% WP	2-4 oz.	
Canker stain	benomyl, 50% WP	See remarks	Add ½ teaspoon per gallon to asphalt-base tree wound dressing.
TAXUS - See Yew			
TULIPTREE			
Fungus leaf spots	copper	See label	If severe, spray 2 or 3 times, 10 days apart. Start at budbreak.
Powdery mildew	benomyl, 50% WP	½-1	If severe, spray twice, 10 days apart, starting when mildew first appears.
	Karathane, 22.5% WP	½-1	

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
VIBURNUM			
Powdery mildew	benomyl, 50% WP	½-1	Spray 2 or more times, 7 to 10 days apart. Start when disease first appears.
	Karathane, 22.5% WP	½	
	Bayleton, 25% WP	2-4 oz.	
WALNUT, BUTTERNUT			
Anthracnose, Yellow leaf blotch, Fungus leaf spots or blights	benomyl, 50% WP	1	Spray 3 or 4 times at 2-week intervals, starting when the leaves begin to unfold. Thorough coverage is required.
	dodine, 65% WP	1	
	zineb, 75% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
Bacterial blight (of Persian or English walnut)	copper	See label	Spray 3 times: when flowering starts, at full bloom, and at petal-fall.
	streptomycin formulations	See label	
WILLOW			
Tar spot	copper	See label	Spray 3 times, 10 days apart, starting as the buds open. Zineb, maneb, and mancozeb also control rust. Sanitary measures are important.
Leaf blight, scab, Black canker, Spot anthracnose	zineb, 75% WP	1½-2	
	mancozeb, 80% WP	1½-2	
	maneb, 80% WP	1½-2	
	dodine, 65% WP	½-1	
Powdery mildew, Rust	sulfur, 95% WP	4-6	Apply 2 or more times, 7 to 10 days apart. Start when disease first appears.
	Bayleton, 25% WP	2-4 oz.	
WITCHHAZEL			
Powdery mildew	benomyl, 50% WP	½-1	Spray 2 or more times, 7 to 10 days apart. Start when disease appears.
	Karathane, 22.5% WP	½-1	
	sulfur, 95% WP	3-4	
Fungus leaf spot	copper	See label	If severe, spray twice, 10 days apart. Start as leaves begin to unfold.
	plus		
	benomyl, 50% WP	½-1	
VIRGINIA CREEPER - See Ivy			

Plant and disease	Suggested fungicides	Rate[1] (lb./100 gal. unless specified otherwise)	Application and remarks
YEW (*Taxus*)			
Twig blight	bordeaux mixture	4-4-100	Apply when new growth emerges. Repeat twice more at 7- to 10-day intervals.
ALL WOODY PLANTS			
Seed decay, Damping-off, Seedling blights, Root rots, nematodes	thiram, 42-75% WP	See remarks	Apply 2 ounces per pound of seed. If damping-off starts, drench seedbed (4 tablespoons per gallon) when first seen. Follow label directions. Captan and thiram do not control root rots or nematodes.
	captan, 50-75% WP	See remarks	
	methyl bromide or 2:1 methyl bromide and chloropicrin mixtures	See label	Apply under gas-proof cover several weeks prior to planting in nursery beds. Controls damping-off, root rots, and nematodes.
	fenaminosulf (Lesan)	See label	Apply as a soil drench after plants are set; repeat at 2- to 4-week intervals. Fenaminosulf, etridiazol, and metalaxyl control *only Phytophthora* and *Pythium*; may be combined with captan or thiram.
	etridiazol (Truban)	See label	
	Banrot, 40% WP	See label	
	metalaxyl (Subdue)	See label	
Wood rots or decays[7]	thiram, 75% WP	1	Apply thinly in an asphalt or other nonfortified tree wound prepparation. See also Additional Comment 2 on next page.
	benomyl, 50% WP	¼	
	denatured alcohol, 70% formaldehyde, 4%		Dip tools between trees to disinfect them.

Footnotes

[1]The rates given are based on hydraulic application. If using a mistblower, follow label directions.

[2]Whenever possible, benomyl should be alternated with another fungicide or mixed with it to avoid resistant strains or races of fungi from developing.

[3]Copper fungicides include fixed or neutral copper compounds and bordeaux mixture (usually 4-4-100 or 8-8-100).

[4]Arbotect 20-S and MBC-phosphate or carbendazin materials have not been fully tested by specialists in tree pathology; therefore, they cannot be recommended without reservations at this time. Infection through trunk wounds has led to woodstain and decay. The products are to be used by trained arborists and others acquainted with the identification of Dutch elm disease and with injection techniques.

[5]Do not use 2,4,5-T around the home, recreational areas, pond or ditch banks, or similar sites. This treatment helps prevent spread into nearby healthy trees. The chemical is illegal to use in most situations.

[6]Recommended for the leaf-blight stage of anthracnose only.

[7]Do *not* try to remove rotted (soft) tissues in order to fill cavities. Internal wounds break decay-resistant barriers. Do *not* bore holes through sound wood into rotted wood. Callus may close the outer opening, but the plant cannot close the inner opening. Decay fungi can thus pass the natural barrier.

1986 TURFGRASS PEST CONTROL

IMPROVED MANAGEMENT TECHNIQUES and new, more effective materials have made turfgrass culture a highly sophisticated technology. Proper irrigation, mowing, and fertilization practices remain the principal defenses against turfgrass pests, but it is sometimes necessary to control weeds, diseases, and insects with the intelligent selection and use of pesticides.

Pesticide formulations. Pesticides are active against one or more turfgrass pests. These chemicals are generally formulated as liquid concentrates — solutions (S) or emulsifiable concentrates (EC); as wettable powders (WP); and as granules (G). Liquid concentrates and wettable powders are usually added to water and applied to the turf with a sprayer. Granular materials can be applied with a fertilizer spreader.

Active ingredients. Pesticides must be accurately applied at correct rates to yield optimum results. Too little may control pests ineffectively; too much may injure the turf. The specific amount of material that should be applied depends upon the concentration of the pesticide (the "active ingredient") in the commercial preparation.

Concentration is usually expressed as a weight per unit volume or as a percent of the commercial preparation. For example, a 50 percent wettable powder is 50 percent active ingredients (a.i.) and 50 percent inert carrier. If the recommended rate of application is 12 pounds a.i. per acre, then 24 pounds of this commercial preparation are required to treat one acre. This is roughly equivalent to ½ pound per 1,000 sq. ft. (43,560 sq. ft. = 1 acre).

Liquid formulations generally list the number of pounds of the active ingredient per gallon (lb. a.i./gal.) on the pesticide label. For example, if the concentration is 4 lb./gal., then 1 quart of the product is required per acre to supply 1 pound of active ingredient per acre.

Precautions. Pesticides should be stored in their original containers with the label securely attached. Keep them in a cool, dry place that is inaccessible to children, pets, and irresponsible persons. **READ THE LABEL BEFORE USING THE PESTICIDE AND FOLLOW ALL INSTRUCTIONS CAREFULLY.** A few minutes spent studying the information on the label may prevent misuse and needless accidents.

WEED CONTROL

Herbicides control one or more plant species. They may be classified into one of three types — contact, systemic, or soil sterilant — depending upon the nature of their activity on plants.

Table 1. — Chemical Control of Broadleaf Weeds in Turf

	2,4-D[a]	MCPP[b]	Dicamba[c]	Combination of the three[d]
(S = susceptible; I = intermediate control; R = resistant)				
Black medic	R	I	S	S
Carpetweed	S	I	S	S
Chickweed, common	R	S-I	S	S
Chickweed, mouse-ear	R	S-I	S	S
Chicory	S	S	S	S
Daisy, oxeye	I	I	I	I
Dandelion	S	S-I	S	S
Dock, curly	I	I-R	S	S
Ground ivy	I-R	I	S-I	S
Hawkweed	S-I	R	S-I	S
Henbit	I	I	S	S
Knotweed	R	I	S	S
Lambsquarters	S	S	S	S
Mallow, roundleaf	I-R	I	S-I	S
Plantain, broadleaf	S	I-R	R	S
Plantain, buckhorn	S	I-R	R	S
Purslane	I	R	S	S
Red sorrel	R	R	S	S
Speedwell, creeping	R	R	R	I
Speedwell, purslane	I	I	I	S
Spurge, prostrate	I-R	I	S-I	S
Thistles	S-I	I	S	I
Violet[e]	R	R	R	R
White clover	I	S	S	S
Wild carrot	S	S-I	S	S
Wild onion	I	R	S-I	S
Woodsorrel, yellow	I	I	I	S
Yarrow	I	I-R	S	S

Note: Bromoxynil may be used at ⅜ lb./A. for broadleaf control in seedling or newly-established turf.

[a] A basic herbicide for use in combination with one or more of the others for broad-spectrum postemergence control of broadleaf weeds. Standard rate of application is 1 lb./A. Not recommended for use on bentgrass putting greens.

[b] Safe for use on bentgrass putting greens at ½ to 1 lb./A. during cool weather periods. Can apply to general turf at 1 lb./A. with 2,4-D.

[c] A very effective herbicide for broadleaf weed control when combined with 2,4-D or as a 3-way combination. Use at ¼ lb./A. with 2,4-D; use at ⅛ lb./A. with 2,4-D + mecoprop. Do not apply above roots of trees and shrubs.

[d] Premixed combinations of 2,4-D, MCPP, and Dicamba are commercially available (Trimec and Trexsan are two of the many products that are readily available).

[e] A combination of 2,4-D and triclopyr (Turflon D) can provide effective control of wild violets and other hard-to-control weeds.

Contact herbicides kill plant parts covered by the chemical. *Systemic herbicides,* absorbed by plant organs and translocated throughout the plant, may be either *selective,* killing certain weeds without injuring desirable grasses, or *nonselective,* controlling all vegetation.

Prepared by T. W. Fermanian, Assistant Professor, Department of Horticulture; M. C. Shurtleff, Professor, Department of Plant Pathology; and R. Randell, Professor, Agricultural Entomology.

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Glyphosate, a nonselective herbicide, is useful in renovating turfs infested with extensive populations of annual weeds. Glyphosate is also used to kill perennial weedy grasses, such as quackgrass, that cannot be controlled by selective herbicides. Because glyphosate has no residual soil activity, treated areas may be reseeded soon after application. Mecoprop is a selective herbicide used to control broadleaf weeds in turf.

Soil sterilants are chemicals that render the soil toxic to all plant life. How long the soil remains sterile depends upon the material used, the rate of application, and the prevailing environmental conditions that affect decomposition of the herbicide in the soil. Soil sterilants have no place in turfgrass management; however, they are useful in preventing plant growth under fences and other areas that are difficult to mow.

Herbicides may be applied to prevent weeds from infesting a turf or to control weeds already present. Ben-

Table 2. — Chemical Control of Weed Grasses in Turf

Weeds	Life length	Herbicide	Rate (lb. a.i. per acre)	Remarks
Annual bluegrass	annual or perennial	benefin (Balan)	3	Apply in late summer. Do not use on bentgrass putting greens.
		bensulide (Betasan)	10	Apply in late summer before the return of cool weather to prevent development of new plants. Fairly safe for use on bentgrass putting greens.
		DCPA (Dacthal)	12	Apply in late summer. Do not use on Cohansey or Toronto bentgrass putting greens.
		ethofumesate (Prograss)	1.5	Use on perennial ryegrass or bermudagrass turf only. Has both preemergence and early postemergence activity. Apply in early spring and late summer.
		pendimethalin (Scotts turf-weedgrass control)	1.5-3	Apply in late summer. Do not use on bentgrass turf.
Crabgrass Foxtails Barnyardgrass	annual	benefin (Balan)	2	Apply before emergence of crabgrass in early spring. Not recommended for use on bentgrass turf.
		bensulide (Betasan)	7.5	Apply before emergence of crabgrass in early spring. Higher rates may be necessary for control of foxtails.
		DCPA (Dacthal)	10	Apply before emergence of crabgrass in early spring. May injure bentgrasses and fine-leaf fescues.
		siduron (Tupersan)	12	Apply before emergence of crabgrass in early spring. Use at half the recommended rate in conjunction with seeding Kentucky bluegrass. May injure some bentgrasses and fine-leaf fescues. Do not use on bermudagrass.
		pendimethalin (Scotts turf-weedgrass control)	1.5-3	Apply before emergence of crabgrass in early spring. Do not use on bentgrass turf or *Poa annua* turf.
		organic arsenicals (DSMA, MSMA, etc.)	follow labels	Apply soon after emergence of crabgrass. Three applications at 7- to 10-day intervals are usually required. May cause some discoloration of the turf.
Goosegrass	annual	DCPA (Dacthal)	15	Goosegrass is harder to control than crabgrass; complete control is rarely achieved. Better control may result if an early application is followed by a second at half the rate in early June.
		oxadiazon (Ronstar)	3	Apply before emergence of crabgrass in early spring. Do not use on red fescue or bentgrass. Do not apply to wet turf.
		organic arsenicals (DSMA, MSMA, etc.)	follow labels	Apply soon after emergence. Three or more applications at 7- to 10-day intervals may be required for control. May cause some discoloration of the turf.
Bentgrass Nimblewill Tall fescue Quackgrass Bermudagrass	perennial	amitrole dalaphon glyphosate	4 10 2	These give nonselective control. Amitrole and dalapon may persist in the soil for up to 4 and 6 weeks, respectively. Overseeding should be delayed until chemical residues have dissipated. Glyphosate has no residual activity in the soil; repeated treatments may be necessary for complete control.
Nutsedge	perennial	bentazon	1	Treat soon after emergence before new nutlets form. Repeat application as necessary for control, up to a total of 3 lb. a.i. per acre per season.

sulide is a *preemergence* herbicide applied in spring to prevent development of crabgrass. Once the weed has germinated, DSMA may be used as a *postemergence* treatment to selectively control the crabgrass invader.

INSECT CONTROL

Insecticides are pesticides that reduce insect populations below levels that are injurious to turf. Although insecticide chemistry is quite varied, most of the commonly used materials act as contact poisons. Effective control is dependent upon ensuring contact between the insect and the insecticide. Control of soil-inhabiting insects (such as grubs) is best achieved by drenching the insecticide into the soil, whereas foliar-feeding insects (for example, sod webworms) should be controlled by a foliar spray with no irrigation or rainfall for at least 24 hours afterwards.

Most insecticide applications are for control — the insect is controlled after the early signs of injury have been observed. No single insecticide will control all insect pests found in turf. Identify the specific insect before attempting control with an insecticide. Learn to recognize early signs of insect injury to avoid wide-scale loss of turf.

DISEASE CONTROL

Fungicides are pesticides that kill or inhibit the growth of disease-causing fungi. Depending upon the manner in which they protect plants against infection, fungicides are of two general types: protective-contact and systemic.

Protective-contact fungicides are applied to seed, foliage, or soil to keep disease-causing fungi from entering plants. This kind of fungicide must be applied fairly frequently to turf (7- to 21-day intervals) since mowing and irrigation remove much of the surface chemical soon after application. Relatively high spray volumes (5 gal. water per 1,000 sq. ft.) are required to supply uniform and continuous coverage of the foliage by the fungicide. Adding spreader-stickers (surfactants) to the spray mixture facilitates good foliar coverage. Most of the available fungicides for turf are the protective-contact type.

Systemic fungicides, or chemotherapeutants, are absorbed and distributed within the plant, destroying established infections and controlling certain diseases for several weeks or months. These fungicides are absorbed principally by the roots and hence should be drenched or watered in for best results. Examples of systemic fungicides are benomyl (Tersan 1991), chloroneb (Terraneb SP), and etridiazole (Koban).

Table 3. — Chemical Control of Insects

Insect	Insecticide[a]	Formulation[b]	Suggestions
Annual white grubs Ataenius grubs	diazinon trichlorfon (Dylox, Proxol) isofenphos (Oftanol) bendiocarb (Turcam)	EC or G SP or G G or EC WP	Apply as spray or granules to small area and then *water in thoroughly* before treating another small area. Grub damage will usually occur in late August and September. Ataenius grubs occur in June, July, and September.
Cicada killer and other soil-nesting wasps Ants	diazinon	EC or G	Apply as spray or granules and water in thoroughly. For individual nests pour 1% diazinon in nest and seal in with dirt.
Sod webworms	carbaryl (Sevin) diazinon chlorpyrifos (Dursban) trichlorfon (Dylox, Proxol)	WP or G EC or G EC or G SP or G	Webworms usually damage lawns in late July and August. As sprays, use at least 2½ gal. water per 1,000 sq. ft. Do not water for 72 hours after treatment. As granules, apply from fertilizer spreader.
Millipedes and sowbugs	carbaryl (Sevin) diazinon	WP or G EC or G	Spray around home where millipedes or sowbugs are crawling. If numerous, treat entire lawn.
Armyworms Cutworms	carbaryl (Sevin) chlorpyrifos (Dursban) trichlorfon (Dylox, Proxol)	WP or G EC or G SP or G	Apply as sprays or granules. Use 5 to 10 gal. of water per 1,000 sq. ft.
Chinch bugs	chlorpyrifos (Dursban) diazinon trichlorfon (Dylox, Proxol)	EC EC SP	Spray infested areas where chinch bugs are present.
Aphids	acephate (Orthene) chlorpyrifos (Dursban)	EC EC	Spray grass thoroughly.
Chiggers	diazinon	EC	Spray grass thoroughly.
Slugs	Mesurol	bait	Apply where slugs are numerous. Scatter in grass. For use only in flower gardens and shrubbery beds.

[a] Use one of the insecticides recommended for a given group of insects, being sure to use the proper dosage for the formulation chosen. Follow labels as to correct rate of application.

[b] E.C. = emulsion concentrate; W.P. = wettable powder; G = granules; SP = soluble powder.

Table 4. — Chemical Control of Turfgrass Diseases

Diseases[a]	Principal turfgrasses affected	Normal season and intervals of application	Fungicide preparations (oz. per 1,000 sq. ft.)[b]
"Helminthosporium" diseases			
Leaf spot, Melting-out (*Drechlera poae*)	**Kentucky bluegrass**	March-June; Sept.-Nov. 7 to 21 days	**Acti-dione RZ (1.2 oz.)** **Acti-dione Thiram (2 to 4 oz.)** **Acti-dione TGF (2 oz.)** Bromosan (see label) Chipco 26019 WP 50% (2 oz.) **Daconil 2787 WP 75% or 500 (4 to 11 oz.)** **Duosan WP 75% (4 to 6 oz.)** Dyrene or Dymec WP 50% (4 to 8 oz.) Fore or Formec 80 WP 80% (4 to 6 oz.) **Kromad WP (3 to 6 oz.)** **Manzate D WP 80% (4 to 8 oz.)** **PCNB (Terraclor) WP 75% (see label)** **Tersan LSR WP 80% (4 to 8 oz.)** **Vorlan WP 50% (2 oz.)**
Leaf spot, crown and root rot (*Bipolaris sorokinianum*)	**All turfgrasses**	May-Sept. 7 to 21 days	
Zonate eyespot (*Drechlera giganteum*)	**Bermudagrass** **Bluegrasses** Bentgrasses	June-Sept. 7 to 21 days	
Net blotch, crown and root rot (*Drechlera dictyoides*)	**Fescues** **Ryegrasses**	March-July 7 to 21 days	
Brown blight (*Drechlera siccans*)	**Ryegrasses**	April-June 7 to 21 days	
Leaf blotch (*Bipolaris cynodontis*)	Bermudagrass	March-June 7 to 21 days	
Red leaf spot (*Drechlera erythrospila*)	**Bentgrasses**	April-Sept. 7 to 21 days	
Summer patch and necrotic ring spot (***Phialophora graminocola* and *Leptosphaeria korrae***)	**Bentgrasses** **Bluegrasses** **Fescues** **Ryegrasses** **Bermudagrass**	April-Sept.	Banner (see label) *or* Bayleton WP 25% (4 to 8 oz.) *or* Chipco 26019 WP 50% (4 oz.) *or* Cleary's 3336 (6 to 8 oz.) *plus* Fungo WP 50% (4 to 8 oz.) *or* Rubigan WP 50% (2 to 4 oz.) *or* Tersan 1991 WP 50% (5 to 8 oz.)
Comments: **Apply when disease is expected or first appears. Repeat in 14 to 21 days if necessary. Drench fungicide into root zone using ½ inch (300 gal.) of water per 1,000 sq. ft. Water the turf thoroughly the day before (300 to 450 gal. water per 1,000 sq. ft.).**			
Dollar spot (***Lanzia* and *Moellerodiscus* spp.**)	**All turfgrasses**	**May-Nov. 7 to 14 days**	**Acti-dione Thiram (2 to 4 oz.)** **Acti-dione TGF (1 to 2 oz.)** Banner (see label) **Bayleton WP 25% (1 to 2 oz.)** Bromosan (see label) **cadmium compounds (see label)** **Chipco 26019 WP 50% (2 oz.)** **Daconil 2787 WP 75% or 500 (4 to 11 oz.)** **Duosan WP 75% (3 to 6 oz.)** Dyrene or Dymec WP 50% (3 to 8 oz.) **Fungo WP 50% (2 oz.)** **Kromad WP (3 to 6 oz.)** **Rubigan WP 50% (0.2 to 0.4 oz.)** **Tersan 1991 WP 50% (1 to 2 oz.)** **thiram WP 75% (4 oz.)** **Vorlan WP 50% (2 oz.)**
Red thread or pink patch (*Laetisaria fuciformis* and *Limonomyces roseipellis*)	**All turfgrasses**	**April-June; August-Nov. 7 to 14 days**	
Comments: Resistance to cadmium compounds, benomyl, thiophanate materials, Dyrene, and other fungicides has been reported in some areas. Using combinations of active ingredients or alternating between products is advisable.			
Rhizoctonia brown patch (*R. solani*)	**All turfgrasses**	**May-Oct. 5 to 14 days**	**Chipco 26019 WP 50% (2 oz.)** **Daconil 2787 WP 75% or 500 (3 to 11 oz.)** **Duosan WP (4 to 6 oz.)** Dyrene or Dymec WP 50% (4 to 8 oz.) **Fungo WP 50% (2 to 3 oz.)** **Kromad WP (3 to 6 oz.)** **Rubigan WP 50% (0.4 to 0.8 oz.)** **Tersan 1991 WP 50% (2 to 3 oz.)** Vorlan WP 50% (2 oz.)
Rusts: leaf and stem (*Puccinia* spp.)	**All turfgrasses, especially certain cultivars of Kentucky bluegrass, Perennial ryegrass, Zoysiagrass, and Bermudagrass**	**June-Oct. 7 to 14 days**	**Acti-dione Thiram (4 oz.)** **Acti-dione TGF (2 oz.)** **Bayleton WP 25% (1 to 2 oz.)** **Daconil 2787 WP 75% or 500 (4 to 11 oz.)** **Duosan WP 75% (4 to 6 oz.)** **Dyrene WP 50% (4 to 8 oz.)** Fore or Formec 80 WP 80% (2 to 4 oz.) **zineb WP 75% (2 to 4 oz.)**

[a] Causal fungus listed in parentheses.

[b] Denotes either fungicide, coined name of that material, or representative trade names. Mention of a trade name or proprietary product does not constitute warranty of the product and does not imply approval of this material to the exclusion of comparable products that may be equally suitable. Except where indicated, all materials should be applied in 3 to 5 gal. of water per 1,000 sq. ft. Use lower fungicide rates in *preventive* programs, higher rates for *curative* programs. Only one from each recommended group of preparations need be used. Fungicide use and restrictions are subject to change without notice. Always read and follow the current package label instructions and precautions.

Table 4. — Chemical Control of Turfgrass Diseases (continued)

Diseases[a]	Principal turfgrasses affected	Normal season and intervals of application	Fungicide preparations (oz. per 1,000 sq. ft.)[b]
Anthracnose (*Colletotrichum graminicola*)	All turfgrasses, especially annual bluegrass	June-Sept. 7 to 21 days	**Bayleton WP 25% (5 to 8 oz.)** **Daconil 2787 WP 75% or 500 (4 to 11 oz.)** **Duosan WP 75% (3 to 6 oz.)** **Fungo WP 50% (1 to 2 oz.)** Rubigan WP 50% (2 to 4 oz.) **Tersan 1991 WP 50% (1 to 2 oz.)**
Leaf smuts Stripe smut (*Ustilago striiformis*) Flag smut (*Urocystis agropyri*)	All turfgrasses, especially certain bentgrasses, bluegrasses, and ryegrasses	Oct.-Nov.	Bayleton WP 25% (6 to 8 oz.) *or* Fungo WP 50% (6 to 8 oz.) *or* Rubigan WP 50% (4 oz.) *or* Tersan 1991 WP 50% (6 to 8 oz.) *plus* PCNB (Terraclor) WP 75% (see label)
Comments: Make two applications, 14 to 21 days apart. Drench fungicide into soil, using 1 inch (600 gal.) water per 1,000 sq. ft., immediately after application.			
Powdery mildew (*Erysiphe graminis*)	Bluegrasses Bermudagrass Fescues	March-Nov. 7 to 14 days	**Acti-dione Thiram (2 to 4 oz.)** **Acti-dione TGF (1 to 2 oz.)** **Bayleton WP 25% (5 to 8 oz.)** **Fungo WP 50% (1 to 2 oz.)** **Tersan 1991 WP 50% (1 to 2 oz.)**
Snow molds Typhula blight (*T.* species) Fusarium patch (*F. nivale*)	All turfgrasses	Nov.-March see label for interval	**Bayleton WP 25% (5 to 8 oz.)** **Chipco 26019 WP 50% (2 to 4 oz.)** **Calo-clor, Calo-Gran (see label)[c]** **Daconil 2787 WP 75% or 500 (8 to 11 oz.)** PCNB (Terraclor) WP 75% (see label) **Rubigan WP 50% (2 to 4 oz.)** Teremec SP or Terraneb SP WP 65% (6-9 oz.)
Pythium blight, grease spot, spot blight (many *P.* species) *Comments:* Apply fungicide in 10 gal. water per 1,000 sq. ft.	All turfgrasses	April-Nov. 5 to 10 days	**Banol WP 65.5% (1⅓ to 4 oz.)** **Koban WP 35% (4 to 8 oz.)** **Subdue 2E WP 25% (1 to 2 oz.)** **Terrazole WP 35% (4 to 8 oz.)** Teremec SP or Terraneb SP WP 65% (4-6 oz.)
Fairy rings (*Marasmius oreades, Agaricus* or *Psalliota campestris, Chorophyllum* [*Lepiota*] species)	All turfgrasses		**methyl bromide** **chloropicrin** **Vapam Soil Fumigant** **Vorlex** **formaldehyde**
Comments: Soil temperature should be above 60° F. for fumigation. Cover area with gas-proof cover for several days, *or* instead of treating with fungicide, use root feeder attachment on hose to drench rings with water. Repeat when symptoms reappear.			
Seed rot, damping off, seedling blights (*Pythium* sp., *Fusarium* sp., *Rhizoctonia solani, Helminthosporium* sp., *Colletotrichum graminicola*)	All turfgrasses	Treat seed before planting.	captan *or* thiram 50% to 75%, *plus* Koban WP 35% *or* Apron (see label)
		Spray at early seedling emergence and 7 to 10 days later (see labels).	Koban WP 35% *or* Subdue 2E WP 25% *plus one of these:* captan WP 50% Chipco 26019 WP 50% Dyrene *or* Dymec WP 50% **zineb WP 75%**
Nematodes (many genera and species)	All turfgrasses	fenamiphos (Nemacur), ethoprop (Mocap, Proturf Nematicide, or fensulfothion (Dasanit): granules.	
Comments: Follow the manufacturer's directions carefully. Follow nematicide immediately with at least ½ inch of water to ensure penetration into soil to prevent toxic effects. Treat in fall or spring (or both, if nematodes are a serious problem) when soil temperature is above 55° F. Aerifying turf before application improves results. *Do not apply to newly seeded areas.* For use only by certified pesticide applicators.			
Slime molds (*Physarum cinereum, Fuligo* sp., *Mucilago spongiosa, Stemonitis* spp.)	All turfgrasses	May-Sept. Mow, rake, pole, or hose down to remove mold when seen. Controlled by any fungicide listed for "Helminthosporium" diseases.	
Algae, green or black scum	All turfgrasses	Apply when first seen; reapply as needed.	copper sulfate (1 to 2 oz.) **Daconil 2787 WP 75% or 500 (4 to 11 oz.)** Fore *or* Formec WP 80% (4 to 6 oz.)
Moss	All turfgrasses	Apply when first seen; reapply as needed.	ferrous ammonium sulfate (1 to 4 lbs.) ferric sulfate (1 to 4 lbs.)

[c] **Cleared for use *only* on golf course greens, aprons, and tees by certified golf course superintendents.**

Disease Control Programs for Flowers and Other Nonwoody Ornamentals

M.C. Shurtleff and H.W. Kirby

Table 1. General Instructions for Most Ornamentals*

Disease	Chemicals for control	Remarks
Damping-off Seed rot or decay Seedling blights	captan, metalaxyl (Subdue and Apron), etridiazol (Truban or Terrazole), Banrot	Apply captan or Apron as a seed treatment any time before planting. Grow plants in sterilized (pasteurized) soil wherever feasible. Metalaxyl, Banrot, and etridiazol are mixed into soil or applied as drenches.
Storage decay	zineb, captan, Botran, or benomyl	Spray, dust, or dip plants, bulbs, corms, and other plant parts before shipping or placing in storage.
Cutting rots Damping-off Seedling blights Crown (foot) and stem rots Root rots	PCNB (Terraclor), captan-PCNB mixtures, Banrot, benomyl (Benlate), or PCNB-etridiazol (SA Terraclor Super-X)	For *Botrytis*, *Rhizoctonia*, *Sclerotinia*, and *Sclerotium* stem and root rots *only*. Apply as a soil drench (1 pint per sq. ft.) or work into upper 2 to 4 inches of soil before planting. Check labels for crop registrations.
	fenaminosulf (Lesan), etridiazol (Truban or Terrazole), Banrot, metalaxyl (Subdue), or PCNB-etridiazol (SA Terraclor Super-X)	For *Aphanomyces*, *Phytophthora*, and *Pythium* stem and root rots (water molds) *only*. Usually applied as a soil drench at intervals of 2 to 8 weeks. Check label instructions. Sometimes combined with PCNB (Terraclor) or other fungicide.
Leaf, stem, and flower spots or blights caused by fungi	benomyl *plus* captan, zineb, maneb, mancozeb, ferbam, folpet (Phaltan), chlorothalonil (Daconil 2787, Exotherm Termil), or vinclozolin (Ornalin), or iprodione (Rovral)	Benomyl *plus* captan, zineb, folpet, chlorothalonil, or mancozeb also gives *Botrytis* control, as does vinclozolin and iprodione. Applications are needed at intervals of 5 to 7 days in rainy weather and every 7 to 10 days in drier weather. Check labels for specific information and crop registrations.

*For more specific details, see Table 2.

Table 1. (continued)

Disease	Chemicals for control	Remarks
Rusts	zineb, maneb, mancozeb, ferbam, oxycarboxin (Plantvax), triadimefon (Bayleton), or bitertanol (Baycor)	Applications are usually needed at intervals of 7 to 10 days starting when rust *first* appears. Check labels for current crop registrations.
Powdery mildews	benomyl, sulfur, dinocap (Karathane), triforine (Funginex), triadimefon (Bayleton), or cycloheximide (Acti-dione PM)	Frequent applications and thorough coverage are essential. Cycloheximide, sulfur, and dinocap may cause plant injury, especially in hot weather (85° F. or above). Check labels for current crop registrations.
Bacterial flower, leaf, and shoot blights	streptomycin formulations or copper fungicide	Strictly follow manufacturer's directions or plant injury may result. Note label restrictions.
Wilt diseases (most *Fusarium* and *Verticillium)* Crown and root rots Fasciation Crown gall	steam (180° F. for 30 minutes or 160° F. for 1 hour) or fumigate soil with methyl bromide, chloropicrin, Vorlex, or Vapam Soil Fumigant	Treat soil several days to a month before planting. Carefully follow the manufacturer's directions as chemicals are *very* toxic and some may be used only by licensed commercial applicators. Also treat containers, benches, work surfaces, potting table, tools, and other equipment. Galltrol-A and Norbac 84-C are new crown gall controls. See label for Vydate uses.
Soil nematodes (including root-knot and root-lesion nematodes)	Same as wilt diseases (above) or apply 1,3-D (D-D), ethylene dibromide (EDB), or oxamyl (Vydate)	
Foliar nematodes	Same as wilt diseases (above) or use oxamyl (Vydate)	For application by certified, commercial applicators ONLY. Carefully follow all label directions and precautions. See label for Vydate uses.
Viruses, Viroids, Mycoplasmas	Apply insecticides at frequent intervals to keep the insects from feeding, as recommended by University of Illinois Extension entomologists	Control insects--especially leafhoppers, aphids, and thrips--that transmit the causal agents. Rogue the first infected plants. Keep down broadleaf weeds.

Table 2. Instructions for Specific Flowers

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
African violet				
Botrytis blight	chlorothalonil	See label		Spray at 1- to 2-week intervals during cool, damp, overcast weather. In greenhouses, may use Exotherm Termil.
	benomyl, 50% WP	1/2 lb.	2 t	
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Apply at 10- to 14-day intervals; more frequently when disease is severe. Add a spreader-sticker to the spray. Do *not* apply Karathane to open flowers.
	Karathane, 22.5% WP	1/4 lb.	1 t	
Crown and stem rots	Lesan, 35% WP, or	1/4 lb.	1 t	Drench established plants *once*. You can purchase the fungicides separately or as a combination mix. Repeat at 4- to 8-week intervals as needed.
	Truban *plus*	See label		
	PCNB (Terraclor), 75% WP, or	1/2 lb.	1 T	
	Banrot, 40% WP	6 to 12 oz.	---	
Ajuga				
Sclerotium (crown) rot or southern blight	PCNB (Terraclor), 75% WP,	See label		Apply 2 lb. PCNB/1,000 sq. ft. as dust on soil surface before planting. Thoroughly work into top 2 inches of soil. See label for Banrot applications.
	Banrot, 40% WP	6 to 12 oz.	---	
Amaryllis				
Red blotch or leaf scorch	Copper oxychloride	See label		Keep the foliage protected during wet periods. To ensure coverage, add a spreader-sticker to the spray mix.
Aster, China				
Botrytis blight (bud and stem rot and petal blight), and powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	For Botrytis petal blight, spray weekly, starting when the buds form. For mildew, start spraying when disease first appears. Apply benomyl sprays to seedlings at 2-week intervals to control Botrytis stem rot.
	chlorothalonil	See label		

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Aster, China (cont.)				
Rust, and fungal leaf spots	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray at 7- to 10-day intervals. Begin when disease first appears. Add a spreader-sticker to the spray mix.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	Bayleton, 25% WP	2 to 4 oz.	See label	
Rhizoctonia stem (crown) and root rot	PCNB (Terraclor), 75% WP	1/2 lb.	1/2 T	Thoroughly drench soil *once* using a 1 pint to 1 qt. per sq. ft. and/or rotate plant beds. Spray the base of seedlings with benomyl, 50% WP (1 t/gal. of water).
	Banrot, 40% WP	6 to 12 oz.	---	
Sclerotinia or cottony stem rot	benomyl, 50% WP	1/2 lb.	2 t	Spray the stems and soil surface at 2- to 4-week intervals during cool, rainy, and overcast periods.
Root rots	Lesan, 35% WP	See label		Drench seedlings and older plants at 2- to 4-week intervals using 1 pint to 1 qt. per sq. ft. of bed.
	Banrot, 40% WP	6 to 12 oz.	---	
Aster yellows	Apply recommended insecticide at frequent intervals.			Spray weekly, starting about mid-June. Six-spotted leafhoppers are vectors of the aster yellows mycoplasma. Or grow plants under 22-thread cloth to keep out insects.
Begonia				
Botrytis blight, leaf spot, and stem rot, and other fungal leaf spots	benomyl, 50% WP	1/2 lb.	2 t	Spray at least weekly during cool, damp, overcast weather. In greenhouses, may use Exotherm Termil according to directions on the container label.
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
	chlorothalonil	See label		
	Zyban, 75% WP	1-1/2 lb.	---	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray at 7- to 14-day intervals, starting when mildew *first* appears. Add a spreader-sticker to the spray mix.
	Karathane, 22.5% WP	1/4 lb.	1 t	
	Acti-dione PM, 0.027% WP	See label		
	Bayleton, 25% WP	2 to 4 oz.	See label	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Begonia (cont.)				
Root and stem or crown rots	PCNB (Terraclor), 75% WP	See label		Apply monthly drenches to plants and soil; do *not* apply to very young seedlings. Follow manufacturer's directions.
	plus			
	Lesan, 35% WP, or	See label		
	Truban, 30% WP, or	See label		
	metalaxyl (Subdue)	See label		
	Banrot, 40% WP	6 to 12 oz.	See label	
Damping-off, and tuber rot	captan, 50% WP	4-1/2 lb.	4 T	Soak clean, disease-free tubers of tuberous begonias for 30 minutes; then drain and plant in well-drained soil.
Bacterial leaf spot	Kocide 101, 77% WP	See label		Keep foliage protected. Avoid wetting the foliage when watering.
Calendula				
Fungal leaf spots	benomyl, 50% WP	1/2 lb.	2 t	Spray or dust foliage and flowers at 7- to 14-day intervals. Start when disease *first* appears.
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Several spray or dust applications are usually needed, spread 7 to 10 days apart. Start when mildew first appears. Check label instructions and precautions.
	Karathane, 22.5% WP	1/4 lb.	1 t	
	sulfur, 95% WP	See label		
Rhizoctonia and Sclerotinia (or cottony) stem and root rots	PCNB (Terraclor), 75% WP	1 lb.	1 T	Apply Terraclor as a soil drench *once*, or work dust into the top 2 inches of soil about a week before planting. Apply benomyl as a drench to plants and soil.
	benomyl, 50% WP	See label		

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Calla				
Fungal rhizome and root rots	Lesan, 35% WP	See label		Thoroughly drench the soil at 4- to 8-week intervals, carefully following the manufacturer's directions.
Bacterial soft rot	formaldehyde, 38 to 40% L			Soak disease-free, dormant rhizomes for 1 hour (1 part of formaldehyde in 49 parts of water) before planting.
Carnation				
Alternaria branch rot and leaf spot, greasy blotch, and other fungal leaf spots	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Use zineb or mancozeb and captan or folpet in alternate sprays at 7- to 10-day intervals. Apply at first sign of disease. Add a spreader-sticker to spray to ensure wetting the foliage. Sanitary measures are important. Apply Zyban according to label directions.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	captan, 50% WP	2 lb.	2 T	
	folpet, 50% WP	1-1/2 lb.	1-1/2 T	
	Zyban, 75% WP	1-1/2 lb.	---	
Rust	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray at 7- to 10-day intervals with a spreader-sticker. Start with captan when cuttings are first stuck in the propagating bench. If rust is serious in greenhouses, add Plantvax (5 ppm) to the irrigation water.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	captan, 50% WP	2-1/2 lb.	2-1/2 T	
	Bayleton, 25% WP	2 to 4 oz.	See label	
	Plantvax, 75% WP	1 lb.	1 T	
Botrytis blight (or gray mold)	zineb, 75% WP	1 lb.	1 T	Apply at 7- to 10-day intervals in damp, cloudy weather. Start when disease first appears. During bloom, apply twice weekly. In greenhouses, may use Exotherm Termil.
	captan, 50% WP	1/2 lb.	1 T	
	benomyl, 50% WP	1/2 lb.	2 t	
	chlorothalonil	See label		
	Ornalin, 50% WP	1-1/2 lb.	---	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Carnation (cont.)				
Rhizoctonia stem rot	PCNB (Terraclor), 75% WP	1 lb.	1 T	Apply Terraclor or Banrot *once* as a preplant drench. Follow the manufacturer's directions. Spray base of cuttings (after they are stuck) or transplants with benomyl, 50% WP.
	benomyl, 50% WP	1 lb.	4 t	
	Banrot, 40% WP	6 to 12 oz.	See label	
Fusarium stem rot	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Alternate zineb and captan on a weekly basis. Drench soil with zineb (1/2 lb./ 50 gal./400 sq. ft. of bench). Spray cuttings in rooting medium with benomyl, 50% WP.
	captan, 50% WP	1-1/2 lb.	1-1/2 T	
	benomyl, 50% WP	1/2 lb.	2 t	
Pythium and Phytophthora root rots	Lesan, 35% WP	1/2 lb.	2 t	Apply as a soil drench at 4- to 8-week intervals using 1 gal./8 sq. ft. of bed; then water chemical in well.
	Banrot, 40% WP	6 to 12 oz.	---	
	Truban, 30% WP	See label		
Chrysanthemum				
Ascochyta stem and ray blight, and Septoria and other fungal leaf spots	mancozeb, 80% WP	1 lb.	1 T	Spray foliage and flowers at 5- to 7-day intervals during damp weather. Start when disease first appears. Add a commercial spreader-sticker (surfactant) to the spray to ensure wetting the foliage. Mix benomyl with another fungicide. Follow label directions.
	zineb, 75% WP	1 lb.	1 T	
	captan, 50% WP	1 lb.	1 T	
	chlorothalonil	See label		
	benomyl, 50% WP	1 lb.	1 T	
Rust	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray at 7- to 10-day intervals, starting a week before rust is expected.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	ferbam, 76% WP	1-1/2 lb.	2 T	
	Bayleton, 25% WP	2 to 4 oz.	See label	
Botrytis flower blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Spray foliage or mist-spray blooms weekly during cool, damp, overcast periods. Use fungicides at half strength on blooms. In greenhouses, may use Exotherm Termil.
	Ornalin, 50% WP	1-1/2 lb.	---	
	chlorothalonil	See label		
	Zyban, 75% WP	1-1/2 lb.	---	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Chrysanthemum (cont.)				
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray at 7- to 14-day intervals, starting when mildew first appears. Add a surfactant to the spray.
	Karathane, 22.5% WP	1/4 lb.	1 t	
	Bayleton, 25% WP	2 to 4 oz.	See label	
Root and stem or foot rots *(Pot mums)*	Lesan, 35% WP, or Truban, 30% WP *plus* PCNB (Terraclor), 75% WP	1/2 lb. See label 1/4 lb.	2 t 1 t	Make *one* soil drench application of Lesan or Truban *plus* Terraclor, 1/2 pint/6-inch pot. Irrigate immediately. Or apply Banrot strictly according to the manufacturer's directions as given on the package label.
	Banrot, 40% WP	6 to 12 oz.	---	
Root and stem or foot rots *(Field mums)*	Lesan, 35% WP, or Truban, 30% WP *plus* PCNB (Terraclor), 75% WP	1/2 lb. See label 3/4 lb.	2 t 1 T	Make *one* soil drench application, 100 gal./400 sq. ft. of bed. Or mix Banrot into top 2 inches of soil before planting. Mist-spray base of plants with Lesan, 35% WP *or* Truban, 30% WP *plus* benomyl, 50% WP (1 teaspoonful of each in a gallon of water).
	Banrot, 40% WP	6 to 12 oz.	---	
Rhizoctonia and Sclerotinia (or cottony) stem rots	benomyl, 50% WP	1 lb.	1 T	Spray the base of the transplants thoroughly and repeat the application 10 to 14 days later.
	Ornalin, 50% WP	1-1/2 lb.	---	
Aster yellows, and spotted wilt	Apply recommended insecticides at frequent intervals.			Spray at about weekly intervals. Six-spotted leafhoppers are vectors of the aster yellows mycoplasma; thrips transmit the spotted wilt virus.
Cineraria				
Botrytis blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Apply benomyl sprays at 7- to 10-day intervals during cool, damp, overcast weather. Sanitation is also important.
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray at 7- to 10-day intervals. Start when mildew is first evident. Karathane may damage open flowers.
	Karathane, 22.5% WP	1/4 lb.	1 t	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Cineraria (cont.)				
Root and crown rots	Lesan, 35% WP *plus* PCNB (Terraclor), 75% WP	1/2 lb. 1/4 lb.	2 t 1 t	Drench the soil *once* with the fungicide mix, using 1 pint/sq. ft. of bed or 1/2 pint/6-inch pot.
Clematis				
Ascochyta leaf spot and stem rot	benomyl, 50% WP sulfur, 95% WP	1/2 lb. 3 to 4 lb.	2 t 2 to 3 T	Spray the foliage thoroughly at 7- to 10-day intervals during rainy spring and early summer weather.
Cyclamen				
Botrytis blight or crown rot	zineb, 75% WP benomyl, 50% WP Ornalin, 50% WP	1-1/2 lb. 1/2 lb. 1 to 1-1/2 lb.	1-1/2 T 2 t ---	Spray at 7- to 10-day intervals during damp, overcast weather. Mist-spray blooms at 3- to 7-day intervals, but reduce the rate (benomyl 1/2 rate; zineb 1/3 rate). In greenhouses, may use Exotherm Termil. Follow manufacturer's directions when using Ornalin.
Fungal leaf spots	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray the foliage at weekly intervals during wet weather.
Stunt disease	ferbam, 76% WP	1-1/2 lb.	2 T	Spray at weekly intervals during damp, overcast weather.
Daffodil--See Narcissus				

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Dahlia				
Botrytis flower blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Mist-spray blooms weekly in cool, damp, overcast weather. Start when disease *first* appears. Add a commercial spreader-sticker (surfactant) to the spray to ensure wetting.
	zineb, 75% WP	3/4 lb.	3/4 T	
	mancozeb, 80% WP	3/4 lb.	3/4 T	
	Zyban, 75% WP	1-1/2 lb.	---	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray or dust the foliage at 7- to 10-day intervals, starting when powdery mildew first appears. Avoid applications in hot weather (temperatures over 80° to 85° F.). Apply benomyl at 10- to 14-day intervals.
	sulfur, 95% WP	3 to 4 lb.	2 to 3 T	
	Karathane, 22.5% WP	1/4 lb.	1 t	
	Acti-dione PM, 0.027% WP	See label		
	Bayleton, 25% WP	2 to 4 oz.	See label	
Delphinium, Larkspur				
Sclerotium root and crown rot, and Sclerotinia wilt	PCNB (Terraclor), 75% WP	1 lb.	1 T	Apply as a soil drench (1 pint/sq. ft.) after planting or to the base of established plants as new growth appears.
	Banrot, 40% WP	6 to 12 oz.	---	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray the foliage thoroughly at 7- to 10-day intervals, starting when powdery mildew first appears.
	Karathane, 22.5% WP	1/4 lb.	1 t	
Fungal leaf spots	ferbam, 76% WP	1-1/2 lb.	1-1/2 T	Spray at 7- to 10-day intervals. Start when the disease first appears. Sanitary measures are important.
Botrytis blight (or gray-mold)	chlorothalonil	See label		Spray the foliage and flowers at 7- to 10-day intervals during cool, damp, overcast periods. Reduce the fungicide rate when the plants are in flower.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	benomyl, 50% WP	1/2 lb.	2 t	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Delphinium, Larkspur (cont.)				
Black leaf spot	fixed copper, 50 to 56% Cu	See label		Drench soil at base of plants in fall. Spray young shoots in spring with fixed copper (2 T/ gal. of water).
Dieffenbachia				
Bacterial soft rot or stem rot	Streptomycin formulations	Apply at 200 parts/million		Dip cane cuttings. Carefully follow the manufacturer's directions as printed on the container label.
Fungal root and stem rots	Banrot, 40% WP	See label		Keep soil mix on the dry side.
Botrytis blight (gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Spray the foliage at 10-day intervals in cool, damp weather.
	Ornalin, 50% WP	1-1/2 lb.	---	
Bacterial leaf spot	Streptomycin formulations	Apply at 200 parts/million		Spray the foliage and canes during damp weather, starting when disease appears. Follow the manufacturer's directions.
English Ivy				
Fungus leaf spot and blight, stem spot, and twig blight	benomyl, 50% WP	1/2 lb.	2 t	Spray or dust several times at 7- to 10-day intervals. Keep the foliage protected during rainy spring and early summer weather. Start when the disease first appears.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	fixed copper, 50-56% Cu	See label		
Root rot	Banrot, 40% WP	See label		Keep soil mix on the dry side.
Botrytis blight (gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Spray the foliage at 10-day intervals in cool, damp weather.
	Ornalin, 50% WP	1-1/2 lb.	---	
Foliage plants				
Botrytis blight (gray-mold), and Sclerotinia blight	benomyl, 50% WP	1/2 lb.	2 t	Spray the foliage at 10-day intervals in cool, damp weather.
	Ornalin, 50% WP	1-1/2 lb.	---	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Foliage plants (cont.)				
Fungal cutting or stem rots	Banrot, 40% WP	6 to 12 oz.	---	Apply 100 gal. to 400 sq. ft. of bed (or 1/2 pint/ 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals. Apply *once* as a soil drench (1 pint/sq. ft.) to established plants. Water liberally.
	Lesan, 35% WP, or	1/2 lb.	2 t	
	Truban, 30% WP, or Subdue 2E	See label		
	plus	See label		
	PCNB (Terraclor), 75% WP	1/4 lb.	1 t	
Fungal leaf spots	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray at 10-day intervals during rainy periods. Start when disease appears. Add a spreader-sticker to the spray.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	Zyban, 75% WP	1-1/2 lb.	---	
	Kocide 101, 77%	See label		
Root rots	Banrot, 40% WP	6 to 12 oz.	---	Apply 100 gal. to 400 sq. ft. of bed (or 1/2 pint/ 6-inch pot). Irrigate immediately. Retreat at 4- to 12-week intervals.
Freesia				
Bacterial scab	thiram (Arasan), 50 or 75% WP	See label		Thoroughly dust corms before planting and again after cleaning and before putting in storage for the winter.
Botrytis blight (or gray-mold)	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray foliage and flowers at 7- to 10-day intervals in cool, damp, overcast weather. Follow container directions.
	benomyl, 50% WP	1/2 lb.	2 t	
	Ornalin, 50% WP	1-1/2 lb.	---	
Fuchsia				
Botrytis blight (or gray-mold)	chlorothalonil	See label		Spray at 7- to 10-day intervals in cool, damp, overcast weather. In greenhouses, may use Exotherm Termil.
	benomyl, 50% WP	1/2 lb.	2 t	
Rust	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray weekly starting when rust first appears.

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Gardenia				
Canker	ferbam, 76% WP	---	---	Mix 1/2 lb. ferbam with 100 lb. of sand for cutting bed, or spray rooted plants with ferbam (1-1/2 lb./100 gal. or 2 T/gal.). Spray at 10-day intervals to keep plants protected.
Fungal leaf spots	ferbam, 76% WP	1-1/2 lb.	1-1/2 T	Spray cuttings and plants at 7- to 10-day intervals. Start when disease first appears. Add a spreader-sticker to the spray.
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	chlorothalonil	See label		
Geranium (Pelargonium)				
Botrytis blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Spray weekly during cool, rainy, or damp overcast periods. Start a month before first cuttings are taken. In greenhouses, may use Exotherm Termil. Keep old flowers and leaves picked off.
	zineb, 75% WP	1 lb.	1 T	
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
	chlorothalonil	See label		
Fungal leaf spots	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray or dust at 7- to 14-day intervals. Start when disease first appears. Keep the foliage protected during damp, overcast weather when infections occur. Sanitation is important.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	chlorothalonil	See label		
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
Rust	Plantvax, 75% WP	1 lb.	1 T	Apply Plantvax or Bayleton at 2- to 4-week intervals when rust is present. Spray or dust maneb, mancozeb, and zineb at 7- to 10-day intervals, starting when rust is first evident.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	Bayleton, 25% WP	2 to 4 oz.	See label	
Rhizoctonia root and stem rot	PCNB (Terraclor), 75% WP	1/2 lb.	2 t	Drench established plants with Terraclor *once*, using 1 pint to 1 qt./sq. ft. (or 1/2 pint/6-inch pot). Spray base of plants with benomyl every 2 to 3 weeks.
	benomyl, 50% WP	1/2 lb.	2 t	
	Banrot, 40% WP	6 to 12 oz.	---	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Geranium (Pelargonium) (cont.)				
Blackleg (*Pythium*)	captan, 50% WP	2 lb.	1-1/2 T	Spray cuttings in the cutting bench. Several spray applications may be necessary, spaced about a week apart.
	Truban, 30% WP	See label		
	Lesan, 35% WP, or Truban, 30% WP *plus*	1/2 lb. See label	2 t	Drench established, well-rooted plants *once*. Use 1 quart of fungicide mix per sq. ft. (or 1/2 pint/6-inch pot).
	benomyl, 50% WP	1/2 lb.	2 t	
	Banrot, 40% WP	6 to 12 oz.	---	
Gerbera (Transvaal Daisy)				
Phytophthora root rot	Lesan, 35% WP	1/2 lb.	2 t	Apply as a soil drench or mix thoroughly into the soil just before planting. Follow the manufacturer's directions.
	captan, 50% WP	2 lb.	2 T	
	Banrot, 40% WP	6 to 12 oz.	---	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Apply several sprays at 7- to 14-day intervals, starting when mildew first appears on the foliage.
	Karathane, 22.5% WP	1/4 lb.	1 t	
Gladiolus				
Fusarium yellows and corm rot, and Penicillium corm rot	benomyl, 50% WP	1-2/3 lb.	2 T	Within *24* hours after digging, soak gladiolus corms (in a basket or loosely woven sack) for 15 minutes at a water temperature of 80° to 85° F. Or dust corms as for bacterial scab. Dry and store properly.
	Mertect, 60% WP	1-1/2 lb.	2 T	
	Ornalin, 50% WP	1-1/2 to 2 lb.	---	
Stromatinia corm rot	Botran, 50% WP	8 lb.	---	Dip corms in Botran solution (8 lb. of Botran/100 gal.; 3/4 lb./10 gal.) before planting. Or apply Botran in the furrow (1-1/3 lb./1,000 ft. of row) at time of planting.
Bacterial scab	thiram (Arasan), 50 or 75% WP			Dust disease-free corms with thiram or thiram-insecticide combination before planting and just before storage.

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Gladiolus (cont.)				
Botrytis leaf and flower spot, and corm rot	benomyl, 50% WP	1/2 lb.	2 t	Spray weekly during damp or rainy periods. Start when disease first appears. Spray the cut flower spikes with benomyl before shipment or storage. Treat the corms as for Fusarium yellows.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 to 2 lb.	1-1/2 to 2 T	
	captan, 50% WP	2 lb.	2 T	
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
Other fungal leaf spots	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray weekly during rainy periods, starting when the leaf spots appear. Add a spreader-sticker to the spray.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	Dyrene, 65% WP	2 lb.	2 T	
Gloxinia				
Botrytis bud and flower rot	benomyl, 50% WP	1/2 lb.	2 t	Spray weekly in cool, damp, overcast weather. Start when the buds first begin to appear.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
Crown rot, and leaf and tuber rot	Lesan, 35% WP	1/4 to 1/2 lb.	1 to 2 t	Drench established plants *once*, using 1 pint to 1 qt./sq. ft. of bed (or 1/2 pint/6-inch pot).
	Banrot, 40% WP	6 to 12 oz.	---	
	Truban, 30% WP	See label		
Hollyhock				
Rust	maneb, 80% WP	1-1/2 lb.	1-1/2 T	Thoroughly spray or dust 5 or 6 times, 7 to 10 days days apart. Start when new foliar growth commences in the spring. Sanitation is important.
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	ferbam, 76% WP	2 lb.	2 T	
	sulfur	See label		
	Bayleton, 25% WP	2 to 4 oz.	See label	
Hyacinth				
Botrytis blight (or gray mold)	PCNB (Terraclor), 75% WP	1/2 lb.	2 t	Drench *once* after panning. Repeat if gray mold appears, using Botran at half strength. Or try benomyl, 50% WP, 1/2 lb./100 gal. (or 2 t/gal.).
	Botran, 50% WP	1 lb.	1 T	
Fungal bulb rots	Truban, 30% WP	See label		See remarks for root rot complex of lily for fungicide combinations. Dust disease-free bulbs with thiram just before planting or storage.
	plus			
	benomyl, 50% WP, or Mertect 340-F, 42.28%	1/2 lb.	2 t	
	thiram (Arasan), 50-75% WP	See label		

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Iris				
Leaf spot, and rust	chlorothalonil	See label		Spray four to six times, 7 to 10 days apart. Start when new leaves are several inches tall. Add a spreader-sticker to the spray to ensure better wetting and coverage. If *rust* is a problem, spray with mancozeb or zineb.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	folpet, 50% WP	1-1/2 lb.	1-1/2 T	
	benomyl, 50% WP	1 lb.	1 T	
	Bayleton, 25% WP	1 lb.	See label	
Fungal crown, rhizome, and bulb rots	PCNB (Terraclor), 75% WP	1/2 lb.	1 T	Apply as a soil drench (1 pint to 1 qt./sq. ft.; 1 to 2 pounds per 1,000 sq. ft.) at or before planting and again when new growth appears in the spring.
	Botran, 50% WP	1-1/2 lb.	1-1/2 T	
Bacterial soft rot and rhizome rot	Apply recommended insecticides starting when fan leaves are several inches tall.			Spray weekly until bloom. Dig up infected plants after flowering is over and transplant disease-free rhizomes that are free of borers. The soft rot bacteria enter wounds made by iris borers and other injuries.
Kalanchoë				
Crown or stem rot and wilt, and root rot	Lesan, 35% WP	1/2 lb.	2 t	Drench plants once, 1 pint to 1 qt./sq. ft. (or 1/2 pint/6-inch pot).
	Banrot, 40% WP	6 to 12 oz.	---	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray at 7- to 14-day intervals. Start when mildew first appears. Add a surfactant to the spray.
	Karathane, 22.5% WP	1/4 lb.	1 t	
	Zyban, 75% WP	1-1/2 lb.	---	
Botrytis blight (or gray-mold), and Sclerotinia blight	benomyl, 50% WP	1/2 lb.	2 t	Spray several times at 10-day intervals during cool, damp weather.
	Ornalin, 50% WP	1-1/2 lb.	---	

Larkspur--See Delphinium.

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Lily				
Root rot complex	Lesan, 35% WP, or	1/4 lb.	1 t	Drench established plants
	Truban, 30% WP	4-1/4 oz.	---	with Lesan or Truban plus
	plus			benomyl (1/2 pint/6-inch
	benomyl, 50% WP	1 lb.	4 t	pot) and repeat at monthly
	Banrot, 40% WP	6 to 12 oz.	---	intervals; or mix 2-1/2 oz. of Truban into each cu. yd. of potting mix. Banrot can be applied at 4 to 12-week intervals.
	Truban, 30% WP	4-1/4 oz.	---	Dip bulbs 10 to 15 minutes
	plus			just before planting and
	benomyl, 50% WP,	2.7 oz.	---	within 24 hours after dig-
	or Mertect			ging. Or mix Truban into
	340-F, 42.28%	2-1/2 oz.	---	porous potting mix (2-1/2
	Lesan, 35% WP	4 oz.	---	oz./cu. yard). Drench
	Banrot, 40% WP	6 to 12 oz.	---	growing plants monthly with Truban, 30% WP (3 to 8 oz./100 gal.) or Lesan, 35% WP, or Banrot, 40% WP.
Botrytis flower blight (or gray mold) and leaf spot	benomyl, 50% WP	1/2 lb.	2 t	Spray 3 times, 7 days
	chlorothalonil	See label		apart, starting when dis-
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	ease first appears on the lower leaves. Mist-spray buds and blooms with benomyl (1/4 lb./100 gal. or 1 t/gal.). In greenhouses, may use Exotherm Termil. Sanitation is important.
Bulb rots (*Rhizopus* and *Penicillium*)	thiram (Arasan), 50-75% WP, or thiram *plus* benomyl, 50% WP			Clean bulbs thoroughly and dust blemish-free ones with thiram or thiram *plus* benomyl before placing in storage. Discard all diseased bulbs when first discovered.
Fusarium bulb rot, and Phytophthora shoot or foot rot	Lesan, 35% WP, or	1/2 lb.	2 t	Thoroughly mix fungicides
	Truban, 30% WP	See label		into soil just before
	plus			planting, or drench the
	benomyl, 50% WP,	See label		plants after potting as
	or Mertect			outlined for root rot com-
	340-F, 42.28%	See label	---	plex. Dip bulbs for 10 to
	Banrot, 40% WP	6 to 12 oz.		15 minutes as given under root rots.

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Lily (cont.)				
Virus diseases	Apply recommended insecticides to prevent insects from feeding.			Spray at about weekly intervals to control aphids that spread the viruses from plant to plant. Or fumigate greenhouses following the manufacturer's directions.
Marigold				
Botrytis blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Apply several sprays at 7- to 14-day intervals during cool, damp, overcast weather when infections occur.
	chlorothalonil	See label		
	Ornalin, 50% WP	1-1/2 lb.	---	
Phytophthora stem rot and wilt	Truban, 30% WP	See label		Thoroughly mix the fungicide into the soil just before planting or apply as a soil drench after planting.
	Banrot, 40% WP	6 to 12 oz.	---	
Narcissus, Daffodil				
Fungal bulb rots	PCNB (Terraclor), 75% WP	50 lb.	1/2 lb.	Dip cleaned bulbs for 5 minutes in a suspension of Terraclor, Mertect, *or* benomyl for 15 to 30 minutes in water at 80° to 85° F. Apply Ornalin according to manufacturer's directions. *Or* dust bulbs with thiram before planting and again before putting in storage. Keep bulbs dry.
	Mertect, 60% WP	1-1/2 lb.	2 T	
	benomyl, 50% WP	1-2/3 lb.	2 T	
	Ornalin, 50% WP	1-1/2 to 2 lb.	---	
	thiram (Arasan), 50 or 75% WP	See label		
Orchids				
Black rot, root rot, and damping-off	8-hydroxyquinoline sulfate, 5% WP	See label		Dip infected plants, pot and all, for 1 hour. Repeat a week later if disease persists. Or drench plants with Lesan or Truban as directed by the manufacturer.
	Lesan, 35% WP	See label		
	Truban, 30% WP	See label		
Botrytis flower spot or blight or gray mold	chlorothalonil	See label		In closed greenhouses you may use Exotherm Termil as directed by the manufacturer. Test trial varieties for possible injury.

[a] WP = wettable powder; L = liquid.

[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Pachysandra				
Volutella leaf and stem blight (canker)	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Make 5 spray applications at about 10 to 14-day intervals, starting in the spring when new growth commences.
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	Zyban, 75% WP	1-1/2 lb.	---	
Pansy, Violet, Viola				
Anthracnose, scab, fungal leaf spots, and Botrytis blight (or gray-mold)	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray weekly during damp or rainy periods. Start when disease *first* appears. Add spreader-sticker to all sprays. Also make a fall application just before covering plants with mulch. Check label directions.
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	benomyl, 50% WP	1/2 lb.	2 t	
	Zyban, 75% WP	1-1/2 lb.	---	
Seed rot, seedling blights, and damping-off	captan (Orthocide), 50 or 75% WP			Dust seeds thoroughly with captan just before planting. Screen off excess fungicide. Avoid overseeding and overwatering. Apply Banrot as a soil drench, following manufacturer's directions.
	Banrot, 40% WP	6 to 12 oz.	---	
Pelargonium--See Geranium				
Peony				
Botrytis blight, leaf blotch, bud blast, and shoot blight	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray weekly during cool, damp, overcast weather. Start when new shoot growth is 2 to 4 inches tall in the spring and continue until flowers begin to open. Add spreader-sticker to spray.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	benomyl, 50% WP	1 lb.	1 T	
Phytophthora blight	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray foliage, bases of shoots, and nearby soil at 7- to 10-day intervals during rainy periods. Add spreader-sticker to each spray to ensure wetting the foliage.
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
Periwinkle (Vinca minor)				
Phoma stem rot or canker	benomyl, 50% WP	1/2 lb.	2 t	Thoroughly soak stems and soil once *before* disease appears in mid-spring.

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Petunia				
Botrytis blight (or gray-mold), leaf blotch, and flower blight	benomyl, 50% WP	1/2 lb.	2 t	Apply spray at 10- to 14-day intervals during cool, damp, overcast weather. In greenhouses, may use Exotherm Termil as directed by the manufacturer.
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
Fungal root and crown or foot rots (*Rhizoctonia* and *Pythium*)	Banrot, 40% WP	6 to 12 oz.	---	Drench the soil surface using 1 pint to 1 qt./sq. ft. of bed after the plants are set. Repeat several more times at 4- to 12-week intervals.
Philodendron				
Bacterial leaf spot	Streptomycin formulations	Apply at 200 parts/million		Spray foliage during damp weather, starting when the disease first appears. Follow label directions.
	Kocide 101, 77% WP	See label		
Damping-off, and root and stem rots	Banrot, 40% WP	6 to 12 oz.	---	Drench plants following the manufacturer's directions.
Phlox				
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray several times, about 10 days apart. Start when mildew first appears on the leaves. Proper spacing of plants and plenty of sunlight are important.
	Bayleton, 25% WP	2 to 4 oz.	See label	
	Karathane, 22.5% WP	1/4 lb.	1 t	
Fungal leaf spots	zineb, 75% WP	1-1/2 lb.	1-1/2 T	Spray several times, 7 to 10 days apart. Start when disease first appears on the leaves. Proper plant spacing and sanitation are important.
	benomyl, 50% WP	1/2 lb.	2 t	
	ferbam, 76% WP	2 lb.	2 T	
	Bayleton, 25% WP	2 to 4 oz.	See label	
Poinsettia				
Botrytis blight (or gray-mold), stem canker, and leaf spot	benomyl, 50% WP	1/2 lb.	2 t	Spray several times at 7- to 14-day intervals during cool, damp, overcast weather.
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Poinsettia (cont.)				
Root and stem rot complex (*Rhizoctonia, Thielaviopsis, Pythium*)	Banrot, 40% WP	See label		If disease appears after potting, drench *established* plants *once*. Apply 1/2 pint/6-inch pot and water the chemical into the soil immediately. If the disease appears later, apply Lesan (1/2 lb./100 gal.) *plus* benomyl, 50% WP (1/4 lb./100 gal.) using 1/2 pint/6-inch pot at 20-day intervals. Or apply Banrot alone as directed by the manufacturer.
	Truban, 30% WP, or Lesan, 35% WP *plus*	3 to 10 oz. 1/4 lb.	See label 1 t	
	PCNB (Terraclor), 75% WP	1/4 lb.	1 t	
Snapdragon				
Anthracnose, and fungal leaf spots	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray or dust at 7- to 10-day intervals during rainy periods. Start when disease first appears. Adding a spreader-sticker ensures better wetting. In closed greenhouses, may use Exotherm Termil. Sanitation is important.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	chlorothalonil	See label		
	benomyl, 50% WP	1/2 lb.	2 t	
	captan, 50% WP	2 lb.	2 T	
	Zyban, 75% WP	1-1/2 lb.	---	
Botrytis blight (or gray-mold), Phyllosticta leaf and stem blight	benomyl, 50% WP	1/2 lb.	2 t	Spray at weekly intervals during cool, damp, overcast weather. In closed greenhouses, may use Exotherm Termil. When plants are in bloom, use only benomyl and at half strenth (1/4 lb./100 gal. or 1 t/gal).
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	chlorothalonil	See label		
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
	Zyban, 75% WP	1-1/2 lb.	---	
Rust, downy mildew, and other fungal leaf spots and blights	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray at 5- to 10-day intervals in damp or rainy weather. Start when disease first appears. Plantvax and Bayleton control rust but not the other diseases.
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	Zyban, 75% WP	1-1/2 lb.	---	
	Bayleton, 25% WP	2 to 4 oz.	See label	
	Plantvax, 75% WP	1 lb.	1 T	
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Spray at 7- to 10-day intervals. Add spreader-sticker to the spray. Use benomyl (1 t/gal.) on seedlings.
	Karathane, 22.5% WP	1/4 lb.	1 t	
	Bayleton, 25% WP	2 to 4 oz.	See label	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Snapdragon (cont.)				
Rhizoctonia stem and root rot, wirestem, or damping-off	PCNB (Terraclor), 75% WP	1/2 lb.	1 T	Apply as a soil drench *once* to established plants when disease is expected. Follow all directions and precautions printed on the container label.
	Banrot, 40% WP	6 to 12 oz.	---	
Pythium root rot	Lesan, 35% WP	1/2 lb.	2 t	Drench established plants using 1 pint to 1 qt./sq. ft. Repeat 6 to 8 weeks later if needed.
	Truban, 30% WP	See label		
	Banrot, 40% WP	6 to 12 oz.	---	
Stock				
Botrytis blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Spray several times at 7- to 10-day intervals during cool, damp, overcast weather. Sanitation is important.
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
Root and stem rot	PCNB (Terraclor), 75% WP	1/2 lb.	2 t	Drench plants using 1 pint to 1 qt./sq. ft. after transplanting. Repeat if the disease appears.
Sweetpea				
Powdery mildew	Karathane, 22.5% WP	1/4 lb.	1 t	Spray several times at 7- to 10-day intervals. Start when mildew first appears on the leaves.
	benomyl, 50% WP	1/2 lb.	2 t	
Anthracnose, fungal leaf spots and blights	benomyl, 50% WP	1/2 lb.	2 t	Spray several times at 10- to 14-day intervals during rainy weather. Start when disease is first evident.
Anthracnose, and streak	formaldehyde, 38 to 40% L			Dip seed in formaldehyde solution for 5 minutes just before planting in fertile, well-drained soil.
Root rots	PCNB (Terraclor), 75% WP	1 lb.	1 T	Thoroughly mix Terraclor as dust into the top 2 inches of soil before planting. Or apply Terraclor or benomyl as a soil drench *once* (1 pint to 1 qt./ sq. ft.) after planting.
	benomyl, 50% WP	See label		
Transvaal Daisy--See Gerbera				

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Tulip				
Fire or Botrytis blight (or gray-mold)	Botran, 50% WP	1 lb.	1 T	Spray several times at 5- to 10-day intervals. Start when the leaves emerge from the soil and continue to early bloom. Add a spreader-sticker to the spray to ensure wetting the foliage and getting good coverage. Treat the soil at planting time and drench the soil before emergence using Botran or benomyl (1 T/gal.).
	chlorothalonil	See label		
	benomyl, 50% WP	1/2 lb.	2 t	
	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	
	Ornalin, 50% WP	1 to 1-1/2 lb.	---	
Bulb rots	PCNB (Terraclor), 75% WP, or	50 lb.	1/2 lb.	Before planting, dip bulbs for 5 minutes in a Terraclor suspension or Ornalin *or* dust bulbs thoroughly with thiram, 50 to 75%. See remarks on root rot complex of Lily.
	thiram (Arasan), 50 to 75% WP, or	See label		
	Truban, 30% WP	See label		
	plus			
	benomyl, 50% WP, or Mertect 340-F 42.28%	1/2 lb.	2 t	
		See label		
	Ornalin, 50% WP	1-1/2 to 2 lb.	---	
Verbena				
Rhizoctonia stem and root rot	PCNB (Terraclor), 75% WP	1 lb.	1 T	Thoroughly mix Terraclor into top 2 inches of soil before planting. Or apply Terraclor or benomyl as a soil drench once after planting (1 pint to 1 qt./sq. ft. of bed).
	benomyl, 50% WP	See label		
	Banrot, 40% WP	6 to 12 oz.	---	
Vinca--See Periwinkle				
Viola, Violet--See Pansy				
Zinnia				
Alternaria leaf spot or blight	mancozeb, 80% WP	1-1/2 lb.	1-1/2 T	Spray the foliage weekly during rainy periods in spring and early summer. Start when disease first appears or when plants are 6 to 12 inches tall. Treat seed with Captan or Orthocide, 50 or 75% WP. Sanitation is important.
	maneb, 80% WP	1-1/2 lb.	1-1/2 T	
	zineb, 75% WP	1-1/2 lb.	1-1/2 T	
	folpet, 50% WP	1-1/2 lb.	1-1/2 T	
	ferbam, 76% WP	2 lb.	2 T	
	Zyban, 75% WP	1-1/2 lb.	---	

[a] WP = wettable powder; L = liquid.

[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Table 2. (continued)

Flower and disease	Chemicals for control[a]	Rate[b] 100 gallons	Rate[b] 1 gallon	Remarks
Zinnia (cont.)				
Powdery mildew	benomyl, 50% WP	1/2 lb.	2 t	Thoroughly spray the foliage at 7- to 10-day intervals. Start when mildew first appears. Adding a spreader-sticker to the spray usually aids in disease control.
	Karathane, 22.5% WP	1/4 lb.	1 t	
	Acti-dione PM, 0.027% WP	See label		
	chlorothalonil	See label		
	Bayleton, 25% WP	See label		
	Zyban, 75% WP	1-1/2 lb.	---	
Botrytis blight (or gray-mold)	benomyl, 50% WP	1/2 lb.	2 t	Spray the foliage several times at 10- to 14-day intervals during cool, damp, overcast weather.
Root and stem rot complex	Banrot, 40% WP, or	6 to 12 oz.	---	Thoroughly drench the soil around established plants *once*. Use 1 pint to 1 qt. of spray mix/sq. ft. of bed.
	Lesan, 35% WP *plus*	1/4 lb.	1 t	
	PCNB (Terraclor), 75% WP	1/2 lb.	2 t	

[a] WP = wettable powder; L = liquid.
[b] T = tablespoon(s); t = teaspoon(s); lb. = pound(s); oz. = ounce(s).

Fungicides, Disinfectants, Grain Preservatives, Surfactants, and Soil-Disinfesting Chemicals

M.C. Shurtleff, B.J. Jacobsen, T.A. Melton, and H.W. Kirby

ANILAZINE [4,6-dichloro-N-(2-chlorophenyl)-1,3,5-triazine-2-amine or 2,4-dichloro-6-(o-chloranilino)-s-triazine]

A broad-spectrum, protective foliar fungicide useful in controlling many turfgrass diseases plus some anthracnoses, Botrytis blights, fungus leaf spots, and blights of many vegetables, woody ornamentals, flowers, bush and bramble fruits, and strawberries.
Trade names. Dyrene 50% Wettable Powder Foliage Fungicide; Agway Granular Turf Fungicide with Dyrene; Patterson's Turf Fungicide W/Dyrene; Dyrene Lawn Disease Control; Scotts ProTurf Fungicide III; Dymec 50 Turf Fungicide; Dyrene Turf Fungicide.

BENOMYL [Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate]

A broad-spectrum fungicide that is preventive, curative, long lasting, and systemic. Benomyl is effective against a wide range of fungus diseases on a wide range of plants.
Trade names: DuPont "Benlate" Benomyl Fungicide; Tersan 1991 Turf Fungicide; Bonide Benomyl (DuPont New Systemic Fungicide); Science Benomyl Systemic Fungicide; Rockland Benomyl Fungicide; Benomyl Turf Fungicide Granules; Miller's Benomyl Systemic Fungicide, Patterson's Benomyl Systemic Fungicide; Scotts ProTurf fertilizer plus DSB Fungicide.

BORDEAUX MIXTURE

A broad-spectrum, long-lasting, protective fungicide used mostly as a soil drench, dormant spray, and foliar spray to control needle diseases of conifers. It is also used as an insect repellent, as an emulsifier in dormant oil sprays, and as a general disinfectant for work surfaces, storage cellars, and other areas.
Trade names: Prepared dry bordeaux products include Acme Bordeaux Mixture; Patterson's Bordeaux Misture; Copper Hydro Bordo; Bor-dox; Pratt Bordeaux Mix; Black Leaf Bordeaux Powder; Ortho Bordo Mixture.

BOTRAN (DCNA) [2,6-dichloro-4-nitroaniline]

A foliar, seed, soil, and post-harvest fungicide that controls a range of seed decays and seedling blights; stem (crown), fruit, bulb or corm rots; and blights of certain vegetables, tree and bush fruits, and ornamentals caused by species of Botrytis, Monilinia, Rhizopus, Sclerotinia, and Sclerotium. Also effective as a cut-flower spray or dip for Botrytis control. Botran may injure some tender crops.
Trade names: Botran 50% WP, Botran 75W, Botran 75WP, E-Z-Flo Botran 6 Dust. Bo Cap and Botec Peanut Seed Protectant are 30:30 mixtures of Botran and captan, while Orthocide Botran 35-35 Seed Protectant contains 35% each of Botran and captan. Ortho Difolatan Botran 20-60 Seed Protectant and 35-35 Seed Protectant contain 20%-60% and 35% each of Botran and captafol, respectively.

CAPTAFOL [N-[(1,1,2,2-tetrachloroethyl)thio]-4-cyclohexene-1,2-dicarboximide]

A very long-lasting, protective contact-eradicant foliar, fruit, seed, and soil fungicide related to captan and folpet. Controls downy mildews, numerous fungus leaf spots and blights, blossom blights, fruit spots and rots, scabs, anthracnoses, seed rot, damping-off, and gray molds (Botrytis) of certain tree and bush fruits, vegetables, and ornamentals. Some persons are allergic or become sensitized to captafol. Avoid contact with eyes, skin, or clothing.

Trade names. Ortho Difolatan 4 Flowable; Ortho Difolatan 4 Flowable Seed Protectant.

Difolatan-Botran contains a 60-20 mix of these two fungicides.

CAPTAN [N-[(trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide]

A broad-spectrum fungicide used on foliage, fruit, and in soil. Does NOT control powdery mildews and rusts. Available primarily as wettable spray powders, dusts, and special flowable seed protectants. Both a protectant and a mild eradicant. Captan is more effective against Botrytis under low temperatures (48°-50°F) than some other fungicides.

Trade names. Stauffer Captan 50-WP, 80-WP, Captan-Moly-Planterbox Treater, Captan-Thiram 43-43 WP & Dust; Captan 25, 75, and 80 Seed Protectant; Captan Garden Spray; Evershield Captan Seed Protectant; Gallotox Captan FP-700R; Captan 80 Spray-Dip; Orthocide 50 and 80 Wettable; Orthocide Fruit and Vegetable Wash; Agway Captan 5D and 7.5D; Orthocide 65 and 75 Seed Protectant; Miller's Captan 50W; Patterson's Captan Garden Spray; F & B Captan 7.5 Dust and Captan 50-WP; Chipman Captan Dust; Hopkins 7-1/2% Captan Dust; Orthocide 5 Dust, 7.5 Dust, 10 Dust, 15 Dust, and 80 Concentrate; Occidental Captan; Security Captan; Miller's Captan Dust and Captan Garden Dust; Bonide Captan 50W; E-Z-Flo Captan 7-1/2 Dust; Captan 25 Planterbox Treater; Hopkins 25% Captan Seed Protectant and Captan-Moly Planter Box Seed Protectant; Farmrite Captan 5% and 10% Dust; Green Cross 7.5% Captan Dust; Ortho Soybean Seed Protectant and (MO); Orthocide Potato Seed Treater; Orthocide 90 and 92 Seed Protectant Concentrate; Orthocide 4 Flowable Seed Protectant; Security 7-1/2% Captan Peach Dust; Naco Captan 7.5 Dust; Chevron 90 Concentrate; Vancide 89.

Orthocide Vitavax 20-20 is a mixture of captan and carboxin. Agrosol-S, Granox, and Orthocide Maneb 30-30 Seed Protectant are 30:30 mixtures of captan and maneb. Granox P-F-M is a 30:30 combination of captan and maneb with 1% molybdenum.

CARBOXIN [5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide or 2-3-dihydro-5-carboxanilido 6-methyl-1,4-oxathiin]

A protective contact-systemic fungicide effective against various seed- and soil-borne smuts (including loose smut of wheat and barley), some seed-rotting and seedling blight fungi, some rusts, common scab of potato, Rhizoctonia damping-off of seedlings, and Verticillium wilt of annuals. Applied to seeds or soil at planting time. It is registered for use on barley, corn, cotton, oats, peanuts, rice, soybeans, and wheat.

Trade names. Vitavax Fungicide; Vitavax-25 DB Fungicide; Vitavax-EVS Concentrate; Vitavax Flowable Fungicide; Vitavax-17 Flowable Fungicide; Evershield V Seed Protectant.

Vitavax-200 Fungicide contains 37.5% carboxin and 37.5% thiram, while Vitavax 200 Flowable Fungicide contains 17% each of carboxin and thiram.

Orthocide Vitavax 20-20 contains 20% each of carboxin and captan. It is registered for wheat, oats, and barley as a drill-box treatment.

CHLORONEB [1,4-dichloro-2,5-dimethoxybenzene]

A protective, locally systemic seed and soil fungicide that controls pre- and post-emergence damping-off (seedling blights), and root rots of vegetables, soybeans, and ornamentals, as well as Fusarium patch, Pythium blight and snow molds of turfgrasses.

Trade names. Demosan 65W Chloroneb Fungicide; Scotts ProTurf Fungicide II; Tersan SP Turf Fungicide, etc.

Demosan T Seed Fungicide contains 40% chloroneb and 22.5% thiram.

CHLOROTHALONIL [2,4,5,6-tetrachloroisophthalonitrile]

A broad-spectrum, protectant fungicide to control many diseaes. Gives poor control of soil-borne fungi because of rapid breakdown. Use cautiously; some cases of dermatis reported with all formulations.

Trade names. Daconil 2787; Daconil 2787 Flowable Fungicide; Bravo W-75; Bravo 6F; Turf Disease Control; Exotherm Termil; Diamond 75% Chlorothalonil; Scotts ProTurf 101V broad spectrum fungicide and ProTurf fertilizer plus 101 broad spectrum fungicide. Exotherm Termil is a special formulation (20% chlorothalonil) for use in closed greenhouses to control Botrytis and other foliar and flower blights of many species of ornamentals and tomatoes. One can treat 1,000 square feet of greenhouse area.

COPPER (Fixed or Neutral) COMPOUNDS

Low toxicity, moderately residual, broad-spectrum fungicides and bactericides that have largely replaced bordeaux mixture and are available for use as sprays, dusts, and soil drenches. Useful for controlling a wide range of fungus leaf and fruit spots; blotches and blights; downy mildews; powdery mildews; rots; scabs; anthracnoses; rusts; and some bacterial diseases including blights of beans, pepper, tomato, lilac, and walnut.

Federal agencies have decided that no tolerance levels need to be established for most copper compounds.

Trade names. These materials can be conveniently divided into five categories:

1. Sulfates--Basic Copper Sulfate, Ortho Copper 53 Fungicide, Basi-Cop, Kilcop 53, CP Basic Sulfate, Microcop, Citco Tri-Basic Copper Sulfate, Naco 53% Basic Copper Sulfate, Copper '7' Dust, Spraycop 530, T-B-C-S 53, Neutro Cop 53, Copper 53 Fungicide. Cop-O-Zinc contains copper sulfate plus zinc salt.
2. Chlorides--Coprantol, Aceto Copper Chloride, Copper Oxychloride, C-O-C-S, Kaurital.
3. Oxides--Kuprite; Cuprocide; Kocide 101 Wettable Powder, 606, 404 Flowable, 3% and 5% Dust, and SD Seed Dressing; Copper Oxide; Cuprous Oxide; Brown Copper Oxide; and Yellow Cuprocide. Kocide 404S is a flowable formulation containing 27% cupric hydroxide (copper equivalent 17.5%) and 15.5% sulfur for use on peanuts.
4. Liquids, i.e., emulsifiable--Oxy-Cop 8L, Copoloid, Cop-O-Cide, Citcop 4E, Copper-Count, Copper-Count-N, Sol-u-Cop, Carmel Formula GH-41 & Greenhouse Fogging, Emulsifiable Liquid Copper Fungicide.
5. Miscellaneous--Copper Oleate, GH-41 Copper Resinate, Copper Carbonate, Tri-Cop, Zinc Coposil Fungicide, Copper Zeolite.

Oxy-Cop 8LS, Copper-Count-S and -N are liquid fungicides containing 8% ammonical copper and 5% sulfur.

CYCLOHEXIMIDE [3-[2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]-glutarimide]

A short residual, eradicant, highly toxic, anti-fungal antibiotic that is absorbed through plant surfaces and is distributed locally within a plant. Effective against powdery mildews, certain rusts, a number of turfgrass diseases, cherry leaf spot, and azalea petal blight. Plants are very sensitive to overdose with this chemical. Do not apply at temperatures above 85°F.
Trade names. Acti-dione PM, Acti-dione WP (Flower Fungicide), Acti-dione WP (Lawn & Turf Fungicide), Acti-dione TFG, Acti-dione TGP, Actispray. Acti-dione TGF is now registered for tank mixing with triadimefon (Bayleton) and chlorothalonil (Daconil 2787) to control a number of turfgrass diseases.

Cycloheximide-PCNB is sold as Acti-dione RZ.

DINOCAP [2-1(1-methylheptyl)-4,6-dinitrophenyl crotonate and isomers]

A short residual but good eradicant fungicide specific against powdery mildews of fruits, vegetables, and ornamentals. Do not use in hot weather (above 85°F) as dinocap may be phytotoxic. Use a wetting agent with dinocap to ensure wetting the mildew growth.
Trade names. Karathane WD, Karathane Liquid Concentrate, Miller's Karathane 2D and Garden Karaspray, Dinocap 25% WP.

Dikar is a broad-spectrum fungicide-miticide containing 4.7% dinocap and 72% mancozeb (Dithane M-45) used primarily by commercial apple growers.

Orthocide Karathane 50-6 Wettable contains 50% captan and 4.87% dinocap. It is used on fruits, ornamentals, and vegetables.

DODINE [N-dodecylguanidine acetate]

Control certain foliar diseases (fungus leaf spots and blotches, scabs and anthracnoses) of various fruit and nut crops, roses, and shade trees. Gives long-lasting protection; a good eradicant. Does NOT control powdery mildews and rusts. May be sold combined with Crag Glyodin.
Trade names. Cyprex 65-W Fruit Fungicide; Agway Dodine 1D; Miller's Cyprex 4D; Naco Dodine 2, 3, 4, and 6 Dusts; Cyprex Dodine Dust; E-Z-Flo Cyprex 4 Dust; Hopkins 2% and 4% Dodine Dust; Melprex.

ETRIDIAZOL [5-ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole]

A low toxicity, moderately residual soil, turf and seed fungicide specific for controlling soil-borne water molds (Aphanomyces, Phytophthora, Pythium).
Trade names. Olin Terrazole Technical and Terrazole 35% Wettable Powder, Koban, Truban (30% wettable powder, 25% emulsifiable concentrate and 5% granules).

FERBAM [Ferric dimethyldithiocarbamate]

A general-purpose, very low toxicity, long-lasting fungicide that controls a wide range of foliar diseases of floweres, trees, shrubs, and fruit, including fungus leaf spots and blotches, scabs, and rusts. Controls rusts but NOT powdery mildews.
Trade names. Karbam Black; Carbamate; Stauffer Ferbam 76-W; Agway Ferbam 76W and 7.6D; E-Z-Flo Ferbam 76; Ortho Ferbam 76; Allied Ferbam; Aceto Ferbam 76% and 93%; Kerr-McGee Ferbam; Olin Ferbam; Thompson-Hayward Ferbam; Grace Ferbam; Chemform Ferbam (Wettable Powder); Ferbam 76W; Ferbam 95W; Miller's Ferbam; Naco Hi-Test

Ferbam Wettable Powder; Vancide FE 95-W and FE Flowable; Champion 15% Fermate Dust; Crown 15% Fermate Dust; Gold Kist Fermate Dust; Green Cross 7% Karbam Black Dust Fungicide and 76% Karbam Black Fungicide; Naco Fermate 15 Dust; Bartlett Ferbam 76W; Farmrite Ferbam 76%; Chempar Ferbam 76 Wettable Powder; Patterson's Ferbam; Security Ferbam Fungicide; Shepard Chemical Ferbam.

FOLPET [N-[(trichloromethyl)thio]phthalimide]

Used to control many diseases--on bush and tree fruits, flowers, vegetables, trees, and shrubs. A protectant-contact-eradicant fungicide that gives fair control of many powdery mildews but not of rusts. Used as a seed treatment and in plant beds to control damping-off and seedling blights.
Trade names. Ortho Phaltan Rose & Garden Fungicide; Ortho Phaltan 50 Wettable; Niagara Phaltan 50 Wettable; Stauffer Folpet 50-WP; Agway Folpet 50-W; Miller's Phaltan 50-W; Bonide Folpet 50W; "Fungitrol;" Farmrite Phaltan 50-W; Naco Phaltan Folpet 50 Wettable Fungicide; Acme Phaltan Fungicide; Science Rose and Garden Fungicide; Aceto Folpet; Chevron Folpet Wettable; Patterson's Phaltan Wettable Powder.

MANCOZEB (or MANEB AND ZINC ION) [Includes products containing zinc and maneb]

Excellent, very low toxicity, broad-spectrum, largely protective contact fungicide for cereals, nuts, fruits, turfgrasses, vegetables, trees, flowers, and shrubs. Does NOT control powdery mildews.
Trade names. Manzate 200 Fungicide; Tersan LSR Turf Fungicide; Dithane M-45; Fore; Acme Fore; Vancide Maneb Flowable; Amazin Zinc Enriched Maneb 80 Fungicide; Science Fore Lawn Fungicide; Pratt Lawn & Garden Fungicide and Liquid Maneb; Naco Potato Seed Piece Fungicide Dust; Farmrite Potato Seed Dust; E-Z-Flo Dithane M-45 Potato Seed Piece Fungicide; Hopkins Potato Seed-Piece Fungicide Dust; Security 6% Dithane M-45; Agsco Blitex Dust DM-6; Sup'-r-Flo Maneb Flowable, Formec 80 Turf & Ornamental Fungicide.

Zyban contains 60% mancozeb and 15% thiophanate-methyl.

MANEB [Manganese ethylenebisdithiocarbamate]

Excellent, general, broad-spectrum, very low toxicity fungicide used to control a wide range of diseases on a wide range of plants. Controls rusts but NOT powdery mildews. Both a protectant and an eradicant.
Trade names. Manzate Maneb Fungicide; Manzate D Maneb Fungicide; Dithane M-22 and Dithane M-22 Special with Zinc; Sears Lawn Fungicide; Aceto Amazin Maneb 80 WP and Maneb 80 and Maneb Flowable; Patterson's Maneb Fungicide; E-Z-Flo Maneb 7 Dust; Shepard Chemical Maneb 80% WP; Pennwalt Maneb 80; Agsco DB Yellow and DB Green; Chevron Maneb; Black Leaf Maneb Fungicide; Agrisect Brand Maneb (Wettable Powders and Dusts); Agway Maneb 4.5D; Champion 2% Maneb Dust; Miller's Dithane M22-6D and Dithane Dust; Twin Light Maneb Dust; Ortho Maneb 80 Fungicide; Science Maneb Garden Fungicide; Naco Maneb 80 Fungicide; BASF Maneb 80WP; Security Maneb Dust; Agrox N-M Drill box Non Mercurial; Polyram M; Griffin Manex; Vancide Maneb 80.

PCNB [Pentachloronitrobenzene]

A very long-lasting soil, turf, seed, bulb, and corm fungicide that controls various soil-borne diseases of many plants.
Trade names. Terraclor; Tri-PCNB; Pearson's Green Lawn Fungicide; Fungi-clor; Turfcide 10% Granular Fungicide and Emulsifiable Fungicide; Aceto PCNB 80% and

100%; Scotts Lawn Disease Preventer, Turf Builder Plus Lawn Disease Preventer, and ProTurf New FFII; Ortho Lawn Fungicide; Terra-Coat LT-2 and 2-LF Seed Treatment Fungicide; Naco Terraclor Dust; Terraclor 2 EC and Granules.

Captan-PCNB mixtures are sold as Orthocide Soil Treater "X" and "3X"; Orthocide PCNB 10-20 Dust; Orthocide PCNB-Nutrient Spray; Stauffer Captan-Terraclor 10-10 Seed Treatment and 30-30 Seed Protectant; Terraclor 20-Captan 10 Dust; Terraclor 50-Captan 25 Wettable Powder, PCNB-Captan 25-25 Wettable Powder.

POLYRAM or METIRAM [Zinc polyethylenethiuram disulfide complex or polyethylene polymer]

A very low toxicity, broad-spectrum, largely protectant fungicide for application on foliage, fruit, seed, and soil. Polyram's range of activity is very similar to mancozeb, maneb, and zineb.

Trade names. Polyram Wettable Powder; Niagara Polyram 80 WP, 7 Dust, and Seed Treater; Security Polyram; Farmrite Potato Seed Piece Treater; Gold Kist 5% Polyram Dust; Agway Polyram 7D and Polyram 80W, Naco Polyram 3.5 Dust and Polyram Dust; Polyram 80 Wettable Powder; Polyram 7 and 10 Dust; Polyram Seed Treater; Hopkins Potato Seed Treater-P Fungicide; Niagara Polyram Potato Seed Treater.

Polyram-PCNB is sold as a 10:10 dust.

STREPTOMYCIN [Streptomycin sulfate or nitrate]

A short residual, antibacterial antibiotic used to control fire blight of pome fruits and ornamentals, walnut blight, bacterial spots of pepper, tomato and foliage plants, bacterial wilts, blights and rots of various trees and ornamentals, and blackleg (soft rot) of potato. May cause injury to some plants. Apply only under slow-drying conditions (such as during the night) and before infections occur. Do not use at low temperatures, which impair its effectiveness. Streptomycin should be used alone unless it has been purchased in prepared mixes.

Trade names. Agrimycin 17; Stauffer Streptomycin; Phytomycin; Ortho Streptomycin Spray; Streptomycin Antibiotic Spray Powder; Streptomycin Wettable Powder; Ag-Strep; Agri-Strep.

Agri-mycin 100 and 500 also contain the antibiotic oxytetracycline (Terramycin).

Captan-Streptomycin 7.5-.01 Potato Seed Piece Protectant contains 7.5% captan and 0.01% streptomycin.

Agrox Strep, a planterbox seed treatment for corn, contains 5% streptomycin, 20% captan, and 21.5% diazinon.

Hopkins Been Seed Protectant contains 25% each captan and diazinon, and 6.25% streptomycin sulfate.

SULFUR COMPOUNDS (including Liquid Lime-Sulfur)

Old-time combination fungicide-insecticide-miticide that is only protective. It controls powdery mildews, rusts, and many fungus leaf spots, blights, scabs, and fruit rots. May injure plants in hot (85°F or above), dry weather. In dust form the particles should be fine enough to pass through a 325-mesh screen.

Lime-sulfur is a combination fungicide-insecticide (scalecide) more phytotoxic than other sulfurs. It is caustic and disagreeable to apply, and will discolor paint. Now almost exclusively used as a dormant or delayed dormant spray for bramble and tree fruits, roses, and other woody plants.

Trade names. Sulfur; Magnetic "70" and "95;" Ortho Flotox Garden Sulfur; Sulfuron; Microfine Sulfur; Corosul S; Kolodust; Kolospray; Bonsul Spray-Dust Sulphur; Naco Micronized Wettable Sulfur; Pratt Wettable Sulfur; Sperlox-S.

Kolofog contains 30% fused bentonite sulfur. Fungi-Sperse, Liquid Sulfur, and Sperlox are liquid sulfurs. Magnetic 6 and Super Six are trade names for flowable sulfur, a microfine formulation in a liquid suspension with an average particle size not more than 5 microns. Micro-Sperse contains 54% sulfur and 3% copper.

Lime-sulfur is sold as Acme Lime Sulfur Spray, Miller Lime Sulfur Solution, F & B Lime Sulphur Solution, Orthorix Spray, Security Lime Sulfur.

THIABENDAZOLE OR TBZ [2-(4-Thiazolyl) benzimidazole]

A very low toxicity, broad-spectrum, preventive-curative-systemic fungicide closely related to benomyl and used to control a variety of the same diseases. Useful as a foliar, fruit, bulb, corm, tuber, seed, and soil fungicide, and for thermal fumigation. Formulated as a 60% wettable powder, 45% flowable, and smoke generator.

Trade names. Mertect 40, 140F, 160, 260, 340F, and 360; Tecto; Thiabendazole; TBZ. Arbotect S and Arbotect 20-S, the phosphate salt of TBZ, are registered for controlling Dutch elm disease.

THIOPHANATE MATERIALS Dimethyl or diethyl [(1,2,-phenylene) bis (iminocarbonothioyl)] bis carbamate]

Very low toxicity, broad-spectrum, preventive-curative-systemic fungicides closely related to benomyl and used to control a variety of the same diseases on turfgrasses, fruits, vegetables, cereals, ornamentals, and nursery crops. Formulated as wettable powders, paste, and ULV.

Trade names. Topsin-M 70W, ULV and E; Fungo 50; Cleary's 3336; Topmec 70W Turf Fungicide; Scotts ProTurf systemic fungicide; ProTurf Fertilizer plus systemic fungicide.

Banrot is a combination of etridiazol (Truban 15%) and thiophanate-methyl (Topsin-M 25%). Zyban is a combination of thiophanate-methyl (15%) and mancozeb (60%) used as a foliar spray on ornamentals and nursery crops.

THIRAM [Tetramethylthiuram disulfide]

A broad-spectrum, protective fungicide for field crops, vegetables, flowers, grasses, and certain tree and bush fruits. Controls rusts but NOT powdery mildews. Applied to soil as a dust or drench to control crown rot, damping-off, and seedling blights. Do not apply to produce intended for canning or deep freezing as it may "taint" the produce.

Trade names. Tersan 75 Thiram Turf Fungicide; Thylate Thiram Fungicide; Arasan 50-Red Thiram Seed Protectant, 50-Red ND Thiram, 42-S Thiram Fungicide and Repellent, 70-S Seed Protectant, and 75 Thiram Seed Protectant; Evershield T Seed Protectant; Agway Thiram 4.8D and Tinasad; E-Z-Flo 5% Thylate Dust; Rhodia Sup'r-Wet Thirazm; Farmrite Thiram "95" and 5% Dust; Doggett Fison Turftox; Metasol Thiram 75%; Robeco Thiram 98/100%; Shepard Chemical Thiram; Occidental Thiram; Fungisan; Pearson's Moly-Stand Soybean Seed Protectant; Chipco Thiram 75; Naco Hi-Test Thiram Wettable Powder; Thiuram 75; Spotrete; Thiramad Turf Fungicide; Niagara Thiram 65 Wettable Powder; Aceto Thiram-75; Thiram 65% and Thiram-100; Miller's Thiram 65 and 75W; Vancide TM-95 and TM Flowable; Chemform 75% Thiram WP; Kerr-McGee Thiram; Science Gladiolus and Bulb Dust.

Stauffer Captan-Thiram 43-43 Seed Protectant contains 43% each of captan and thiram.

ZINEB [Zinc ethylenebis (dithiocarbamate)]

Excellent, very low toxicity, general, broad-spectrum fungicide for tree and bush fruits, vegetables, flowers, trees, shrubs, and nuts. Will NOT control powdery mildews. Only protective in activity.
Trade names. Dithane Z-78; Security Zineb Dust; Science Zineb Fungicide; Ortho Zineb Wettable; Black Leaf Sheen; Aceto Zineb-75 and 85%; Acme Zineb 75W Fungicide; Niagara Zineb 75 Wettable; Vancide Zineb 85% WP; Sherwin-Williams Zineb; E-Z-Flo Zineb 75; Pennwalt Zineb W-75; Miller's Zineb 6D; Stauffer Zineb 65-W and 75-W; Ortho Zineb 5 Dust; Chipman Zineb; Patterson's Zineb Wettable Powder; Chemform 65% Zineb; Chempar Zineb 75 WP; Zineb Garden Fungicide; Shepard Chemical Zineb; Argisect Brand Zineb 75% Wettable Powder; Hopkins 15% Zineb Dust and 6% Dithane Z-78 Dust; Naco Dithane 6 and 10 Dust; D.H. 10% Dithane Dust; Gold Kist Zineb Dust No. 10; Green Cross Thiogreen Dust Fungicide; New Dragon Tomato Dust; Miller Zineb 75%; Staples Dithane Seed Treating Dust; Vancide Zineb 85; BASF Zineb 80WP; E-Z-Flo Special Mushroom Dust; Superior's Zineb 75% Wettable.

ZIRAM [Zinc dimethyl dithiocarbamate]

General, very low toxicity fungicide, strictly protective. Useful for certain fungus leaf spots and blights of vegetables, fruits, nuts, and ornamentals; especially good for tender seedlings. Applied as spray, dust, or soil drench. Used in some multipurpose mixes. Does NOT control rusts or powdery mildews.
Trade names. Zerlate Ziram Fungicide; Karbam White; Ziram Spray Fungicide; Niagara Z-C Spray; Aceto Ziram-75 and -100; Allied Ziram; E-Z-Flo Ziram 76WP, Miller's Ziram and 95W; Wood Ridge Ziram; Cuman; Chempar Ziram 76WP; Corozate; Vancide MZ-96 and MZ Flowable; Shepard Chemical Ziram; Samincorp Ziram.

Fungicides of Less General Use (see RPD No. 1002 for a complete listing)

These chemicals include a large number of products with limited use. See also Disinfectants; Grain Preservatives; Lawn Fungicides; Other Soil Treatments (including Nematicides); Table 1, Soil-disinfecting Chemicals; Wetting, Spreading, and Sticking Agents (Surfactants).

Banrot--A very effective broad-spectrum, contact-systemic soil fungicide for greenhouse ornamentals. Contains 15% etridiazol and 25% thiophanate methyl as the active ingredients.

Fenarimol (Rubigan)--A new broad-spectrum fungicide that is highly effective against many different fungi on ornamentals, turfgrasses, and fruits. Available as a 12% EC and as a 50% WP. Its use is still largely under experimentation in the United States.

Hexachlorobenzene (HCB or perchlorobenzene)--A dust, slurry, or liquid seed treatment used primarily on cereals to control smuts. It is often combined with captan, maneb, thiram, or other fungicide to control seed rot and seedling blight fungi. See Report on Plant Diseases No. 1001, Seed Treatments for Field Crops, for trade names and diseases controlled.

Iprodione (Chipco 26019, Rovral)--A broad-spectrum contact turfgrass, fruit, and ornamental fungicide with excellent activity against Botrytis, Monilinia, Sclerotinia, Alternaria, Fusarium, Helminthosporium, and Rhizoctonia. Scott's Pro Turf Fungicide VI is a granular turfgrass fungicide containing 1.3% iprodione.

Metalaxyl (Subdue 2E, 5SP; Apron-FL; Ridomil-2E)--A wettable powder or E.C., protective fungicide with systemic properties of promise for fungal diseases of potatoes, vine crops, tomatoes, grapes, tobacco, cotton, ornamentals, turf, and hops. Fungi controlled include downy mildews, Pythium spp., and Phytophthora spp. Contains methyl D,L,N-(2,6-dimethylphenyl)-N-(2'-methoxyacetyl)-alaninate as the active ingredient.

Triadimefon (Bayleton)--A wettable powder, protective fungicide with systemic and eradicant properties. Has excellent activity against rusts, powdery mildews, and other fungi. Shows promise for control of fruit, turf, ornamental, and small grain diseases.

Triadimenol (Baytan)--An experimental systemic fungicide that has shown promise as a seed treatment for small grains. Controls loose smut and bunt and provides protection the following spring for control of powdery mildew, leaf rust, and Septoria tritici on winter wheat.

Triforine (Funginex)--A foliar, locally systemic fungicide (also protectant-contact-curative) that gives excellent control of powdery mildews, scabs, rusts, fungus leaf spots, blights, and rots of ornamentals, fruits, vegetables, and cereals. Triforine is an emulsifiable concentrate that contains 18.2% N,N' [1,4,piperazinediylbis-(2,2,2-trichloro-ethylidene)bis [formamide]] by weight as the active ingredient.

Disinfectants: There are a number of different chemicals that are used to kill or inactivate bacteria and fungi on tools, equipment, potting tables, empty greenhouse benches, pots, flats, other containers, storage areas, and hydroponic equipment. These include dipping, brushing, or spraying with 70 to 100% alcohol (grain, rubbing, or wood); 37 to 40% formaldehyde (1 pint in 5 gallons of water); Lysol; Listerol Household Disinfectant; potassium permanganate; and household bleach or sodium hypochlorite (Clorox, Purex, Sunny Sol), 1 pint of bleach in 1 gallon of water. Several commercial disinfectants are availble. These include:

Bardac-22--Used for treating storage areas, tools, and equipment. It contains 50% didecyl dimethyl ammonium chloride and 20% isopropanol.

Germ-I-Tol--Used for treating storage areas and equipment. It contains 50% alkyl dimethyl benzyl ammonium chloride.

LF-10 (Amphyl)--Used on greenhouse benches, potting tables, walks, tools, flats, plastic pots, and automatic watering systems. A 65% solution containing a mixture of potassium ricinoleate, o-benzyl-p-chlorphenol, isopropyl alcohol, tetrasodium ethyleneamine, tetraacetate, and alcohol. Not effective against resistant resting bodies of some fungi.

Hyamine materials (e.g., Hyamine 1622, 2389, and 3500) show germicidal effectiveness against a wide range of microorganisms. They contain quaternary ammonium compounds and are used in antiseptics, germicides, algicides, detergent-sanitizers, and deodorants. These compounds are available as an 80% ethanol solution, 5% aqueous solution, and 100% crystals.

Physan--Used for treating storage areas, tools, and equipment. It contains 10% each of n-alkyl dimethyl benzyl ammonium chlorides and n-alkyl dimethyl ethyl benzyl ammonium chlorides.

Roccal--A bactericide-fungicide used for treating potato storage areas and equipment. It contains 10% alkyl dimethyl benzylammonium chloride.

Grain Preservatives: These are liquids containing propionic acid or mixtures of it with closely related acids (e.g., acetic acid) that allow early harvesting and storage of high-moisture grain to be utilized for animal feed only without the problems of handling and post-harvest spoilage from storage molds (primarily species of Aspergillus and Penicillium). Sold under such trade names as Aceto Propcorn, ChemStor and ChemStor III, Grain Storer P, Tenox Grain Preservatives, Ortho-Guard G.P., Grain Treet, Grain Treat, and Sentry Grain Preserver. These products are NOT for treating grain that might be used for seed, malting purposes, or human consumption. Treated grain is reduced to sample grade due to persistent odors from the chemical treatment.

Lawn Fungicides: These are usually formulated as multipurpose mixtures to control a number of lawn and fine turfgrass diseases. The more widely available and used products include anilazine (Dyrene), chlorothalonil (Daconil 2787), Kromad, iprodione (Chipco 26019), Fore, Tersan LSR and 1991 Turf Fungicides, Bromosan, Spectro, thiophanate materials (Fungo 50, Topmec 70W Turf Fungicide, Cleary's 3336, Scotts ProTurf systemic fungicide), Acti-dione Thiram and Acti-dione TGF, Sears Lawn Fungicide, Scotts ProTurf and Lawn Disease Preventer fungicides. Turf fungicides that control one to several diseases contain cadmium (Caddy, Cad-Trete, Cadminate), zineb, maneb or mancozeb, and others. See also Commonly Used Fungicides and Fungicides of Less General Use.

Surfactants or Surface-Active Agents (Wetting, Spreading, and Sticking Agents): These materials are added to spray mixes to help keep the pesticide in suspension, improve cohesiveness of the spray, and increase the wetting of leaves, fruits, and stems. They are most useful when spraying hard-to-wet foliage such as that of conifers, broadleaf evergreens, boxwood, carnation, euonymus, gladiolus, iris, narcissus, peonies, roses, cabbage, onions, peas, and peppers. These materials can be classed as nonionic, anionic, cationic, and amphoteric. Most emulsifying agents are of the nonionic type; they do not ionize. Wetting agents and detergents are mostly anionic, becoming ionized in solution with the negative molecule being of primary influence. Cationic forms are not widely used; when these materials are ionized, the positive part of the molecule is dominant. A few commercial spreader-stickers (film extenders) available for tank mixing include Aqua T Non-ionic Organic Wetting Agent, Agway Spreader-Sticker, Bio-Film Spreader-Sticker, DuPont Spreader-Sticker, Chevron Spray Sticker, Citowett Plus, Filmfast Spreader-Sticker, Miller Nu-Film-P and -17, De-Pester Spreader-Activator, Sprint-38 Spreader Sticker, Triton B-1956, Plyac Non Ionic Spreader-Sticker, Aim Spreader-Activator, Ag-Chem Activator, Spray-Stay, At-plus S26, Adsee, and R56-Spreader Sticker.

Commercial spreaders and spreader-activators include Ortho Chevron Spreader, Chipco and Rhodia Spreader-Activator, Flo-Wet, Multi-Film L and X-77, Ortho X-77 Spreader, Pinoline, Sure Spred, Tween 20, Surfactant II, Triton AF and CS-7, Fluxit, Sanomerse 80, Penex, Sur-Ten Wetting Agents, Activate 107, Neptune, At-plus, Bio-88, Buffer-X, and R-11 Spreader-Activator.

Some common stickers include Goodrite PEPS, De-Pester Sticker, and Exhalt 800.

The fungicide or other pesticide label should indicate restrictions in selection of compatible surfactants. Use these commercial preparations according to label

directions. The addition of excess wetting or spreading agent may cause excessive runoff and result in a poor spray deposit.

When selecting a surfactant, consider such factors as the homogeneity of the concentrate, its storage stability, corrosion factors on storage or packaging, ease of mixing in water, effect of water hardness on the emulsion stability or dispersion, plus the use and cost of the ingredients.

Nematicide--Insecticide Materials

Aldicarb (Temik). A highly toxic, long-lasting, granular, systemic combination insecticide-miticide-nematicide with some fungicidal activity for soil application to ornamental plants and some field crops. Contains 2-methyl-2-(methylthio) propionaldehyde-o-(methylcarbamyl)oxime as the active ingredient. For commercial use only.

Carbofuran (Furadan). A contact and systemic, long-lasting, broad-spectrum, soil and turf nematicide-insecticide-miticide that contains 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate as the active ingredient. It is available as 10% granules (15-20 lb/A; 7-15-inch band on 40-inch rows) or as a flowable. Carbofuran is registered for use on some field crops, vegetables, shade trees, and pine seedlings. For commercial use only.

Diazinon, Science Diazinon, Spectracide, AG 500, Lawn Insecticide with Diazinon, and Sarolex. Available as granules, dust, or liquid. A broad-spectrum insecticide-nematicide for application to turf. Contains 0,0-diethyl o-(2-isopropyl-4-methyl-6-pyrimidinyl)phosphorothioate as the active ingredient. Diazinon is sold primarily as an insecticide, but is fairly effective against nematodes in sandy soils.

Disulfoton (Di-Syston, Disyston). A long-lasting, foliar, seed and soil, systemic insecticide-miticide-nematicide for use on certain field crops, vegetables, turfgrasses, flowers, and ornamental trees and shrubs. Available as granules and as a liquid concentrate for use only by commercial growers or professional applicators. Disulfoton contains 0,0-diethyl S-[2-(ethylthio)ethyl]phosphorodithioate as the active ingredient.

Ethoprop (Mocap, ProTurf Nematicide)--A highly toxic, contact, granular, or liquid, long-lasting, broad-spectrum, soil and turfgrass nematicide-insecticide. It is registered for use on certain field crops, ornamentals, and turfgrasses. Ethoprop contains 10% or 15% O-ethyl S,S-dipropylphosphorodithioate as the active ingredient. For soil, apply 1 to 8 gal/A before or at planting time (incorporate thoroughly) or as a post-plant band application. For turf, distribute evenly over the established area to be treated, and drench in immediately using at least one-half inch of water. Carefully follow all manufacturer's directions and precautions.

Fenamiphos (Nemacur). A long-lasting, contact and systemic, broad-spectrum, soil and turf nematicide for commerical or professional use only. Contains ethyl-4-(methylthio)-m-tolyl isopropylphosphoramidate or ethyl 3-methyl-4-(methylthio)-phenyl(1-methylethyl) phosphoramidate as the active ingredient. Available as granules and as an emulsifiable concentrate. Useful on certain field and vegetable crops. Applied as outlined for ethoprop (above). Also used as a seed treatment.

Fensulfothion (Dasanit, Chemagro Dasanit Insecticide-Nematicide, Terracur P, and Dasanit Ornamental and Turf Nematicide). A highly toxic, long-lasting, primarily contact nematicide-insecticide for certain commercially grown turfgrasses, field crops, flowers, ornamental shrubs, foliage plants, and vegetables. Also used as a plant dip. Contains 0,0-diethyl 0-[4-(methylsulfinyl) phenyl] phosphorothioate as the active ingredient. Available as 15% granules and as a 63% liquid spray concentrate. Apply the same as for ethoprop (above); 1 to 3.3 gal/A of liquid concentrate or 20 to 184 lb/A of the granular product.

Oxamyl (Vydate). A liquid or granular systemic and contact nematicide-insecticide-miticide containing 24% methyl-N,N'-dimethyl-N-[(methylcarbamoyl)oxy]-1-thiooxamimidate as the active ingredient. Applied as a foliar spray on woody plants; preplant soil incorporation; soil drench; root, corm and bulb dip; and in transplant water for use on certain vegetables and ornamentals. Not for use in home plantings.

Terbufos (Counter 15G). A systemic insecticide for control of nematodes on corn.

Table 1. SOIL-DISINFECTING CHEMICALS--MATERIALS, BRANDS, CONTROLS, APPLICATION, AND REMARKS

TREATMENTS MATERIALS, BRANDS	*CONTROLS*	*APPLICATION AND REMARKS*
1. *Steam* Heat soil (6 inches deep or the coldest spot) to 180°-200° F (82°-93° C) for 30 min., or to 160° F (71° C) for 60 minutes.	All types of pests--fungi, most bacteria, nematodes, mycoplasmas, viruses, soil insects, mites, garden centipedes, and most weed seeds if moist.	Various methods are available: Pressure cooker (for small amounts), tank or vault, buried tile, perforated pipes on top of or in soil, or inverted-pan. Soil in benches or beds should be covered with a tarp. When steaming large quantities of soil, use a pressure between 15 and 100 pounds per square inch (psi).
Dry heat--Heat soil to 180° F (82° C) and keep at this temperature for 30 minutes.	All types of pests--the same as for Steam (above)	Place small quantities in an oven or use an electric soil pasteurizing box (e.g., Famco, Thermasoil).
2. *Multipurpose Chemicals* *Methyl Bromide*; Dowfume MC-2; Terr-O-Gas; Terr-O-Gel; Picride; Profume; Brom-O-Gas; Brom-O-Sol; Celfume; Meth-O-Gas; Nemaster. (Methyl bromide, usually with chloropicrin added.) Celfume-D and Rotox Gelled Soil Fumigant contain 70% methyl bromide and 28.7% EDB; Dowfume MC-33 and Terr-O-Gas 67 contain 67% methyl bromide and 33% chloropicrin. Trizone contains 60% methyl bromide, 30% chloropicrin and 9% propargyl-bromide.	Nematodes, grubs, garden centipedes, cutworms, wireworms, and other soil insects, weed seeds, damping-off, seedling blights, wilts, other soil-inhabiting disease-causing fungi, e.g., *Pythium, Fusarium, Phytophthora, Rhizoctonia, Sclerotinia, Verticilluum,* actinomycetes.	Treatment is only for commercial applicators who are properly equipped. Compressed gas in aerosol cans, cylinders, or drums. Must apply with a special applicator under a gas-proof cover. A fumigation period of 1 to 2 days is needed. A 1- to 2-week wait is normally required between treating and planting. Good in coldframes, greenhouses, turf, nurseries, and outdoor beds. *Very poisonous.* Carefully follow all manufacturer's directions. To kill soil fungi use 3 to 4 pounds/100 sq ft; for other pests 1 to 2 lbs. Do *not* use before planting onions, garlic, celery, carnations, salvia, snapdragons, conifers, holly, and multiflora rose. Most formulations contain a small amount of chloropicrin (about 1 or 2%) as a warning agent. Tractor-mounted machines with chisel-type applicators are used for field-scale operations. This equipment simultaneouly lays a gas-proof cover. To disinfect tools, containers, and machinery, cover with a gas-proof cover and weight edges down. Apply 1 to 4 lbs/100 cubic feet. Leave cover in place for 2 to 3 days if the temperature is 50° to 59° F; 1 day if temperature is 60° F or above. A full-face gas mask fitted with a black canister must be worn during application and when cover is removed. Do *not* use around living plants.
Chloropicrin; Pic-Clor; Tri-clor; Chlor-O-Pic. (Tear gas or trichloronitromethane.) For combinations with methyl bromide see above; combinations with EDB include Terr-O-Cide 15,30,54-45,72-27; combinations with D-D include Terr-O-Cide 15-D, 30-D and 57/43/T.	Nematodes, damping-off, seedling blights, and other soil-inhabiting, diease-causing fungi and bacteria, weed seeds, and soil insects. Controls same range of pests as does methyl bromide (above). The best chemical for control of Verticillium wilt.	Treatment is only for commercial applicators who are properly equipped. Liquid in pressure cans or cylinders. Apply with special injection equipment in holes 6 to 8 inches deep, at 8- to 12-inch intervals. Inject chemical into each hole and close by stepping on the hole (33-50 gal/A for light soils; 41-77 gal/A for heavy soils). After treatment, apply gas-proof cover or sufficient water to soak upper inch of soil to seal in gas. Maintain water seal or cover for at least 3 days. Do not plant in treated soil until all traces (odor) of chloropicrin has gone (2 to 4 weeks). Use an approved chloropicrin full-face mask, canister, and polyethylene gloves while working. Carefully follow all manufacturer's directions. Do *not* use around living plants.
Methyl isothiocyanate or *MIT*: Vorlex Soil fumigant (20% methyl isothiocyanate and 80% chlorinated C_3 hydrocarbons including dichloropropenes.	Nematodes, soil insects including symphylans, germinating weed seeds, bacteria, damping-off and seedling blight fungi, *Verticillium,* and other soil-inhabit-	Apply like chloropicrin (above) but use chisel spacings of 6 to 8 inches and 7 to 60 gal/A. Pack treated soil and apply a light water seal or plastic cover. Leave soil undisturbed for at least 7 days. Then aerate (cultivate) to prevent soil crusting. Do *not* plant for 3 to 4 weeks or until all odor is gone. Higher rates and cold or heavy soils require

Table 1. (CONTINUED)

TREATMENTS MATERIALS, BRANDS	*CONTROLS*	*APPLICATION AND REMARKS*
	ing, disease-causing fungi.	longer waiting periods (7 days for each 23 lb of active product). Carefully follow all manufacturer's directions.
Metam-sodium or *SMDC*; Stauffer Vapam Soil Fumigant; F & B Vapam; Metam-Fluid BASF; Solasan 500 (32.7% sodium N-methyl dithiocarbamate (anhydrous).)	Nematodes, soil-inhabiting and disease-causing fungi and bacteria, germinating weed seeds, and soil insects including garden centipedes; also a herbicide at higher rates of application.	Sprinkle diluted liquid uniformly over soil with sprinkling can, hose proportioner, sprayer, or meter into irrigation system. Or apply like chloropicrin (above) using 15-45 gal/A. Cover treated area with a tarp for 4 days after treating, or apply a water seal to upper inch of treated soil (15 to 20 gallons per 100 sq. ft). Do *not* treat more than 100 sq ft at a time before applying water seal. When top-treated soil has dried sufficiently, cultivate 1 to 2 inches deep. Do *not* plant until 3 to 4 weeks or more after treatment. Fall application is best. Do *not* use in greenhouses or close to where desirable plants are present.
Dazomet or *DMTT*; Mylone 85% WP, Dust-50; Crag Fungicide 974; Hopkins Mylone 50D; Crag Nemacide; Dazomet-Powder BASF; Basamid-Granular; Miller Mico-Fume 25-D (Mylone) (Tetrahydro 3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione).	Nematodes, soil fungi, certain weed seeds, and soil insects.	Apply as a preplant soil drench (12 to 50 gal/A), dust, wettable powder or granules using a sprinkling can, sprayer, or fertilizer spreader. Disc, rake, or cultivate (rototill) into soil. Used for seed and plant beds. Cover treated area with gasproof plastic cover or apply water seal as for Metam-sodium (above). Wait 3 to 4 weeks before planting. Fall treatment is best. Fumes are toxic to growing plants; greenhouses must be empty. Follow all manufacturer's directions and precautions.
Formaldehyde (Formalin)· DuPont Formaldehyde Solution, Parsons U.S.P. Formaldehyde. (Usually sold as a 37-40% solution in water and methanol.)	Damping-off, seedling blights, other soil-inhabiting and disease-causing fungi and bacteria, soil insects, and many soft or germinating weed seeds. Good disinfectant for tools, equipment, and storage areas. Also a seed disinfestant. Does NOT control nematodes.	Mix 3 tablespoons of formaldehyde in a cup of water and sprinkle over a bushel of soil (32 qts); 1 tablespoon in 1/2 cup of water treats a florist's flat of soil. Mix in very thoroughly with a shovel or hoe on a flat surface. Put treated soil in flats, pots, or leave in pile and cover with plastic, wet burlap, or canvas for 2 to 3 days. Drench soil in plant beds or seed flats. Use 1 cup in 3 gal of water. Apply slowly and evenly, 1/2-1-1/2 gal/sq ft, using a sprinkling can. Cover soil. After 2 to 4 days remove cover, work soil, and plant when all odor is gone. Never use in a greenhouse or where plants are growing; fumes are toxic to plants.
3. Chemicals Primarily for Nematode Control (Nematicides)		
EDB; Ethylene Dibromide; Celmide; EDB-85; Kop-Fume; Nephis; E-D-Bee; Soilbrom 40, 85 and 90; Ortho Ethylene Dibromide; Bromofume; Pestmaster Fumigant EDB-85 (1,2-dibromoethane). Terr-O-Cide 15 is a mixture of 40% EDB and 15% chloropicrin; Terr-O-Cide 30 contains 36% EDB and 30% chloropicrin.	Nematodes, wireworms, grubs, garden centipedes, and certain other soil-borne pests. Does little to control soil-borne fungi and bacteria.	Apply preplant, 6 to 8 inches deep at 10- to 12-inch intervals with a hand injector or special tractor-mounted equipment using 3 to 50 gal/A. Do *not* use around living plants or where onions, lilies, amaryllis, and other bromine-susceptible plants will be grown within 3 years. Wait 3 to 4 weeks or more before planting. EDB is recommended for fall treatment only. Fumes are toxic to plants; greenhouses and other enclosed areas must be empty. Carefully follow all manufacturer's directions.

Table 1. (CONTINUED)

TREATMENTS MATERIALS, BRANDS	*CONTROLS*	*APPLICATION AND REMARKS*
1,3-D; D-D Soil Fumigant: Telone II; Stauffer DD Soil Fumigant; Ortho D-D Soil Fumigant; Nemafume (mixed dichloropropenes). Terr-O-Cide 15D is a mixture of 85% D-D and 15% chloropicrin. Terr-O-Cide 30D contains 70% D-D and 30% chloropicrin.	Nematodes, wireworms, garden centipedes, and other soil insects, weed seeds, and certain other soil-borne pests. Gives poor control of soil bacteria and fungi.	Apply preplant 6 to 8 inches under soil surface like EDB (above) at 10- to 12-inch intervals using 8-120 gallons per acre. Cover with a gas-proof plastic cover for 1 week. Do *not* plant until 3 to 6 weeks after treatment. Carefully follow all manufacturer's directions. Never use in a greenhouse or where plants are growing. Recommended for fall treatment only.
4. Chemicals Primarily for Fungus Control (Fungicides)		
Captan, etridiazol, thiram, Polyram, Banrot, Metalaxyl, Polyram, zineb, ferbam, ziram, benomyl, thiabendazole, chloroneb. (See also under these names.)	Seed rot, damping-off, seedling blights, caused by fungi in greenhouse (cutting) benches, flats, hot beds, pots, cold frames, and flower beds.	Apply as dust or spray uniformly over loose, fairly dry soil. Cultivate thoroughly into top 2-1/2 to 4 inches of soil. Seed can be planted immediately after treatment. May also be applied as a post-plant soil spray or drench. Use about 1 pint to 1 quart of prepared mix per square foot. Repeat at 5- to 40-day intervals if disease persists. Check and follow all label directions and precautions.
PCNB or quintozene; Terraclor; Brassicol; Fungiclor. (Pentachloronitrobenzene.)	PCNB controls certain disease-causing fungi, e.g., *Rhizoctonia, Botrytis, Sclerotinia, Sclerotium.* (Etridiazol and fenaminosulf control water molds.)	Various application methods including suspension in transplant water, soil surface sprays or dusts, and dry mixing into upper 2 to 6 inches of soil. Sometimes mixed with etridiazol, fenaminosulf (Lesan), captan, ferbam, captafol, benomyl, or chloroneb. Thorough mixing with soil is essential. Follow manufacturer's directions regarding rates and methods of application.

Restricted-Use Pesticides

F.D. Miller

In 1972, amendments to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provided the legal mechanism for restricting the use of certain pesticides. The U.S. Environmental Protection Agency (EPA), confronted with the enormous task of reviewing all registered pesticides, proposed to classify pesticides by their active ingredient, subdividing each active ingredient into its various formulations or uses. This classification system provided the EPA with more flexibility to restrict some, but not all, products containing the same active ingredient. The process was called classification by regulation. When pesticides are restricted in this manner, the manufacturer is given 270 days to amend the label on all the affected products. This timetable has been of particular interest to pesticide dealers because once the restricted-use label is applied to the container, it can be sold only to a certified applicator.

In addition to reviewing existing products, the EPA is required to register new products not previously marketed. Some of these new products have been classified for restricted use. This process is called classification by registration.

Pesticides classified for restricted use by registration and regulation are listed in Table 1.

Table 1. Restricted-Use Pesticides (January 1986)

Active ingredient	Trade name	Type	Formulation	Criteria for restricted use
aldicarb	Temik	insecticide	all formulations	accident history
aluminum phosphide	Phostoxin, Detia, many others	fumigant	all formulations	human inhalation hazard
amitraz	Tuco BAAM, Mitac E.C.	insecticide-acaricide	all formulations	possible oncogenicity
azinphosmethyl	Guthion, many others	insecticide	all liquids with concentrations above 13.5%	human inhalation toxicity
brodifacoum	Talon G, Rodenticide Pellets, Rodenticide Bait Pack	rodenticide	pellets	hazard to nontarget
bromadiolone	Maki Urban Rat and Mouse Meal Bait	rodenticide	only product	fish and wildlife hazard
calcium cyanide	Degesch, calcium cyanide, G-fumigant	fumigant	all formulations	human inhalation hazard
carbofuran	Furadan	insecticide	concentrate suspensions and wettable powders; all granular formulations	acute inhalation toxicity
chlordimeform	Galecron	insecticide	all formulations	causes cancer in laboratory animals
chlorfenvinphos	several	insecticide	all formulations	acute dermal toxicity
chlorobenzilate	Acaraben	insecticide	all formulations	oncogenicity
chlorophacinone	Rozol Blue Tracking Powder	rodenticide	all formulations	human hazard, potential for food contamination
chloropicrin	many	fumigant	all formulations	acute inhalation toxicity

Table 1. (continued)

Active ingredient	Trade name	Type	Formulation	Criteria for restricted use
chlorpyrifos	Killmaster II	insecticide	2% in lacquer base	restricted at registration
cycloheximide	Acti-Aid	fungicide	all formulations greater than 4%	acute dermal toxicity
cypermethrin	Cymbush, Ammo	insecticide	all formulations	oncogenicity, hazard to non-target organisms
demeton	Systox	insecticide	all formulations	acute oral and dermal toxicity
diallate	Avadex	herbicide	only product	oncogenicity, mutagenicity
diclofop methyl	Hoelon	herbicide	all formulations	oncogenicity
dicrotophos	Bidrin, others	insecticide	all liquid formulations	acute dermal toxicity, residue effects on birds
diflubenzuron	Dimilin	insecticide	all formulations	lack of envirionmental hazard data
dioxathion	Delnav, Deltic	insecticide	all formulations	acute dermal toxicity
disulfoton	Di-Syston	insecticide	all granular formulations greater than 2%; all solutions	acute dermal and inhalation toxicity
endrin	Endrin, many others	insecticide	all formulations	acute dermal toxicity, hazard to nontarget organisms
EPN	EPN, many others	insecticide	all liquid and dry formulations	acute dermal and inhalation toxicity, residue effects on birds
ethoprop	Mocap	insecticide	all formulations	acute dermal toxicity

Table 1. (continued)

Active ingredient	Trade name	Type	Formulation	Criteria for restricted use
ethyl parathion	many	insecticide	all formulations	acute dermal and inhalation toxicity, effects on birds, fish, and mammals
fenamiphos	Nemacur	nematicide	emulsifiable concentrates	acute dermal toxicity
fensulfothion	Dasanit	insecticide	emulsifiable concentrates and solutions, all granular formulations	acute dermal and inhalation toxicity
fenvalerate	Pydrin	insecticide	emulsifiable concentrates, (ear-tags not included)	high fish toxicity
flucythrinate	Pay-Off	insecticide	all formulations	possible adverse effects on aquatic organisms
fluoroacetamide	1081, others	rodenticide	all formulations	acute oral toxicity
fonofos	Dyfonate	insecticide	all liquid formulations; granular formulations greater than or equal to 20%	acute dermal toxicity
heptachlor	Heptachlor, many others	insecticide	all formulations	administrative order
hydrocyanic acid	several	fumigant	all formulations	human inhalation hazard
isofenphos	Amaze, Oftanol	insecticide	all liquid formulations	conditional registration
lindane	many	insecticide	all liquid formulations	RPAR decision, possible oncogenicity
magnesium phosphide	Degesch Fumi-Gel, Degesch Fumi-Strip	fumigant	all formulations	acute inhalation toxicity

Table 1. (continued)

Active ingredient	Trade name	Type	Formulation	Criteria for restricted use
methamidophos	Monitor	insecticide	all liquid formulations 40% or greater, dust formulations 2.5% or greater	acute dermal toxicity, residue effects on birds
methidathion	Supracide	insecticide	all formulations	residue effects on birds
methiocarb	Borderland Black Repellent, Hopkins Mesrepel, Mesurol	bird repellent	some formulations	possible hazard to nontarget organisms
methomyl	Lannate, Nudrin	insecticide	all concentrated solution formulations	residue effects on mammals, accident history
methyl bromide	many	fumigant	all formulations in containers heavier than 1.5 pounds	accident history, acute inhalation toxicity
methyl parathion	many	insecticide	all formulations	acute dermal toxicity, residue effects on birds, bees, and mammals
mevinphos	Phosdrin, many others	insecticide	all formulations	acute dermal toxicity, residue effects on birds and mammals
milban	Milban	fungicide	all formulations	corrosive to eye tissue
monocrotophos	Azodrin, many others	insecticide	liquid formulations	residue effects on birds and mammals
nicotine	Blackleaf 40	insecticide	all formulations	acute inhalation toxicity, effects on aquatics
paraquat	Paraquat	herbicide	most formulations	use and accident history
pentachlorophenol	Agway Penta Wood preservative	wood preservative	all formulations	voluntary restriction, reproductive effects

Table 1. (continued)

Active ingredient	Trade name	Type	Formulation	Criteria for restricted use
permethrin	Ambush, Pounce	insecticide	all formulations (except ear-tags)	high fish toxicity
phorate	Thimet	insecticide	all formulations, liquid and granular formulations greater than 5%	acute dermal toxicity, residue effects on birds and mammals
phorazetim	Gophacide	rodenticide	baits (discontinued)	residue effects on birds and mammals
phosphamidon	Dimecron, others	insecticide	all formulations	acute dermal toxicity, residue effects on birds and mammals
picloram	Tordon	herbicide	all formulations except Tordon 101R	hazard to nontarget plants
pronamide	Kerb	herbicide	Kerb 50W	oncogenicity
propetamphos	Safrotin	insecticide	only product	voluntary restriction
simazine	many	herbicide	all formulations	terrestrial uses; possible groundwater contamination
sodium cyanide	many	fumigant	all formulations	acute inhalation toxicity
sodium fluoro-acetate	1080	rodenticide	all formulations	acute oral toxicity, use and accident history
starlicide	Gull-Toxicant 98% Concentrate	bird repellent	only product	hazard to nontarget organisms
strychnine	many	rodenticide	all formulations greater than 0.5%	acute oral toxicity, effects on nontarget organisms, accident history
sulfotep	Bladafum	fumigant	all formulations	acute inhalation toxicity
sulprofos	Bolstar	insecticide	all formulations	wildlife hazard

Table 1. (continued)

Active ingredient	Trade name	Type	Formulation	Criteria for restricted use
TEPP	Tetron, Vapotone	insecticide	all formulations	acute dermal and inhalation toxicity, residue effects on birds and mammals
terbufos	Counter	insecticide	all formulations	effects on nontarget organisms
toxaphene	many	insecticide	all formulations	oncogenicity, hazard to nontarget organisms
triphenyltinhydroxide	many	fungicide	all formulations	possible mutagenic effects
zinc phosphide (all products suspended)	Phosvin, Blue-Ox	rodenticide	all formulations	acute oral and inhalation toxicity, hazard to nontarget organisms

Suggestions for Minimizing Bee, Fish, and Wildlife Losses from Pesticides

G.C. Sanderson, R.C. Hiltibran, and E.E. Killion

It may be almost impossible to use pesticides without the possibility of endangering some nontarget species, such as fish and wildlife. However, through prudent use, the hazards to fish and wildlife from the use of pesticides can be substantially reduced. Here are some precautions to follow:

1. Apply pesticides according to the instructions given by the manufacturer and the Cooperative Extension Service.

2. If more than one pesticide is available to control a specific pest, use the pesticide least toxic to nontarget organisms. (Usually this information is not readily available to the applicator in the field. Also, frequently there is not much difference between pesticides in toxicity to nontarget organisms.)

3. Avoid drift. (Most applicators are aware of drift problems. However, problems are caused by the fact that climatic conditions often change after the application of a pesticide, and these changes cannot always be predicted.)

4. Follow instructions in disposing of pesticide containers.

5. In wildlife and aquatic areas use ground equipment so that pesticides can be confined to specific target areas.

6. Make sure that pesticide-treated seed is not readily available to birds or mammals.

7. Do not apply to water pesticides that are not registered for aquatic use. For application to water, use only those pesticides registered by the federal EPA for aquatic use (Rule 203h, Water Pollution Regulations, as amended).

8. If a pesticide is extremely toxic to fishes, avoid applying it in the immediate watershed, including ditches and channels that drain into bodies of water.

9. Wash application equipment properly, and do not permit wash water to enter any water area.

Some Characteristics of Animal Populations in Illinois That Are Helpful in Understanding the Wildlife-Pesticide Problem

First of all, it should be emphasized that we know little about the overall effects of any pesticide on any population of wild vertebrate animals. Certain general facts have been established, however. A considerable amount of data is available on the acute toxicity of various compounds to a variety of species in captivity. Also, a limited number of studies have been made on the rate of recovery of a population following one or more applications of a pesticide to an area. In populations of wild vertebrates some pesticides may produce great mortality both directly and indirectly

through the food chain. It has been shown that persistent chemicals such as the chlorinated hydrocarbons are concentrated from the bottom of the food chain to the top of the food chain so that animals at the top of the food chain often accumulate heavy dosages of the toxin. As a result, whole populations may lose their reproductive capacity. Accumulations of organo-chloro insecticides through the food chain may have reduced the reproductive capacity of the bald eagle, duck hawk, and other raptor populations both in Europe and North America, as well as certain species of fishes and fish-eating birds such as loons, cormorants, and pelicans.

While these discussions refer to all wild vertebrates in general, most of the remarks and examples will refer to birds. Because of their migratory and highly mobile nature, a greater number of birds are susceptible to poisoning from a single application of pesticide than are mammals.

Certain ecological principles should be obvious to everyone. The simpler the habitat, the fewer organisms it supports, both in terms of the number of organisms and the variety of organisms. Conversely, the more complex the habitat, the greater the number and variety of organisms. For example, in summer, bare plowed ground usually supports only about 3 to 5 native species of birds with only about 1 bird for every 2 acres. At the other extreme is forest, which supports about 80 to 85 nesting species of birds with about 5 to 8 birds per acre. Of the agricultural habitats in Illinois, corn and soybean fields have the poorest bird populations, essentially the same as plowed bare ground; wheat fields are only slightly better, but oat fields have conspicuously higher bird populations. Grasslands and hayfields are very rich bird habitats with 40 to 70 native species in summer and 3 to 5 birds per acre. The shrub borders and hedges at the edges of cultivated fields have some of the densest populations of birds of any Illinois habitat. Marshlands also have high populations and many species. In Illinois, the prairie-grassland and marsh-dwelling species are the ones in greatest danger of extermination.

Regrettably, the effects of pesticides applied to a wheat field do not stop at the borders of the wheat field because animals, especially birds, from adjacent fields may pass through the poisoned wheat field or even forage at its boundaries. A study made in Illinois in 1964 indicated that in a single breeding season two successive populations of birds were killed in a hayfield from the effects of one application of 1/4 pound of dieldrin on a nearby wheatfield. The hayfield was not sprayed, but the birds there died. A third population of birds that moved into the hayfield within a month of the spray date was unable to produce fertile eggs.

Populations of birds shift greatly from season to season. Between April 15 and June 10, and again between September 1 and November 15, the bird populations in all parts of Illinois reach their greatest heights. Over 200 species are present in the state, and the numbers are many times the normal breeding population. Many of these species are highly insectivorous. After October 1, more and more waterfowl appear in the wetlands of the state. The songbird populations penetrate every habitat, but are most abundant where there is some woody vegetation. Populations of songbird migrants in open field habitats probably reach their peak in late March to mid-May and in October and early November. Fortunately most of the migrants do not spend time in plowed fields, or corn or bean fields, i.e., bare fields. An exception is the golden plover, which passes through the state by the thousands in April and May; these birds regularly feed on bare fields and grasslands and concentrate particularly around rain pools.

In Illinois, bird populations reach their lowest levels in the northern third of the state in the winter (Jan. 1 - March 1), but in the southern third of the state winter populations are even higher than the summer populations in practically all habitats.

Some Useful Facts about Pesticides and Fish Mortality

Fish kills in ponds and streams are caused by insecticides, herbicides, liquid fertilizers, barnyard wash, and numerous other factors that affect the supply of oxygen. Specifically, some insecticides are much less toxic to fish than others, so proper selection and use of insecticides will reduce potential danger. Extreme care and caution are urged in applying any pesticide near streams and ponds. If toxic agents are applied in a short section of a stream or drainage channel, fish and other animals may be killed as the toxic agent flows downstream. When a fish kill occurs, examine all possible causes, including pesticides.

The accompanying table may be of some help to you in answering questions about insecticides and fish kills. We compiled this information from several sources. In using the data, consider the stability of the compound, its tendency to store in fat, method and rate of use, affinity for soil particles, and solubility, as well as exact toxicity.

LD_{50} is the number of milligrams (0.001 gram) needed per kilogram (1,000 grams) or 2.2 pounds of body weight to kill 50 percent of selected healthy laboratory test animals, usually white rats. Both oral and dermal toxicities are included in the table.

Also in the table, LC_{50} means the amount of pesticide in parts per billion needed to kill 50 percent of the test fish in a 24-hour period in an aquarium. Note that this information indicates those killed immediately after exposure. Low levels of some pesticides may be stored in fat tissues over a period of weeks. Theoretically, this stored material could cause fish mortality if the fat were suddenly used under stress and the pesticides were redistributed throughout the fish's system.

The LC_{50} and the rate per acre-foot of water are based on laboratory tests on 2-inch bluegills exposed to that concentration for 24 hours at a water temperature of 75° F. When they were exposed for 96 hours, the concentration required to reach the LC_{50} was much lower. Toxicity varies greatly with fish species, chemical, and formulation of the chemical. The LC_{50} for naled (Dibrom) to rainbow trout was 70 ppb and for bluegill, 200 ppb; for trichlorfon (Dylox) it was 28 ppm for trout and 5.6 ppm for bluegill. Thus this table serves only as a guide. Bluegills were used rather than trout because they are a popular Illinois fish species.

Some Facts about Pesticides and Bees

Bees are highly important as pollinators of apples, pumpkins, clovers, cantaloupes, watermelons, blueberries, cucumbers, squash, and other crops in Illinois. Honey bees visit blooming soybeans in all areas of the state and improve yields of some varieties. The bees also visit sweet corn and field corn tassels when they are shedding pollen. Growers should consider the bees' presence before applying insecticides during soybean bloom and when corn is pollinating. Highly poisonous to bees of all kinds, some common insecticides may cause serious losses to social bees, such as honey bees and bumble bees, as well as to the less-known solitary bees, such as alkali bees and leaf cutter bees. Efficient management of control

Insecticides, Their Common Agricultural Rates, Extent of Use, LD50 to White Rats and Other Animals, 24-Hour LC50 to Bluegills, and the Calculated 24-Hour LC50 in Pounds of Toxicant per Water Acre 3 Feet Deep

Insecticide	White rats Approximate LD50, mg./kg. Oral	Dermal	Common agr. rate, (lb./A.)	Use in Illinois	Birds[a] LD50 mg/kg	Fish LC50, ppb	Lb. toxicant per ft.-acre for bluegill LC50	Comments apply only to fish kill
toxaphene[b]	85	925	1.5	Moderate	31	7	.02	Extremely toxic to fish. Do not use in the vicinity of streams or ponds.
DDT[b]	115	2,510	...	None	595	7[c]	.02	
azinphosmethyl (Guithion)[d]	12	220	.5	Moderate	75	8?	.02+	
aldrin[b]	49	98	1.0 to 1.5	Heavy[e]	6	10	.03	
phorate (Thimet)[d]	1	3	1.0	Heavy	<1	10	.03	
rotenone	75	940+	...	None	>1,414	24	.06	
methoxychlor[b]	5,000	6,000+	1.5	Light	>2,000	31	.08	
heptachlor[b]	131	230	1.0 to 1.5	Moderate[e]	>2,000	35	.09	
diazinon[d]	92	680	1.0	Moderate	4	54	.15	Highly toxic to fish. Use great caution if applied in the immediate vicinity of streams and ponds.
parathion	12	14	.25 to .5	Light	2	56	.15	
lindane[b]	89	950	...	None	900	61	.16	
malathion[d]	1,200	4,000+	1.0	Moderate	167	120	.32	Moderately toxic to fish. Use cautiously around streams and ponds. Avoid direct application of agricultural sprays to water insofar as fish are concerned.
demeton (Systox)[d]	5	11	...	None	7	195	.53	
naled (Dibrom)[d]	250	800	.75	Light	52	220	.59	
carbofuran (Furadan)	5	885	.75-1.0	Heavy	<1	240[f]	.60	
carbaryl (Sevin)[g]	675	4,000+	1.0 to 2.0	Heavy	265	3,400	9.2	Least toxic to fish. Reasonably safe to use around ponds or streams insofar as fish are concerned.
trichlorfon (Dylox)	595	2,000+	1.0	Light	37	5,600	15.1	
methyl parathion[d]	19	67	.25-.5	Light	8	8,500	23.0	
dimethoate (Cygon)[d]	215	505	.5	Light	9	28,000	75.6	

[a]Test bird: Mallard duck, ring-necked pheasant, bobwhite, or California quail. Toxicant administered as a single oral dose. Data from Denver Wildlife Research Center, Bureau of Sport Fisheries and Wildlife.

[b]Chlorinated hydrocarbons, aldrin (as dieldrin), DDT, dieldrin, and heptachlor (heptachlor epoxide) are stored in fat and persist as residues. Methoxychlor is less readily stored, and its toxicity is lower than many others. Toxaphene does not tend to store and is rapidly excreted.

[c]Lower than some studies show.

[d]Organic phosphates are usually not readily stored and break down in water. Some are highly toxic to warm-blooded animals.

[e]Used as soil treatments; adheres readily to soil particles.

[f]Four-day exposure for LC50.

[g]This carbamate is more residual than many phosphates but is relatively nontoxic to fish and wildlife.

programs and of bees can do much to reduce loss of bees through necessary agricultural pest-control operations. Relating spraying operations to knowledge of daily bee activity, insecticide toxicity, plant maturity, and spray drift will reduce bee losses and may mean the difference between a satisfied producer and one faced with a lawsuit.

If informed of intended pesticide applications that could damage bees, a beekeeper may be able to protect his colonies to some extent. Beekeepers are required to register with the Illinois Department of Agriculture, Bureau of Plant and Apiary Protection, 522 South Jefferson, Paris, Illinois 61944. Local county Extension advisers have a current listing of beekeepers and hive locations that are available to spray operators. Additional assistance can be obtained from the chief apiary inspector.

Relative Toxicity of Pesticides to Honey Bees

Pesticides differ greatly in their effect on honey bees. The formulation of the material plays an important role in its toxicity to bees. In general, sprays are safer than dusts, and emulsifiable concentrates are less toxic than wettable powders. Granular materials usually are not hazardous to bees. Microencapsulated formulations of highly toxic materials are extremely hazardous to bees. Penncap-M should not be used on crops visited by bees or in locations where it may contaminate other blooming crops or weeds.

Fungicides, acaricides (miticides), herbicides, defoliants, desiccants, nematicides, and blossom thinners are relatively nontoxic. These materials and the insecticides can be placed in three groups in relation to their effects on bees—those highly toxic, those moderately toxic, and those relatively nontoxic.

Highly Toxic

This group includes materials that kill bees on contact during application and for one or more days after treatment. Bees should be moved from the area if highly toxic materials are used on plants the bees are visiting.

Pesticides (Trade Name and/or common name)

aldrin
Ambush, permethrin (honey bee repellent)
arsenicals
Avermectin (insect growth regulator)
Azodrin, monocrotophos
Baygon, propoxur
Baytex, fenthion
Bidrin, dicrotophos
Bux, bufencarb
carbosulfan, FMC-35001
Cygon, dimethoate
Cythion, malathion
Dasanit, fensulfothion
DDVP, dichlorvos
Dibrom, naled*
Decis, decamethrin
De-Fend, dimethoate
diazinon, Spectracide
dieldrin
Dimecron, phosphamidon
Dursban, chlorpyrifos
Ekamet, etrimfos
EPN
Ethyl Guthion, azinphos-ethyl
Famphos, famphur
Ficam, bendiocarb
Folithion, fenitrothion
Furadan, carbofuran
Gardona, tetrachlorvinphos
Guthion, azinphos-methyl
heptachlor
Imidan, phosmet
Lannate, methomyl
Lorsban, chlorpyrifos
malathion
Matacil, aminocarb

*Short residual activity. Can usually be applied safely when bees are not in flight. Do not apply over hives.

Highly Toxic Pesticides (continued)

Mesurol, methiocarb
methyl parathion
Monitor, methamidophos
Nemacur, fenamiphos
Nudrin, methomyl
Orthene, acephate
parathion
Pay-Off, flucythrinate
Phosdrin, mevinphos*
Pounce, permethrin (honey bee repellent)
Pydrin, fenvalerate
Sevin, carbaryl
Spectracide, diazinon
Sumithion, fenitrothion
Sumithrin, d-phenothrin
Supracide, methidathion
Synthrin, resmethrin
Tamaron, methamidophos
Temik, aldicarb
tepp*
Vapona, dichlorvos

*Short residual activity. Can usually be applied safely when bees are not in flight. Do not apply over hives.

Moderately Toxic

These materials can be used with limited damage to bees if not applied over bees in the field or at the hives. Correct dosage, timing, and method of application are essential.

Insecticides (Trade Name and/or common name)

Abate, temephos
Agritox, trichloronate
Bolstar, sulprofos
Carzol, formetanate hydrochloride
chlordane
Ciodrin, crotoxyphos
Counter, terbufos
Croneton, ethiofencarb
Curacron, profenofos
DDT
Di-Syston, disulfoton
(honey bee repellent)
Dyfonate, fonofos
endrin
Korlan, ronnel
Larvin, thiodicarb
Metasystox-R, oxydemeton-methyl
Mocap, ethoprop
Perthane, ethylan
Pyramat
Sevin 4-Oil, carbaryl
Sevimol, carbaryl
Systox, demeton (honey bee repellent)
Thimet, phorate
Thiodan, endosulfan
Trithion, carbophenothion
Vydate, oxamyl
Zolone, phosalone

Relatively Nontoxic

Materials in this group can be used around bees with few precautions and a minimum of injury to bees.

Insecticides and Acaricides (Trade Name and/or common name)

Acaraben, chlorobenzilate
Altosid, methoprene
(insect growth regulator)
Baam, amitraz
Bacillus thuringiensis
Bactur, Bactospeine,
Bakthane, Dipel, Thuricide, SOK-Bt
Birlane, chlorfenvinphos
Comite, propargite
Delnav, dioxathion
Dessin, dinobuton
Dimilin, diflubenzuron
(insect growth regulator)
Dylox, trichlorfon
ethion
Fundal, chlordimeform

Relatively Nontoxic Insecticides and Acaricides (continued)

Galecron, chlordimeform
Heliothis polyhedrosis virus
Kelthane, dicofol
Kryocide, cryolite
Marlate, methoxychlor
Mavrik, fluvalinate
Mitac, amitraz
Morestan, oxythioquinox
Morocide, binapacryl
Murvesco, fenson
nicotine
Omite, propargite
Pentac, dienochlor
Pirimor, pirimicarb
Plictran, cyhexatin
Pynamin, allethrin
pyrethrum (natural)
rotenone
sabadilla
Sayfos, menazon
Sevin SL, carbaryl
Sevin XLR, carbaryl
Smite, sodium azide
Tedion, tetradifon
Tetram
Tokuthion, prothiophos
Torak, dialifor
toxaphene
Zardex, cycloprate

Fungicides (Trade Name and/or common name)

Afugan, pyrazophos
Arasan, thiram
Bayleton, triadimefon
Benlate, benomyl
Bordeaux mixture
Bravo, chlorothalonil
captan
copper oxychloride sulfate
copper 8-quinolinolate
copper sulfate
Cyprex, dodine
cupric oxide
Delan, dithianon
Dessin, dinobuton
Difolatan, captafol
Dithane D-14, nabam
Dithane M-22, maneb
Dithane M-45, mancozeb
Dithane Z-78, zineb
Du-Ter, triphenyltin hydroxide
Dyrene, anilazine
ferbam
glyodin
Hinosan, edifenphos
Indar, butrizol
Karathane, dinocap
Kocide, cupric hydroxide
Lesan, fenaminosulf
Morestan, oxythioquinox
Morocide, binapacryl
Mylone, dazomet
Phaltan, folpet
Plantvax, oxycarboxin
Polyram, metiram
Ridomil, metalaxyl
Sisthane, fenapanil
Smite, sodium azide
sulfur
thiram, Thylate
thyfural
Vitavax, carboxin
Zerlate, ziram

Herbicides, Defoliants, and Desiccants (Trade Name and/or common name)

Aatrex, atrazine
alachlor
Alanap, naptalam
Alopex, clofop-isobutyl
Amex 820, butralin
Amiben, chloramben
amitrole
Ammate, AMS
Aquathol K, endothall, dipotassium
Avenge, difenzoquat
Balan, benefin
Banvel, dicamba
Basagran, bentazon
Basalin, fluchloralin
Betanal, phenmedipham
Betanex, desmedipham
Bladex, cyanazine
Blazer, acifluorfen
butachlor
butam

Relatively Nontoxic Herbicides, Defoliants, and Desiccants (continued)

cacodylic acid
Cambilene, 2,3,6-TBA
Caparol, prometryn
Casoron, dichlobenil
Chloro IPC, chlorpropham
Cotoran, fluometuron
2,4-D
DEF
Desiccant L-10, arsenic acid
Devrinol, napropamide
dichlorprop, 2,4-DP
dinoseb, dinitrobutylphenol
diquat
Dual, metolachlor
endothall, sodium salt, Accelerate
Eptam, EPTC
Eradicane, EPTC + safener
Evik, ametryn
Evital, norflurazon
Folex, merphos
Garlon, triclopyr
Goal, oxyfluorfen
Hoelon, diclofop-methyl
Hydrothol 191, endothall
monopotassium salt
Hyvar, bromacil
Igran, terbutryn
IPC, propham
Karmex, diuron
Kerb, pronamide
Lasso, alachlor
Lorox, linuron
Maloran, chlorbromuron
MCPA
Methar, DSMA
Milogard, propazine
Modown, bifenox
MSMA
Mylone, dazomet
Nortron, ethofumesate
Paarlan, isopropalin
paraquat
Planavin, nitralin
Pramitol, prometon
Preforan, fluorodifen
Princep, simazine
Probe, methazole
Prowl, pendimethalin
Ramrod, propachlor
Randox, CDAA
Ronstar, oxadiazon
Roundup, glyphosate
Sancap, dipropetryn
Sencor, metribuzin
silvex, 2,4,5-TP
Sinbar, terbacil
Smite, sodium azide
Surflan, oryzalin
Sutan+, butylate
2,4,5-T
Telvar, monuron
Tenoran, chloroxuron
TOK, nitrofen
Tolban, profluralin
Tordon, picloram
Treflan, trifluralin
Turf Herbicide, endothall, disodium
Vegadex, CDEC
Zorial, norflurazon

Nematicides and Miscellaneous (Trade Name and/or common use)

endothall (plant growth regulator)
Exhalt 800 (sticker/extender)
gibberellic acid (plant growth regulator)
Mylone, dazomet
N-Serve, nitrapyrin
(nitrification inhibitor)
Polaris, glyphosine (chemical ripener)
Smite, sodium azide
Sustar (plant growth regulator/
chemical ripener)

Some Additional Points to Remember

1. Prevention of bee losses is the joint responsibility of the spray operator, the farmer, and the beekeeper. Before spraying is done, the beekeeper should be notified in ample time to allow him to arrange to protect or move his colonies.

2. Sprays generally are less hazardous to bees than are dusts.

3. Late evening and early morning spray treatments (after 9 p.m. DST and before dawn, 3 a.m.) will generally reduce bee deaths. However, applications to corn are safer to bees when made between noon and midnight, *not* early in the morning.

4. Aircraft applications of technical/low volume malathion are HIGHLY poisonous to bees and should be used chiefly on rangelands for grasshopper control.

5. Ground sprayer treatments usually are less severe on bees than are aircraft applications.

6. Spraying or dusting while bees are active in the fields will increase bee kills.

7. Treatment over hives when bees are clustered outside the hive during hot weather increases bee deaths.

8. Drift to neighboring fields in blossom, or to adjacent blossoming weeds and wild flowers, may result in substantial bee poisoning.

9. Bees located in or very near fields before pesticide treatment may sustain serious death losses. Bees moved into fields and orchards after spraying is completed may suffer little loss.

10. To eliminate pests without endangering the bees, use the recommended amount of a pesticide that is least toxic to the bees but potent enough to kill pests.

11. Bees fly most actively at temperatures above 55°F. Spraying when temperatures stay below 55° will do little harm to bees.

12. Insecticides cause heavy bee losses when applied to orchards when trees are not in bloom but when there is attractive clover beneath them, and to alfalfa when weeds, such as yellow rocket and mustard, are in bloom.

Reducing Bird Damage in Illinois

R.D. Ogden

Damage caused by birds is widespread and serious in the central and southern parts of Illinois. The nation's winter population of blackbirds, starlings, grackles, and cowbirds is conservatively estimated at 500 million. Bird damage in Illinois occurs where human use of land is intensive and agricultural foods are available and when certain species of birds congregate following the breeding season, during migration, and in the winter. Extensive fields of agricultural crops near roosts provide attractive and often preferred feed for crop-consuming birds such as blackbirds and starlings. Problems result when the birds radiate out from their roosts into fields of unharvested crops or to livestock feedlots. Whether or not problems occur depends upon many factors including weather conditions, soil moisture, location of feed, time of harvest, and the extent and effectiveness of bird damage control by landowners.

Bird problems are concentrated in local areas determined by the distance the birds fly from roosts to feed in crop fields. This distance is commonly up to 20 or 25 miles, but is rarely more than 40 miles; most problems occur within the first 10 miles from roosts. Within this feeding radius, but especially along local flight corridors, flocks of birds may find a particularly attractive field or feedlot, where they will feed repeatedly if left undisturbed or only slightly disturbed. Birds adapt to local food conditions primarily by shortening or extending their daily feeding radius or by moving to different sites to obtain food within a local feeding zone. These behavioral characteristics of birds must be considered when designing control programs for local bird problems. Estimates of the economic impact of birds on agricultural crops in the United States are as high as $100 million annually.

There is no single answer to the bird problem. Even in a specific bird damage situation, a combination of controls is often better than the exclusive use of any one technique. Perhaps desirable for some species, population reductions should not be looked on as the ultimate answer to most bird damage problems. At present there is no economically feasible method to effectively reduce bird populations over wide areas. Because most birds involved are migratory, local population control is equally difficult. Most species of birds have relatively large broods and are capable of two or more successful nestings per year. Even if extreme population reduction were attempted, it would probably be only a short-term solution. To be effective, population control techniques should usually be augmented with other nonlethal control measures.

The best solution to a bird problem will usually involve an integrated approach that includes several control techniques. Control programs that rely exclusively on the use of one method are usually doomed to failure. It is important that a program be planned with a thorough understanding of both the biology of the birds and the advantages and limitations of the various control techniques. This report is intended to provide the reader with a basic understanding of the biology of those birds usually associated with damage, the types of damage control techniques available, and suggestions for dealing with bird damage situations in Illinois.

Starling

Although there are about 110 species of starlings in the world, only one, the European starling *(Sturnus vulgaris)*, is found in North America. Starlings are often mistaken for blackbirds. It is important to be able to recognize different bird species because some types of bird control are more specific for certain species than for others. Adult starlings are more or less black in color, although during the winter the starling's breast is speckled with white check marks. As spring approaches, these marks wear off, leaving the breast more or less a glossy black. The bill is black during part of the year, but turns yellow during the breeding season (January through June). Distinguishing features of the starling include its relatively short tail and short, triangular wings. It flies swiftly and directly and does not undulate up and down in flight as most blackbirds do. Sometimes its flight is a series of glides interspersed with rapid wingbeats.

Starlings, which are year-round residents in Illinois, are communal, living together in smaller flocks of up to several hundred birds during the warmer months. They often nest in colonies and can have one or two broods of four or five young each year. Starlings are not truly migratory, but with the onset of colder months they band their summer flocks together to form huge flocks, and seek a suitable location for their winter roost. These flocks move south as winter conditions and available food dictate. At sunrise the starlings leave their roosts and travel 15 to 30 miles in smaller flocks to their selected feeding and loafing areas. As evening approaches, they return to their favored roosting area, usually in dense pine tree plantations, barns or cattle sheds around rural farmsteads, trees in small towns or suburban areas, and occasionally in or on buildings in downtown urban areas.

Blackbird

The birds most properly associated with this group in Illinois are the red-winged blackbird *(Agelaius phoeniceus)*, the Brewer's blackbird *(Euphagus cyanocephalus)*, and the rusty blackbird *(Euphagus carolinus)*. With habits similar to those of blackbirds, the common grackle and the brown-headed cowbird are often found in mixed flocks of blackbirds. The breeding population is estimated at about 400 million in this country. Rusty and Brewer's blackbirds, similar in size to red-wings, are completely black and difficult to distinguish from each other. The black adult male red-wings with their scarlet shoulders are familiar and unmistakable, but the brown, sparrow-like females and immature males with their streaked breasts often go unrecognized. Red-winged blackbirds are migratory and are not commonly present in northern and central Illinois during winter months. They do, however, nest throughout the state, most commonly in marshland, hayfields, unused pasture, and other abandoned or unused fields. The nests are usually in shrubs or sturdy herbs, sometimes in saplings, but rarely in big trees. Red-wings commonly have two broods of four young per year. The rusty blackbird and Brewer's blackbird migrate through Illinois in the fall and spring, but they generally nest farther north than Illinois. They are, however, sometimes present locally in the winter.

During the nesting season, when the birds are widely scattered, blackbirds feed extensively on grubs, on caterpillars such as armyworms, cutworms, and corn earworms, and on beetles and other insects. During the milk and dough stages, red-wings feed heavily on ripening grain, and then on small grains such as milo and millet until harvest.

Blackbirds make daily trips from their roosts to grain fields. About dawn the red-wings depart in different lines of flight. Some descend upon the first acceptable grain field, some drop out at various intervals along the way, and others continue in beeline flight to destinations perhaps as far as 20 miles from the roost.

By the end of July instead of returning nightly to their breeding areas, groups of red-wings will roost in or near marshlands. By August newcomers from nearby breeding grounds and migrants from more distant areas increase the size of the flocks. These flocks may also be joined by grackles, cowbirds, and starlings.

Common Grackle

Common grackles *(Quiscalus quiscula)* are robin-sized or larger, with long, keel-shaped tails. Adults are an iridescent, glossy black with a purple or bronze cast. Young grackles recently out of the nest are a plain rich brown, but they gradually develop shiny black feathers during the summer. Common grackles are migratory and are seldom found in northern and central Illinois during the winter. They are abundant in the state during spring and fall and are also common nesters throughout Illinois. Grackles nest in colonies in evergreen shrubs and trees, dense woodlots, thickets, hedgerows, and viny tangles, and usually have only one brood of five young per year.

Unlike red-wings, which search marshes and hayfields near their nests, grackles often range quite far in search of food, frequently traveling to fields being plowed or cultivated. After small grain is harvested in late June and early July, when grackles are through nesting, they feed extensively on waste grain in stubble. By the end of July grackles have left their specific breeding areas to roost either in trees or marshes, often joining flocks of blackbirds and starlings. After leaving the roost, grackles do not usually form into groups as small as those of blackbirds, but instead tend to remain in large marauding bands throughout the day, attacking one grain field after another.

Brown-Headed Cowbird

Cowbirds *(Molothrus ater)* are smaller than red-winged blackbirds and have much heavier beaks. Adult males are a glossy black with dark brown heads; females are plain gray with pale throats. Brown-headed cowbirds are migratory. They are uncommon in northern and central Illinois during winter, but are abundant throughout the state from spring through fall. Cowbirds do not incubate their own eggs, depositing them instead in the nests of many other species found in Illinois. Cowbirds lay one or two eggs per host nest from April through July. Having been raised to maturity by foster parents, the young cowbirds join in flocks with other cowbirds. Cowbirds are often associated with flocks of blackbirds, which have similar flocking habits.

House Sparrow

The house sparrow *(Passer domesticus)* was introduced into this country from Europe in the middle 1800's. These rather small, brown birds are usually found near human habitation and are familiar to most people. The male is recognized by his black bib and bill and white cheeks. The female, often confused with other sparrows, has an unstreaked, dingy breast and a streaked back. House sparrows are nonmigratory and are abundant, permanent residents in Illinois. Capable of producing several broods of four young per year, they are highly gregarious and often form into flocks. They prefer to nest in or around buildings and are very difficult to get rid of once

established. Although their food consists primarily of seeds and insects, sparrows can cause serious damage to fruit or ripening grain. Probably a more serious problem is the filth caused by their droppings and bulky nests.

Pigeon

Pigeons *(Columba livia)* similar to those now living in a semiwild state in towns and cities have been closely associated with man since before recorded history. Originally, these birds probably came from the blue rock or common pigeon of Europe, Asia, and Africa. Pigeons use man-made structures such as barns, city buildings, bridges, and overpasses almost exclusively for their roosting and nesting sites. Pigeons are nonmigratory and are common throughout Illinois wherever suitable nesting and roosting areas are available. They lay two eggs per nesting, mainly from January through June, but a few may be laid in any month. As scavengers for grain and seeds, pigeons may feed in or near stubble fields, feedlots, grain elevators, and the like. Pigeons owned by individuals can generally be recognized by numbered bands on their legs. Excessive numbers of pigeons can cause property damage and may constitute a health hazard.

Crow

The crow *(Corvus brachyrhynchos)*, a large, black bird with a heavy bill, is generally well known and easily recognized. Common in Illinois, crows lay about four eggs some time between mid-March and the end of May. Crows are somewhat migratory, but do not winter as far south as do most birds. In winter the number of crows in Illinois may increase because of an influx of birds from the northern states or Canada. Plant material comprises about two-thirds of the crow's diet. Although wheat is their most important food on a year-round basis, they apparently do not cause serious damage to this crop. Grain sorghum and corn may be damaged in local situations; cherries, watermelons, and other fruits can also be seriously damaged. On rare occasions crows may attack weak, sick, or injured lambs, pigs, or calves. Crows perform a valuable, sanitary function by consuming carrion.

Techniques for Controlling Bird Damage

Methods for alleviating bird damage generally fall into three broad categories: biological, mechanical, and chemical.

Biological Controls

Decoy crops and cultural practices. Sometimes it is economical to plant a less valuable crop, one that is more attractive to depredating birds, adjacent to valuable crops to divert the birds. Often techniques such as planting or harvesting early or late, changing crop types, leaving stubble fields standing, and planting all grain in an area at the same time can reduce serious bird damage to field crops.

Habitat manipulation. Most commonly used for roosting problems, this technique consists of thinning or removing roosting cover or eliminating access to roosting or nesting sites in or around buildings and other structures.

Bird-resistant varieties. Some progress has been made in developing bird-resistant crop varieties. The use of these varieties, especially grain sorghum, may prove to be a promising means of combating losses to birds in the future.

In general, because most biological methods are costly or impractical, they have not been widely accepted by agriculturalists. When applicable, however, these methods have effectively reduced bird damage.

Mechanical Controls

Mechanical control methods, consisting primarily of scaring devices, are widely used and often are effective in the control of birds in grain fields and in urban areas. Frightening devices include propane or acetylene exploders, shellcrackers, fireworks, windmills, scarecrows, and hawk or owl models. Recorded alarm or distress calls of birds broadcast through mobile or stationary units or played on record players are also effective. Other types of mechanical controls include netting, "porcupine wires," and sticky compounds used to discourage birds from roosting in or on buildings. Frightening devices are discussed in greater detail later in this report. Decoy traps have been used effectively in Illinois and elsewhere to remove small populations of birds, especially in feedlots, orchards, and berry plantings.

Chemical Controls

The chemical approach to reducing bird damage to agricultural crops is promising. Most major research efforts have been concentrated in this area. Chemicals applied for control of birds must be species selective, effective, economically practical, and environmentally safe. Types of chemicals for managing bird problems include repellents, stressing agents, toxicants, chemosterilants, and frightening agents. The use of poisons (toxicants) for bird control in Illinois is restricted to nonprotected species or to use by trained governmental agents. Refer questions about the legality of a planned bird control program to the Illinois Department of Conservation or to the U.S. Fish and Wildlife Service (ADC), both located in Springfield, Illinois.

Repellents. The most promising repellent compound found to date is methiocarb, which has been shown to be effective in protecting newly planted corn from blackbirds, crows, and pheasants. Registered for use in Illinois as a seed treatment, methiocarb has also shown promise as a protectant for ripening sunflowers and grain sorghum and in controlling bird damage to fruit. After further testing, it is hoped that this product will become more widely available for use in controlling bird damage to crops.

Frightening agents. One of the most useful chemicals for reducing bird damage to agricultural crops is the chemical frightening agent Avitrol®. This chemical is considered a frightening agent because most birds that ingest treated bait react by emitting distress cries while flying erratically. This behavior frightens other members of the flock from the area. Avitrol is relatively effective at low use levels and is relatively safe, killing less than one percent of the flock. It is effective in reducing bird damage to field corn and sweet corn, and initial studies on sorghum, although inconclusive, are promising. Avitrol can be mixed on many types of grain baits and has been shown to be an effective control in feedlots and other areas, in addition to grain fields. Avitrol can only be used by licensed Pest Control Operators or government personnel trained in bird control.

Stressing agents. Stressing agents are essentially detergents or wetting agents that lower the surface tension of water and enhance the wetting of a bird's feathers. The bird-stressing agent PA-14 is registered for use by qualified United States Fish and Wildlife Service personnel or by those under their direct supervision. Before application can be made, a feasibility study must be conducted and alternative dispersal methods explored. If the use of this compound is approved, then the material

is sprayed on large roosting concentrations of starlings or blackbirds immediately before or during cold, wet weather. Death occurs when the bird's feathers become wet enough that they lose their insulating effect, thus causing excessive loss of body heat. The chill factor must be near 42°F, and at least a half inch of rain should fall during or immediately after treatment. This chemical is poisonous to fish and, to some degree, plants. Spraying tree roosts should be confined to the period when trees are dormant. Use of this chemical is recommended only in cases of extremely large and serious bird problems where other techniques will not work.

Toxicants. The development of toxic agents or poisons has been directed primarily at starlings. Starlicide® is a pelleted toxic bait registered for use in cattle feedlots and poultry-raising operations. The treated pellets, diluted with untreated pellets at a 1:10 ratio, are scattered thinly in empty pens and alleyways or in troughs placed above feeding bunks. Available only in the pelleted form, Starlicide may not be effective unless mixed with materials the starlings are feeding on. Starlicide is a slow-acting poison highly toxic to starlings and blackbirds, but is generally less toxic to most other birds. The safety of the compound can be increased by careful consideration of bait material and placement, dilution rates, and timing. Its effectiveness is probably related to its slow action. It takes up to 48 hours for birds to die after they ingest a lethal dose, and they do not show bait aversion. About 40 percent of the dead birds will be found at the nighttime roost rather than at the bait site. Strychnine-treated grain (0.6 percent) is sometimes used for the control of sparrows and pigeons, but its use is not generally recommended because of the hazard to other species. After using any toxicant, dead birds should be picked up and properly disposed of whenever possible.

Poison perches. Poison perches are useful for killing birds inside or on buildings when it is impossible to exclude them by other means. These perches, consisting of a small metal tube with an exposed wick, vary from a few inches to several feet in length, with different sizes to fit the feet of the target birds.. The cloth wick inside this tube is soaked with a contact poison; birds perching on the tube absorb the poison through their feet and are killed. Because of its low toxicity to other animals, Fenthion is most desirable for use in these perches. Endrin can also be used, but it is highly toxic to other animals. *Extreme care should be practiced in the use of contact poisons.* These chemicals should be used only by a licensed Pest Control Operator, and perches should not be near feeding operations or food storaged areas.

Chemosterilants. The only registered chemosterilant for birds is Ornitrol®, which is used on wild pigeons. Although this form of "birth control" for pigeons works, it has several disadvantages. The success of the technique requires that the treated bait be eaten in a sufficient quantity for several days before it is effective. This chemical is capable of inhibiting reproduction for up to six months and must be used once or twice each year to ensure population supression. Research is being conducted in an attempt to develop a chemosterilant for reducing damage by blackbirds.

Bird Problems and Solutions

Protecting Grain Fields

Damage to ripening grain can be avoided or reduced by modifying the crop culture, frightening birds from fields, or both.

Cultural methods. Grain plantings should be scheduled so that most of the grain in a general area enters the vulnerable stage at the same time. The number of birds in many grain producing areas increases as the season progresses; thus, late grain may be subject to the heaviest attack, whereas early grain is less damaged. Bird damage is usually greatest in fields or parts of fields close to a body of water, marshland, desirable resting cover, or a regularly used flightline. In this type of situation a decision to grow a crop not usually subject to severe bird attack may be in order. Sometimes grain damage can be reduced by removing loafing or roosting cover adjacent to grain fields. Stubble fields left standing until the bird danger is past will provide the birds with alternate feeding sites, resulting in decreased damage to unharvested crops.

Certain varieties of grain show some resistance to blackbird attack. Even when an attack is heavy, sorghum growers can usually obtain appreciable relief from crop damage if they use protection methods properly.

Frightening devices. Gas exploders, .22 caliber rifles, rope firecrackers, shell-crackers, airplanes, shotguns, and recorded blackbird alarm cries are used to scare blackbirds from grain fields. Frightening blackbirds from a field will not necessarily correct the problem. If other acceptable seed foods occur nearby, blackbirds will feed on them.

For best results from frightening devices, the following procedures are recommended:

(1) Bird scaring should begin when grain is first susceptible to damage or at least at the earliest indication that blackbirds are feeding on grain.

(2) During the damage season, corn protection measures should be used throughout the day, particularly in the early morning when blackbirds first appear, and again during the late afternoon feeding period. Extra protection is also required during rainy or foggy weather. Birds should not be allowed to remain in a field, since they serve as decoys attracting others. If blackbirds are permitted to settle down, they often stay in the vicinity for the day.

(3) A combination of bird-scaring techniques should be used whenever possible, particularly at times when bird pressure is high, such as in early morning, in late afternoon, and during bad weather. Although farmers can usually reduce blackbird damage to grain by using one scaring device correctly, crop protection can be most effective when several scaring techniques are used. The relative costs and benefits of increased protective measures should be carefully evaluated, however, before using additional techniques.

(4) For maximum benefit, the scaring devices, especially the stationary ones such as gas exploders and rope firecrackers, should be moved frequently (twice daily) in a grain field.

The automatic gas exploder, probably the principal bird frightening device, usually reduces grain damage. Gas exploders produce loud explosions at automatically timed intervals when a spark or pilot flame ignites the propane, butane, or acetylene gas. Some exploder models have unique modifications, such as automatic starting and stopping switches controlled by timing or light-sensing mechanisms, an apparatus for partly rotating the exploder after each firing so that the sound carries in a different direction, and a means of mounting the exploder on a vehicle with a detonating switch in the cab.

Exploders mounted on platforms and operated above the height of the corn give best results. Some farmers have excellent results by mounting an exploder on the roof of a pick-up truck in addition to using stationary units in the field. A woods margin or buildings may help direct or intensify the sound. The effective range of an exploder varies. Tests show that grain damage can be cut in half within 600 feet of an exploder (equivalent to 26 acres of protection), but as a general rule with moderate bird pressure, one exploder should be used for every 10 acres of grain.

The .22 caliber rifle is an effective bird-scaring device, but should be used only where it is legal and safe. One rifleman from a high position such as a rooftop, silo, or tall platform can protect as much as 100 acres. As birds settle into a field, a bullet is fired earthward into their midst.

Flash-salute-type firecrackers, popularly known as bulldogs, cannon crackers, cherry bombs, or salutes, are used in rope firecrackers. Firecracker fuses are inserted at intervals between strands of a loosely twisted, cotton rope, one end of which is tied to the apex of a tripod of wooden stakes. The free end of the rope is ignited and as it burns, the ignited firecrackers drop from the rope and explode. Approximately 10 acres of standing grain can be protected with one rope firecracker assembly. A 55-gallon barrel with the rope suspended inside amplifies the sound and reduces the fire hazard. Fireworks are prohibited in many areas. Consult local laws before using fireworks in bird control.

A shotgun firing either regular ammunition or shellcrackers is an effective bird-scaring tool. Shellcrackers are special shotgun shells that discharge a projectile that explodes after traveling about 100 yards. Shotgun shells and shellcrackers may be used to supplement automatic devices or used alone, especially in early morning and late afternoon. Shellcrackers should not be fired over or into dry vegetation or other potentially flammable materials. The occasional killing of a bird with regular shotgun shells can increase the effectiveness of shellcrackers and other scare devices. Shooting is much more effective when a vehicle is used to get within range of birds quickly.

Light airplanes, sometimes equipped with sirens or horns and flown slightly above tassel height, are used in some areas to frighten birds. Pilots often try to cover a grain field systematically, because the birds frequently drop farther down into the grain rather than flushing when the plane approaches. Airplane operations, restricted to times when flying conditions are favorable, are expensive and the results inconsistent. Federal law prohibits shooting or harassing any wildlife from aircraft without an appropriate state permit.

Broadcasting recorded alarm and distress calls of birds has been found effective in small corn acreages. This method is not commonly used, however, because of the expense of the equipment involved.

Chemical frightening agents. The use of Avitrol has been demonstrated to be of value in protecting field corn, sunflowers, and sweet corn from damage by blackbirds. When treating fields, do not place the bait nearer than 40 to 50 feet to the edge, because nontarget birds use the outer perimeter heavily. Avitrol is registered for use in protecting corn but not for grain sorghum. Preliminary tests using this chemical have not shown as much promise for reducing bird damage to grain sorghum, particularly where large numbers of brown-headed cowbirds are involved. Cowbirds do not respond as well to the Avitrol baits as do some blackbirds. Use of Avitrol is restricted to Pest Control Operators or government personnel trained in bird damage control. Several aerial applicators have been certified in Illinois to apply Avitrol to cornfields.

Other methods. In areas where other control techniques are not legal or practical, visual deterrents can offer some protection. These methods include twirlers, windmills, scarecrows, twine strung over the grain, and reflecting plates. Small plots can be protected by covering the grain with netting or by putting paper cups or bags on individual ears after pollination.

Population reduction. Blackbirds are protected by Illinois state law. They can be killed when committing or about to commit serious damage to agricultural crops only after a permit has been received from the Illinois Department of Conservation. Such operations must be conducted in conformity with state law, so check with the Illinois Department of Conservation before initiating lethal bird control activities. There is no feasible method at present for appreciably reducing most populations of grain-depredating birds during the damage period in late summer and early fall. Shooting is widely practiced, but it is more effective as a scaring technique. The large decoy trap, which has been moderately successful in certain fruit-growing areas, has not been successful as a means of alleviating grain damage because so many traps are needed. No completely satisfactory chemicals have been developed either as repellents, lethal baits, or contact poisons for use in ripening grain fields or roosting areas. These problems are compounded by the fact that most of the problem species are migratory and have a high reproductive capacity.

Bird Roosts

Urban roosts. Urban roosts pose a number of problems to residents of cities, suburbs, or towns. Excrement and feathers from roosting birds contaminate sidewalks, cars, and outdoor furniture. Occasionally birds die and their carcasses add to the insanitary conditions. The sheer volume of noise made by large flocks of birds is also annoying to many people. Collections of droppings under bird roosts create ideal conditions for the growth of the histoplasmosis fungus, which can cause a respiratory disease in humans. Birds most commonly associated with urban roosts are starlings, although some grackles, red-wings, and robins are often present. Usually the roosting flocks begin to build up in late summer, following the end of the nesting season. Most birds will leave the roost as winter approaches, but starlings may remain throughout the winter if adequate sources of food are available within a 20- or 30-mile radius.

In general, fireworks, shotguns, propane exploders, and other noise-making devices cannot be used in an urban situation without obtaining special permits. Broadcast-amplified recordings of the distress calls of starlings and other birds are usually the most practical alternative. These recordings are most effective if begun before the birds have become well established at the roost. Begin playing the recordings near sundown as soon as a significant number of birds have arrived at the roost. The sound is most effective if it is directed at the birds and is not obstructed by buildings, trees, and the like. For greatest effect, the sound should be broadcast from one or more mobile units or from several stationary units. If a large area of a town or city is concerned, broadcasting alarm calls over a local radio station and having residents play their radios out the windows can be successful. Another alternative is to distribute recordings to a number of residents in the affected area. Generally, there will be no noticeable reduction in the number of birds for the first several nights, but usually by the fourth or fifth night most of the birds should have left. Distress calls are sometimes more effective if birdshot or shellcrackers are periodically fired into the flocks. Persistence is the key to dispersing roosts with distress calls.

Rural roosts. Starlings, blackbirds, and grackles sometimes cause problems in rural areas by roosting in woodlots or pine plantations. In general, the alarm call techniques described for urban roosts also work for rural roosts. In a rural situation, however, it is usually possible to use other types of frightening devices, including fireworks, propane exploders, and shellcrackers. These techniques should be used near sunset when the birds are returning to the roost. Using poison baits to control bird numbers at roosts is difficult unless the feeding area is known. Wetting agents can sometimes be effective in a severe bird roosting situation, but weather conditions must be nearly perfect before they are successful. These chemicals can only be used by or under the supervision of government personnel trained in bird control and are not generally recommended. The main difficulty of any bird problem is the tremendous numbers that are involved. Even a population reduction of tens of thousands of birds may be only a small portion of the total population in an area. Large clutches of eggs and repeated nestings enable many pest birds to compensate rapidly for population reductions.

Roosts in and on buildings. House sparrows, pigeons, and starlings are the most common birds creating roosting problems in buildings. They may get into machine sheds, barns, garages, and so forth, either to nest or to roost. The best and most permanent solution to this type of problem is, of course, to deny the birds access to the building or to roosting or nesting sites within the building. Doors should be tight-fitting and should be kept closed; windows should be closed or covered with quarter-inch or smaller wire mesh.

If it is impossible to exclude birds from the interior of the building, it is sometimes possible to screen off rafters and other preferred nesting and roosting areas with quarter-inch hardware cloth. Sticky or irritating compounds can be applied to roosts and will sometimes discourage the birds from using them. Perches poisoned with Fenthion or endrin can be used, but ways to keep birds from getting in should also be used. Revolving lights and ultrasonic sounds have had varying results in repelling birds from buildings and warehouses. Homeowners can usually control individual starlings by live-trapping them with a nest-box trap or other type of live trap. Sparrows and pigeons can be discouraged from nesting in buildings by destroying their nests and eggs at two-week intervals during the spring and summer months. Use a hook fastened to the end of a long pole to tear down nests in rafters or under eaves. If at all possible, block off nesting sites after the nests have been destroyed. Several types of commercial traps are also available and are sometimes effective in reducing numbers of sparrows and pigeons. Poison baits may also be used if other techniques do not work.

In urban areas the problem is not so much with birds roosting in buildings as roosting on buildings. High buildings with ledges and ornate stonework are the preferred sites. These ledges, cornices, and ornate stonework can be treated with commercial, sticky substances. A good quality material properly applied may be effective for several months or more, but it is messy and may discolor the building. A permanent method of disrupting starling roosts is to eliminate ledges that encourage roosting. Construction of new buildings and modernization of old ones should be planned with this end in mind. Projecting signs or decorations and offset ledges should be eliminated. Boards, sheet metal, or mortar placed on a sharp slant will effectively keep all birds off ledges or from under eaves that can be treated. Ledges can also be protected with sharp upright spines of stainless steel wires ("porcupine wires") or with electrically charged wires. The latter methods generally require the services of a Pest Control Operator or building maintenance crew. Persistent use of distress calls in conjunction with shooting of birds with shotguns has been successful in moving starling roosts from downtown urban areas.

Birds and Feedlots

Cattle feedlots are prime locations for bird concentrations, especially from about October through mid-March. Starlings, and to a lesser extent grackles, blackbirds, cowbirds, sparrows, and pigeons, are the primary species associated with feedlot damage. Feedlots have an abundant food supply and sometimes provide warmth and shelter. One of the keys to successful bird control in feedlots is knowing the seasonal cycle of the birds and also anticipating the problem. Controls implemented as soon as the birds begin to congregate are much more effective than those applied after they have already become established. Many problem birds are migratory or at least seasonal in their activities. Most blackbirds, cowbirds, and grackles are a problem only during spring and fall when migrating in large flocks. In southern Illinois, however, they establish winter roosts. Starlings, although not totally migratory, also gather into flocks from late summer until early spring. During the nesting season in late spring and early summer they are well scattered and present little trouble to the feedlot operator. Sparrows, of course, are year-round residents and can be a nuisance during any season.

Economic losses to birds at feedlots are difficult to estimate. Best estimates indicate that about $175 per 1,000 starlings is lost for the six-month wintering period. Several techniques are available for controlling birds in feedlots. One of the most important considerations in using chemicals to control birds at feedlots is to determine where to place the bait. These methods have been discussed earlier in the section on controls. Sometimes in warm weather, large fly populations at feedlots may attract and hold large numbers of birds. Therefore, an effective fly control program may also reduce a bird problem.

In many feedlot damage situations it will probably be necessary to use an integrated approach. Most toxicants used in conjunction with scare devices are not effective unless used to concentrate birds into one area. Live traps may also supplement the other techniques. Wherever possible, roosting or nesting sites should be eliminated, and care should be taken to avoid feed spillage. Every situation is unique. It is important that you consult with people knowledgeable in bird control before designing or implementing a major bird control program. Some bird problems at feedlots are among the most difficult wildlife damage problems there are to solve. Persistence is the key to success.

Fruit Protection

Frightening devices are usually effective for protecting vine and cane fruits, especially in small to moderate-sized areas. Tree fruits can also be protected by noise devices, but more time, equipment, and persistence are required. Propane or acetylene exploders have been effective in orchards and vineyards against starlings, grackles, and blackbirds, but not as effective against robins, cedar waxwings, warblers, juncoes, orioles, and so forth. Rope firecrackers have about the same effect as exploders, but cover a smaller area. In using either device, it is important to place it well above the tops of the trees or vines if at all possible. Shellcrackers or ordinary shotgun shells are useful as a supplement to automatic noise devices because they will move large flocks of birds more effectively.

Relatively inexpensive cloth or plastic netting is often best for fruit or vegetable crops. Plastic twirlers, cloth strips, suspended pie tins, and other moving objects help to reduce damage, especially in small areas. Shredded newspapers wrapped

around posts may reduce damage in small fruit patches or vineyards. Lethal measures are not very effective in reducing fruit damage. They are also hazardous and may endanger protected species. Use of decoy traps can provide relief in many situations. Traps should be kept well supplied with food and water, and protected species should be released. Methiocarb, now registered as a repellent for control of bird damage to cherries and blueberries, is being studied as a repellent on milo and sunflowers.

Agency Responsibility

The primary objectives of bird damage control in Illinois must be to prevent or minimize losses, diseases, and nuisance problems caused by birds. The Federal Migratory Bird Act places responsibility for managing migratory birds with the U.S. Department of the Interior through the Fish and Wildlife Service. Illinois law places responsibility for managing nonmigratory birds with the Illinois Department of Conservation, Fish and Wildlife Resources. All birds except starlings, house sparrows, and ferrel pigeons are protected by Illinois law, and a permit must be obtained before any lethal control can be used. Permits can be obtained through the Division of Fish and Wildlife Resources in Springfield or through the local conservation police officer. Plans for decoy traps and leaflets on other controls can be obtained from the U.S. Fish and Wildlife Service, Room 105, 600 E. Monroe, Springfield, Illinois 62701 (217-492-4308).

Control of Rats and Mice

R.D. Ogden

Rats and mice have been among the most persistent and damaging pests of man since the dawn of history. Because they are very adaptable, they live in close association with man but remain wild and undomesticated.

RATS

Biology

To control rats, it is helpful to understand certain of their behavior patterns. Because they are social animals and live in colonies, nesting close to one another and sharing a food source, they can be controlled with fewer bait replacements than are needed for mice. They will, however, travel no farther than necessary to obtain food and water. In urban areas, rats stay on their own block and are usually restricted to smaller areas within the block. By reducing, concentrating, or eliminating food sources and harborages, competition is increased, the reproductive rate decreases, and mortality and dispersal increase.

Rats have rather poor vision, but their sense of smell, taste, hearing and touch are quite highly developed. Even though they are easily frightened by sudden or unusual sounds, they are often quite active in noisy locations. They prefer to run next to walls or other surfaces that they can touch with their whiskers as they run. They constantly explore and reexplore their surroundings but are wary of new objects or changes in their environment. They approach new objects cautiously and may even avoid them for the first few days. Even a change in position of a familiar object causes suspicion. Therefore they may avoid traps and bait boxes the first night or two. Even changes of light, noise, or other factors may upset the rat and make him more wary, so, when putting out bait or traps, avoid changing anything else in the rat's environment.

Rodents' need for food is influenced by temperature, amount of available drinking water, and the amount and kinds of available food. Rats prefer good-quality food, so the bait must be as good as or preferably better than the rat's regular food.

Rats that have become conditioned to eating a particular food approach new food with much suspicion and taste it cautiously. If it tastes bad or makes them sick, they will not eat it again. This reaction is called "bait shyness." Once the rat finds a food it likes, however, it will fill itself in one feeding. Thus, when you are putting out bait for rats, you can often get effective control by using a bait that is identical to the food the rats are using.

If a different food is used as bait, prebaiting for several nights with unpoisoned bait will increase bait acceptance. Another advantage of prebaiting is that the weaker rats are usually the first to investigate a change, so you will trap or kill the weaker, nonbreeding rats first and the dominant rats may become bait or trap shy and remain to breed. Prebaiting or placing unset traps ahead of time will help overcome this reaction.

A knowledge of rat water requirements is also useful. Rats require free water to drink if they are feeding on dry foods. If water sources can be eliminated, liquid baits are very effective.

Control

Once you establish where the rats are living, feeding, and traveling, the first step in controlling them is the elimination of their shelter, food, and water. Sanitation is the backbone of a successful rat-control program whether the structure is a barnyard, feedlot, residence, office building, or food-handling business. Obscure corners and shelves and under and in such areas as cabinets, worktables, lockers, and equipment must not be overlooked or neglected.

Outside harborage areas should also be given attention. Grass, weeds, and other vegetation near buildings should be kept closely cut. Debris such as lumber, rock piles, rubbish, old equipment, and construction materials must be eliminated, and items that must be kept should be stored at least 18 inches off the ground and 12 inches away from walls or fences. Spaces such as under loading docks and outside storage buildings or sheds must be blocked off so that rats cannot gain entry. Also, old rat burrows and holes should be filled in with earth.

Ratproofing

Rat control is impossible in many buildings because their construction permits rats to get in faster than they can be killed. In such cases, it is necessary either to accept a lesser degree of control than is normally desirable or to ratproof the structure to allow adequate control. It is impossible to list every conceivable condition where ratproofing may be necessary, but every possible route or rat access to a building or to storage bins must be considered. A judicious use of sheet metal, hardware cloth, and concrete will usually give the desired result.

One of the principal places of entry for rats is through the space under exterior doors. The bottoms and edges of these doors can be built up with wood so that no opening is greater than 0.5 inch. The doors can then be covered with a metal cuff. Where wood doorjambs are susceptible to gnawing by rats, they can also be covered with sheet metal (24 gauge or heavier).

Openings such as windows, coal chutes, ventilating fans, and foundation vents can be ratproofed by tightly covering the opening with 19-gauge hardware cloth that has openings not larger than 0.5 inch. Holes through wooden walls can likewise be covered with hardware cloth or sheet metal, and holes through masonry walls should be cemented shut.

Pipes and wires running up outside walls should be protected with metal guards. Grain bins and corn cribs should be protected with sheet metal around the bottom.

Use of Poisons

After you have tried to control rats as much as possible through sanitation and ratproofing, the next step is the use of poison baits or traps.

Perimeter control is very important because it intercepts rats before they invade buildings, bins, or sheds. Burrows must be gassed and sealed. Weatherproof, permanent bait stations plus weatherproof poison baits should be strategically placed along predetermined invasion routes. Bait stations should also be placed along all

potential avenues of entry, such as doorways and basement windows, and along building walls or shipping docks.

Because rats tend to feed on things familiar to them, using the proper bait will often have more bearing on results than the choice of rodenticide or bait placement. As a general rule, Norway rats (the species commonly found in the Midwest) prefer meat and fish, but even if their favorite food is used, prebaiting may be necessary to gain the rats' acceptance of the bait. The bait material, of course, must be the same during both periods. While prebaiting is useful for controlling "difficult" rats with quick-acting rodenticides, it is too costly for routine or large-scale use and is unnecessary when you use anticoagulants. Test baiting is also a useful technique to determine which baits rats prefer, the number of baits needed, and where they should be placed.

Most poisons must either be mixed in a water solution (where possible) or added as solids to bait materials that are attractive to rats. All bait materials should be fresh and must not taste or smell of chemicals. Anticoagulant poisons are commonly mixed with cereal baits such as corn meal, rolled oats, or cracked corn together with corn oil, peanut oil, sugar, molasses, or similar substances that may add to their attractiveness. Baits should be well mixed so that the toxicant is distributed evenly throughout. Meat, fish, canned cat or dog food, cereals, fruits, vegetables, nuts, and many other baits are also used. Baits may be ground, sliced, or cut into cubes although crumb-sized or sloppy-paste baits are preferable to reduce the possibility of rodents' carrying baits to other areas. All recognizable foods (such as peanut butter) should be prepared in such a way that they are made unrecognizable (e.g., by dyeing green or red).

If you mix your own baits, follow the directions on the registered label. Do not use more than the recommended amount of any poison because to do so would increase the danger of the bait to man and domestic animals and might decrease the bait's acceptability to the rats. Too low a concentration, on the other hand, will lead to incomplete control.

Bait should be placed in rat runways wherever possible. Solid bait should be placed in small cups or dishes so that it can be easily picked up when it is no longer needed. Place all bait close to walls and near doorways wherever possible. When practical, baiting should be done in the late afternoon so that the bait will be fresh at dusk when the rats become active.

Because rats often feed in one place, a small number of bait stations will be sufficient. The amount of bait needed can usually be determined after one night of baiting and depends upon the number of rats present and the toxicant being used. Use enough bait to feed all the rats present, but do not put out more bait than the rats are likely to consume because extra bait will create a hazard to pets and children.

Because bait must be placed so that it is not readily accessible to children, pets, and domestic animals, bait boxes will be needed in some areas. Basically three types of containers are used for rodent bait. (1) Bait trays are used for dry, wet, or liquid baits. They have no top, offer little or no protection to the bait, and do not prevent pets or children from reaching the poison. (2) Covered bait stations are designed to confine the bait, to protect it from the elements, and to avoid environmental contamination but not to provide safety protection to pets or children. (3) Safety bait stations are constructed of materials that will protect the bait and are

designed to prevent pets and humans from having ready access to it. Such containers can be locked to discourage tampering.

Several kinds of rodenticides are available. They are commonly grouped into two categories: (1) anticoagulants and (2) single-dose or quick-acting rodenticides.

Anticoagulant Poisons. Although most anticoagulant formulations are available only for use by specialists, some of the anticoagulants are available to the general public as ready-to-use bait, concentrates to be mixed with baits or water, weatherproof pellets, paraffin blocks or cakes, and tracking powders. Whether they are to be used inside or outside, you should determine the moisture conditions and employ the appropriate formulations. For example, a loose grain bait would not be appropriate for use in a sewer nor a paraffin block in a hot boiler room.

The anticoagulant rodenticides, which include the hydroxycoumarin compounds (Warfarin and Fumarin) and the indandione compounds (Pival, diphacinone, chlorophacinone, and PMP), act by disrupting the normal blood-clotting mechanisms, causing the rats to die of internal hemorrhaging. They are mostly slow acting and take several days of continuous feeding before a rat dies, so a single dose is seldom lethal. *Baits must therefore be made available continuously for 5 to 12 days,* and reasonable control of a rat population may not occur for two weeks. (Single feeding anticoagulants are now being marketed and, if successful, will be very useful in rodent control projects.)

One advantage of anticoagulant baiting is that bait shyness does not develop, primarily because there is no violent reaction to feeding. The action of the poison is apparently painless, and rats do not suspect any danger. Unfortunately, however, anticoagulant baits do not cause rats to go outside before dying, and odor problems will develop if the rats die indoors. (For control of odors, see the last part of the section on mouse control.)

Another advantage of anticoagulant baiting is that the necessity for repeated doses is a built-in safety feature for most animals. Pigs, cats, and dogs, however, are especially susceptible and have succumbed to a single dose of anticoagulant. A useful antidote, vitamin K, is available to veterinarians for treating anticoagulant poisoning.

Thus, although anticoagulants are considered relatively safe, they must still be used in such a manner as to protect the public and domestic animals. You should closely follow the recommendations of the manufacturer and label directions for mixing and safe handling. The concentrations recommended on registered labels should be adhered to for maximum effectiveness and to prevent increasing the hazard or reducing rodent acceptance. The bait should be presented in a safe manner so as to preclude contamination of food or food stuffs. Exposure within a building should be at floor level. Open bait trays can be used indoors only if placed in areas not readily accessible to the public or domestic animals.

When baiting outdoors, place all bait in burrows, tunnels, or covered rodent bait stations or deep into holes. All dry bait should be inspected at least once a week and, if it is insect infested, moldy, or otherwise unattractive to rats, it should be replaced with fresh bait. Daily baiting is necessary when you use perishable baits such as fruits and vegetables. Bait supplies should be available to the rats at all times. Mixed-cereal or solid bait should be placed in waterproof containers in a cool, dry place if stored for a considerable length of time. Upon completion of the control program, pick up and dispose of all bait containers that are accessible to the public. It is also desirable that you pick up and destroy the dead rats.

Single-Dose Poisons. The single-dose or acute rodenticides form a second group and include the more toxic baits: zinc phosphide, strychnine, norbormide, and red squill. Each poison has special characteristics, uses, and hazards, and all should be well understood. These poisons not only kill rodents but are dangerous to man, pets, and domestic animals.

Zinc phosphide is a toxic and effective rat and mouse poison that has been used successfully for many years. It is a black powder with a distinctive odor that makes it unattractive to people and to pets. Some zinc-phosphide rat poison comes with an emetic that gives additional protection for most nontarget animals. Its safety record is very good, but it still requires special handling and mixing in a well-ventilated area. Although (contrary to long-standing belief) zinc-phosphide baits remain toxic for long periods of time, its quick action, effectiveness, and low hazard make it one of the most useful rodenticides.

Strychnine sulfate and strychnine alkaloid are sometimes used as rodenticides, particularly on poisoned seeds for mouse control. The sulfate is preferred for treating grains because it will soak into the kernels, whereas the alkaloid must be coated on the outside with starch and other adhesives. These poisons do not normally give good results in rat control, however, because of their extremely bitter taste and fast action. Because strychnine is so fast acting (death can occur as soon as 12 minutes after eating) and is toxic to all forms of life, it is a very hazardous material and must be used in only special situations and with great care. Because use of strychnine creates secondary hazards, pick up all dead animals and dispose of them either by burning or deep burial.

Norbormide, better known by the finished-bait trademark Raticate or the chemical trademark Showoin, is a quick-acting poison for Norway rats. Although it has shown great promise because of its quick action and safety, norbormide is not widely used because bait acceptance is poor and tolerance develops following sublethal doses. It is useful, however, for quick reduction of a Norway rat population where safety is of utmost importance.

Red squill is a quick-acting rodenticide with a natural emetic action that causes prompt vomiting except in rats, which cannot vomit. It also has a bitter taste that is objectionable to man and many domestic animals. Because of its strong taste, red squill is effective against the Norway rat only, and even with this pest a sublethal dose will cause severe bait shyness. As a result, its most effective use is for a quick reduction of a rat population over a short period of time. Red squill absorbs water from the air and becomes caked and hard, so it should be stored in tightly sealed containers. Care should be taken not to get it on the skin because it is extremely irritating.

Tracking powders (anticoagulant and single-dose poisons) can be used in enclosed areas where food materials will not be contaminated.

Poison Gases. Certain gases can be used to supplement the anticoagulant and single-dose poisons. Calcium cyanide (Cyanogas or "A" Dust), chloropicrin, and methyl bromide are used for quick kill of rodents and their ectoparasites in burrows outdoors. These gases can be quite dangerous and should be used very carefully.

Calcium cyanide is available as a dust that can easily and safely be put into burrows with foot pumps made available specifically for this purpose. The dust reacts with

water vapor in the air and gives off hydrogen cyanide gas (HCN), an extremely toxic fumigant. HCN can be absorbed through the skin, especially if the skin is damp with perspiration. Calcium cyanide is used primarily in control of rats, but also for control of chipmunks, ground squirrels, and other burrowing rodents. The dust is most effective when forced into rat burrows by inserting the pump hose into the burrow and then closing the burrow to retain the gas within it. This process also aids in telling whether a burrow has been reopened and rat activity still persists. You can usually close burrows by simply stomping dirt into the hole with the heel of your shoe. Dusting should be done on a still day so that air currents will not carry the gas away or to the operator. Burrows that lead under occupied buildings should not be treated.

Chloropicrin and methyl bromide are used in much the same manner to control rodents in burrows. It is very important that label directions be closely adhered to in all control operations.

Use of Traps

In certain situations, particularly where there is danger of contaminating food products or of harming pets or children, it may be necessary to trap for rats. Many types are used: common wood-base snap traps, steel traps, live traps, and multiple-catch box traps such as the Ketch-All. The trap most commonly employed in rat control, however, is the wood-base snap trap. It may be baited, or the trigger device may be expanded and the trap used without bait. Steel traps, like those used to catch small fur-bearing animals, are less suitable for trapping rats because they usually catch the rat by snapping shut on one leg and the rat will often chew the leg off and escape.

To bait snap traps, use suitable food baits not larger than the end of the index finger. Tie the bait to the trigger of the trap, and set it in a runway. To expand the trigger device, securely attach a piece of screen wire or light cardboard (the same width as the trap) to the trigger, and set the trap in a runway so that a rat crossing the trap will step on the enlarged trigger and be captured.

In every case, the traps must be set in the rat runways. Where necessary, boxes or other obstructions (new materials or objects may be avoided for a day or so) may be placed along a wall to create a runway so that the rats will have to cross your traps. It is necessary to move the traps (about every week) and change baits frequently because rats easily become trap shy and will avoid traps baited with the same food or left in one location too long.

Although the traps with enlarged trigger devices do not need bait, it is certainly an additional drawing card. Many baits are effective, from peanut butter and cake crumbs to bacon and gumdrops. Because they tend to spoil easily, however, fresh baits should be used only where the extra attraction is needed.

A number of traps should be used, and they should be spaced within 20 feet of each other. Traps should be checked frequently and trapped rodents removed.

Other Control Methods

Ultrasonic devices are another method of control, but limitations at this time make them impractical. Most units are quite expensive and use a great amount of energy. Only under unusual conditions would it be possible to set up sound barriers that

rats and mice will not pass, and they would remain effective only as long as the equipment was in proper operating condition.

Chemosterilants have been tested in attempts to develop materials to sterilize female, young, or male rats, but most of them are effective only if fed to rats repetitively. Bait shyness has been a major problem with compounds developed to date, and a permanent, effective sterility compound has yet to be developed.

MICE

Biology

House mice are very similar to young black rats. Their ears are large, their tails are as long as their heads and bodies together, and their feet are short and broad. They can be easily distinguished from small rats, however, by their small eyes and feet.

Mice cause a great deal of damage. They are gnawers or nibblers and thus tend to make small holes or other slight damage in many places rather than a lot of damage at one place. Because of their nibbling habit, moreover, they contaminate much of the material that they do not destroy.

Mice have keen senses of touch, smell, and hearing. They can run, climb, jump, and swim very well although they cannot climb as well as most rats. They prefer to feed at night and are most active at dusk. Although under continuous light mice will be active during the quietest periods, mouse activity during the day usually indicates a very heavy infestation.

House mice eat about the same foods as humans, including cereals, seeds, fruits, and vegetables, and are especially fond of sweet liquids. They can survive on extremely small amounts of water, and this trait has led to the incorrect belief that they can live without water. Although mice are unable to survive under carefully controlled conditions in which no water is accessible, their entire water requirements can be provided by moist food, and free water is not necessary. Nevertheless, water baits are readily accepted and may be more useful than dry baits in some situations.

Unlike rats, mice are not suspicious of new foods and will eagerly sample them, which makes it easier to bait for mice. They will, however, feed on other foods if for some reason the bait is not attractive. Also, because mice nibble, feeding as often as 15 to 20 times each day on many different foods and consuming only a small amount of food each time, it is difficult to get them to take a lethal dose of a poisoned bait. Thus, as with rats, there is no perfect bait for all situations.

Control

The first step in mouse control is to look for signs of mouse infestation so that you will know the extent of the problem before you begin control measures. Fresh droppings are a sure sign of mice. Care must be taken, however, to distinguish their droppings from those of the larger roaches that are frequently found in the same areas. The droppings of both are 0.25 inch long, but the mouse's are pointed on the ends whereas the cockroach's are blunt ended and ridged down the sides. Mouse nests are frequently found in and near their food supply. The nest is made from almost any soft material chewed into small bits to make a soft bed. Another sign of infestation is holes. Holes gnawed by mice are usually small and clean cut rather than large and torn like rat holes.

Mouseproofing

Buildings can be mouseproofed by closing openings around pipes, doors, windows, holes in walls, and other places similar to those closed for ratproofing. Because mice can often enter any opening larger than 0.25 inch, it is frequently difficult to find all openings.

Use of Poisons

The same poisons used for rat control (with the exception of red squill) will give effective mouse control. To bait for mice, place many smaller baits rather than a few large baits because mice do not usually travel very far in search of food. Make it easy for a mouse to find your bait. Place cups of bait actually touching the walls along walls and other runways because bait placed several inches from a wall may be bypassed consistently. Be very careful to bait near all openings to the outside of the building where mice may enter and also next to all inside doorways that remain open. Be very careful to replace baits frequently because mice are not attracted to old, dirty bait. Tracking powders can be used in confined spaces where food material will not be contaminated.

Use of Traps

Trapping of all kinds, particularly with the automatic trap, is very desirable in such places where baiting with poisons is hazardous. Traps should be placed within 10 feet of each other.

Bait for mouse traps must be carefully selected. Cheese, although frequently the choice of the housewife, has no place in large mouse-control projects. Bacon, nuts, hard sugar candy, gumdrops, peanut butter, and small sardines are usually the best baits. Solid baits should be tied firmly on the trigger. If mice are removed from traps as they are caught, it is quite possible to catch a dozen or more with the same trap without changing the bait.

Odor Control

Following poisoning, it is desirable to remove dead mice for the same reasons given in the rat-control section. Frequently, however, carcasses are located in wall voids or other inaccessible places in buildings. If the dead rodents cannot be retrieved, the area should be ventilated as well as possible, and a masking agent should be applied. If a carcass is located in a wall void, a pint of water mixed with a masking agent can be poured or forced into the area, and the odor usually will be eliminated immediately. If the rodent cannot be precisely located, a masking-agent solution can be applied more generally to the affected area. In severe cases, it may be necessary to use a mist or ULV machine in the area. Repeated applications may be necessary until the carcasses dry up. Several masking agents are available, including Neutroleum Alpha, isobornyl acetate, and Styamine 1622. Label directions should be closely followed.

Control of Vertebrates Other Than Rats and Mice

R.D. Ogden

Bats

Being nocturnal animals, bats roost by day and fly by night in search of night-flying insects, which are their principal source of food. In nature, they roost in dark places such as in caves, in tree cavities, and under overhanging rocks. They have, however, easily adapted themselves to living in buildings, where they roost under hollow floors and in attics, hollow walls, chimneys, and similar places and thus are of concern to farmers and homeowners. A few species live individually, but most congregate in large colonies, so infestations are frequently severe. Droppings and urine deposits under roosting areas have a strong, disagreeable, and persistent odor that is quite characteristic and will usually serve to attract new bats to a roosting place even if the original inhabitants have been removed.

Because bats are easily attracted to areas where other bats have been roosting, close all openings through which they may enter. Smaller bats can crawl through openings as small as 3/8 inch, so no opening larger than 1/4 inch should be left. Larger openings should be closed entirely with wood, oakum, metal, or concrete, except where ventilation is required, in which case 1/4-inch mesh hardware cloth can be used. One way to be sure all bats are out of the building before closing openings is to close all but a few openings, wait several days until the bats become accustomed to using those that are left, then, when the bats are all out at night, close the remaining openings.

In addition to the general nuisance and odors associated with bat infestations, the animals also harbor ectoparasites such as mites and bat bugs that may leave the nesting area to attack humans in the building, especially when the bat population is removed. Therefore, a part of all bat-control jobs should be to kill any ectoparasites that may remain and try to migrate.

Dead bats and droppings should be removed from the premises whenever possible because the odor from the decaying bodies can be quite offensive. That odor and the odor remaining from the roost can be covered up by paradichlorobenzene (PDB) or any deodorant used to mask the odor of dead rats.

Anyone engaged in any sort of vertebrate pest control has an increased likelihood of contacting rabid animals. Bats should therefore never be handled, dead or alive. They have needlelike teeth and can bite severely. When working with bat infestations, you should use a beekeeper's helmet, gloves, and coveralls. Any bat that acts in an abnormal manner, such as fluttering around on the ground, may be rabid and should be avoided or handled with tongs. Because rabies in man almost always results in death, any bat causing a bite should be captured with its brain intact for examination by health authorities.

Tree Squirrels, Ground Squirrels, and Chipmunks

Tree Squirrels

While they generally build their nests in trees, some species of tree squirrels will settle in an unused attic if conditions are favorable. They can do considerable damage to buildings with their gnawing and will chew on cables and electrical wiring. They may also be very noisy, will bite if cornered, can cause ectoparasite problems in nesting areas, and can damage garden and ornamental plants. They are most active in the early morning and late afternoon. They feed on nuts, seeds, buds, leaves, bulbs, bark, insects, and fruit and like to store some of these foods in outdoor caches.

To control tree squirrels, first determine how they are entering a building and make every effort to seal existing openings with sheet metal or 1/4-inch hardware cloth. They can be kept from climbing trees by placing a two-foot-wide metal band around the tree trunk, three to four feet above the ground. Squirrels can also be repelled from buildings by the liberal use of naphthalene in enclosed spaces that they might enter. Frequently, squirrels will get into a building from a single overhanging tree limb. In this situation, simply prune the limb back 10 feet or more so that they cannot reach the building from it.

If the squirrels cannot be controlled by screening, repelling, or removing tree limbs, it may be necessary to kill or trap them. In cases in which the squirrel population is small, they can be controlled by shotgun. Because most squirrels are protected animals, however, you must make certain that you are not violating any laws in your trapping or killing procedures. To obtain clearance, consult your local conservation police officer. In many areas it is possible to obtain a special permit or other permission to eliminate squirrels if they can be shown to be a nuisance.

Where squirrels cannot be killed, trapping with live traps is usually the best method of control. Traps should be placed, unset, in areas where they are to be used until the squirrels become accustomed to them. Bait (peanut butter) placed by the traps will attract the squirrels to them. Once they have become accustomed to the traps, a few settings will usually capture enough squirrels to eliminate the problem.

Ground Squirrels

Ground squirrels (sometimes called "gophers") often cause damage to lawns, golf courses, and gardens by burrowing and by digging up newly planted seeds. These animals are active from late March until October, at which time they enter their underground burrows to hibernate. They eat roots, fruits, seeds, insects, and green vegetation. They are nervous, excitable animals seldom found far from their burrows. Their preferred habitat is open fields or brushy areas, so they are not usually found in forests or in damp areas. They can be distinguished from tree squirrels by their shorter and less bushy tails and by the fact that they live underground and are excellent burrowers but poor climbers.

Ground squirrels can be controlled with poisons or repellents labeled for these burrowing rodents or with traps. PDB can be used as a liquid fumigant or repellent. The liquid is poured into the burrow and then sealed with dirt. Trapping is effective for removing small infestations of ground squirrels. Rat snap traps, small

live traps, or special box traps should be placed in shallow depressions near the burrow entrance. The animals can be lured into the traps by sprinkling small amounts of grain on the earth covering them or around them.

Chipmunks

Although they generally add to the enjoyment of the outdoors, chipmunks may occasionally become pests by burrowing under buildings and into flower beds, lawns, and golf courses. These small rodents are often confused with the 13-lined ground squirrel, which is a larger animal with 13 alternating light (with spots) and dark stripes. Chipmunks have solid light and dark stripes that also appear on the head and nose. Another characteristic of chipmunks is that they run with their tails up over their backs. They are active from March to October, spending most of the winter in their burrows, which are usually lengthy, covering 30 feet or more. They remove the dirt from the burrow and scatter it away from the burrow entrance. In addition to underground burrows, they are also found in walls and wood piles. They feed on seeds, nuts, grains, fruits, and insects.

Chipmunks can be controlled by trapping, shooting, or using poisons labeled for these burrowing rodents. Rat snap traps or small live traps baited with nutmeats, sunflower seeds, peanut butter, corn, or rolled oats and placed around rock piles or logs or near burrow entrances are usually effective. Where firearms may be used, a small-gauge shotgun is usually preferable and is most effectively used in early morning or late afternoon.

If the chipmunks are alive, they can cause serious bites. In fact, gloves or tongs should be used to handle all vertebrate pests, dead or alive, since they or their ectoparasites may carry disease.

Skunks

The striped skunk is the most common species in Illinois. Skunk damage can be costly because: their odor is nauseous, they are a reservoir in the transmission of rabies, they destroy turf in golf courses and lawns while digging for grubs, they kill poultry and birds, and they harbor ectoparasites.

Skunks are most active after dusk. They emerge from their burrows to feed on grubs and other insects, small rodents, garbage, birds and their eggs, fruits, and berries. If approached, the skunk may eject its musk. Its aim is very good, and the material can be squirted more than 10 feet. If a skunk is aggressive, it should be avoided because it may be rabid.

Skunks are usually a problem if they have gained access to the space under a building. To exclude them from such places, close all but one opening and then sprinkle a little flour in front of it. Examine the flour after dark and, if the tracks show that the animals have departed, close the opening and seal it securely with cement, sheet metal, or wire netting. Another way to get rid of skunks is to throw a light on the area they frequent. To prevent skunks from digging in a lawn, grubproof the turf with an insecticide.

If a skunk must be trapped, use a box trap baited with fish, bacon, chicken parts, or fresh eggs and covered with old burlap sacks or tarps. The trap should be located so that it and the animal can then be removed easily to a release site.

If skunk odor gets on clothing or under buildings, it can be neutralized by liberal use of a deodorant such as neutroleum alpha. Vinegar or chlorine bleach in a weak solution is also suggested for removing the odor from clothing or pets.

Moles

While searching for the earthworms and insect larvae that are their principal food, moles damage ornamental plants by destroying their roots. In addition, their burrows deface lawns and the gardens adjoining them.

Moles are subterranean and rarely come above ground. Their nests are usually deep beneath the protective cover of a large stone, tree, sidewalk, or roadway. Although moles are almost blind, they have keen senses of smell, touch, and hearing. They are most active on damp, cloudy days in spring and fall and have been reported to burrow 100 yards in a single 24-hour period.

Moles can be indirectly controlled by grubproofing lawns and gardens. Although this method does not kill the moles, it forces them to go elsewhere to find food. They may still damage lawns, however, while searching for food or just wandering.

You can buy traps designed for mole control, such as the choker trap and harpoon trap. They should be used according to the manufacturer's directions.

Liquid PDB and calcium cyanide (Cyanogas) are approved for use in fumigating burrows. Follow the label directions closely in applying these gases. Do not put out poisoned peanuts. Their use is ineffective and dangerous.

Snakes

In their natural surroundings, snakes should be left alone both because the poisonous species are dangerous and because they are generally beneficial animals, eating many rodents and insects. Snakes of many kinds, however, find their way into and around buildings. They become a problem for the homeowner in crawl areas, yards, gardens, poultry houses, and outbuildings because they frighten or bite humans, kill birds, and cause odors in warm weather.

Although few native animals are more disliked or more misunderstood, most snakes are not poisonous. Of the 116 species of snakes in the United States, only 19 are dangerous. Fifteen of the dangerous species are rattlesnakes, two are moccasins, and two are coral snakes. None of the rest need be feared. All of the poisonous species except coral snakes have vertical pupils (cat's eyes) and/or a deep pit on each side of the head between the eye and nostril.

Most snakes hibernate over the winter in burrows or dens and become active when the weather is warm, some in the daytime and some at night. When snakes are present in large numbers, an abundance of food must be attracting them. By removing their food source (such as rodents) and cleaning up debris, trash piles, compost heaps, wood piles, thick vegetation, and tall grass, you will drive snakes out of the area. If a snake gets into a building and hides before it can be found, put wet cloths near where it is thought to be and cover them with dry cloths or burlap bags. Snakes like moisture and shelter and will be attracted to this pile of materials. They can then be removed or killed by clubbing or shooting.

To keep snakes from getting in, all points where they might enter should be blocked. Snakes usually enter near or below ground level and can get through extremely small openings, so a number of modifications may need to be made to a structure to snake-proof it.

Miscellaneous Vertebrate Pests

Many other vertebrates may become pests on occasion, including coyotes, feral cats and dogs, raccoons, opossums, rabbits, pocket gophers, woodchucks, and field mice. Measures to prevent damage by these animals can be either protective (removal of food and shelter and repair of buildings to exclude the animals) or reductional (poisons or traps).

Coyotes

Sheepmen, hog raisers, and cattlemen are suffering losses because of coyotes, which are becoming increasingly abundant in Illinois. Coyotes also help themselves to poultry and waterfowl. They can be controlled by shooting or chasing with hounds throughout the year or by trapping during certain months. They are protected from trapping most of the year; however, a permit can be obtained for their control if damage can be proved. They can be excluded from pasture areas by electric fences.

Feral Cats and Dogs

Originally pets, feral cats and dogs are those animals that have been driven away or allowed to stray from home and have acquired wild habits. They may invade areas such as around homes, feedlots, markets, food plants, warehouses, garbage containers, and dumps and may contaminate food, spread ectoparasites, bite and scratch, kill birds and other animal life, and carry diseases of man and other animals such as rabies.

Most of these cats and dogs are active at night and are very cautious, secretive, and solitary except during breeding time. If they must be handled, all precautions should be taken to avoid scratches and bites. Trapping with baited (fish or meat) box traps is the only approved method of control in heavily populated areas. Traps should be set at or near places where strays can be expected to visit, such as around garbage cans or other sources of food. PDB and naphthalene aerosols are available for use as repellents both indoors and outdoors, but they are effective only in small areas or where the animal can be confined. In rural areas, shooting individually recognizable animals is effective.

Raccoons

Common throughout most of the United States, raccoons are a protected furbearing animal in Illinois. They become problems in outbuildings, attics, garbage containers, poultry houses, and cornfields, where they are noisy, overturn garbage containers, kill poultry, and damage corn plants, especially when the ears are in the milk stage. These animals are intelligent, strong, good climbers, and persistent. They are usually active at night and remain in their dens in haylofts, attics, trees, hollow logs, or burrows during the day. In addition to feeding on insects, frogs, and fish, they will eat just about anything man will eat. The most satisfactory method of control is trapping with wire or box-type traps baited with fish, chicken parts, or corn on the cob.

Opossums

These sluggish animals nest in hollow logs and trees and in rock dens, but they often invade crawl areas, attics, lawns, and yards, where they create a nuisance, kill poultry, cause odors, bite, and spread their ectoparasites. Opossums will eat practically anything available, animal or vegetable, often feeding on the carcasses of animals killed on highways. They can be readily taken with box traps baited with fish, putrid meat, or chicken parts.

Rabbits

The value of rabbits as game animals (protected in Illinois) is often outweighed around the home and farm by the damage they do to ornamental plants, fruit trees, and vegetable gardens by consuming plants and gnawing the bark of shrubs and trees. They also spread ectoparasites. Rabbits are active throughout the year, feeding mostly in early morning and late afternoon on leaves, stems, buds, and bark. They prefer areas of heavy vegetation, brush, and piles of debris. By eliminating those harborages, you can often remove rabbits from the area of concern. Other control or protective measures include wire guards and fencing for yards, gardens, and individual plants; the use of repellents such as naphthalene dust, Arasan, and other commercial preparations labeled for rabbit control; trapping with box traps baited with apples, lettuce, or carrots; and shooting (where permitted).

Pocket Gophers

These rodents get their name from their fur-lined, pocketlike cheek pouches in which they carry food. They live in underground burrows that may be several hundred feet in length, ranging in depth from a few inches to several feet, with sometimes several gophers inhabiting a single burrow system. Unfortunately, they dig these burrows in lawns and gardens, pushing the soil from the burrows into mounds that are built in the shape of a horsehoe around the burrow opening, making sometimes 100 or more mounds in a season.

Gophers are active all year but are most active in late summer and fall, when they dig shallow burrows to get roots for winter, usually storing the roots in small chambers within the burrow. In late summer and early fall, many young gophers are forced to the surface and wander about searching for a home. They will inhabit any unused burrow. Control is best accomplished by trapping or using poisoned baits that are labeled for gopher control. Small spring traps are made especially for trapping pocket gophers. Liquid PDB can also be used as a repellent and fumigant in burrows.

Woodchucks

Woodchucks often burrow under foundations or rock walls, causing them to crumble. They also cause considerable damage to crops like soybeans. They hibernate during the winter. They can be controlled by shooting or trapping or by poisoning or gasing the burrows. Woodchuck or "gas" cartridges can be placed in the burrow and the entrances sealed, but these cartridges should not be used under wooden floors, walls, or any other combustible material. February and March are the best months for control because active woodchuck dens are easiest to identify at this time. Woodchucks are completely protected in Illinois during April and May, and throughout the year you must have a permit from the Department of Conservation before you use the woodchuck cartridges.

Field Mice

To find food and shelter, field mice often invade homes, yards, and gardens in the winter. They can create a nuisance and damage ornamental trees and shrubs by root pruning and trunk or root girdling. Extensive damage may occur to orchards during periods of heavy snow cover. Because they move in from adjacent fields and bushy areas, they can usually be eliminated by mowing those areas closely. Mowing of orchards or maintaing bare areas near the base of the trees helps keep populations down. They can also be controlled by wrapping tree trunks, by the proper use of wood-base snap traps and toxic baits labeled for such use, and by making structural modifications to exclude mice from buildings.

Poison Resource Centers

The Poison Resource Centers listed below have been established to provide information about the treatment of poisoning cases. Anyone with a poisoning emergency can call the toll-free telephone number for help. Personnel at the Resource Center will give you first-aid information and direct you to local treatment centers if necessary.

Chicago and Northeast Illinois

1753 West Congress Parkway
Chicago, Illinois 60612
Telephone: 800-942-5969

Northern and Central Illinois

530 N.E. Glen Oak
Peoria, Illinois 61603
Telephone: 800-322-5330

Central and Southern Illinois

800 East Carpenter
Springfield, Illinois 62702
Telephone: 800-252-2022

CONVERSIONS

Fluid

1/6 fluid ounce (oz) = 1 teaspoon (tsp)
1/2 fluid ounce = 1 tablespoon (tbs) = 3 teaspoons
1 fluid ounce = 2 tablespoons = 1/8 cup
8 fluid ounces = 1 cup = 1/2 pint (pt)
16 fluid ounces = 2 cups = 1 pint
32 fluid ounces = 4 cups = 1 quart (qt)
128 fluid ounces = 16 cups = 1 gallon (gal)

Linear

1 inch = 2 1/2 centimeters (cm) = 25 1/2 millimeters (mm)
1 foot (ft) = 12 inches (in)
1 yard (yd) = 3 feet
1 rod = 5 1/2 yards = 16 1/2 feet
1 mile = 320 rods = 1,760 yards = 5,280 feet

Area

144 square inches = 1 square foot
9 square feet = 1 square yard
30 1/4 square yards = 1 square rod
= 272 1/4 square feet
43,560 square feet = 1 acre
4,840 square yards = 1 acre
160 square rods = 1 acre
640 acres = 1 square mile

Weight

1 ounce = 28 1/3 grams (g)
1 pound (lb) = 16 ounces = 453 1/2 grams
2 1/5 pounds = 1 kilogram (kg) = 1,000 grams
1 ton = 2,000 pounds = 907 kilograms

DILUTION TABLES

Amount of Liquid Pesticide Product Required to Obtain Recommended Rate

Concentration of liquid formulation	Recommended pesticide active ingredient (a.i.) per acre or 100 gallons of water				
	¼ lb	½ lb	1 lb	2 lb	3 lb
	Amount of pesticide product required				
1 lb/gal	1 qt	2 qt	1 gal	2 gal	3 gal
1½ lb/gal	1⅓ pt	1⅓ qt or 2⅔ pt	5⅓ pt	5⅓ qt	2 gal
2 lb/gal	1 pt	1 qt	2 qt	1 gal	6 qt
4 lb/gal	8 oz	1 pt	1 qt	2 qt	3 qt
6 lb/gal	6 oz	10 oz	1⅓ pt	1⅓ qt	2 qt
8 lb/gal	4 oz	8 oz	1 pt	1 qt	3 pt

Amount of Dry Pesticide Product Required to Obtain Recommended Rate

Concentration of dry formulation	Recommended pesticide active ingredient (a.i.) per acre or 100 gallons of water				
	¼ lb	½ lb	1 lb	2 lb	3 lb
	Amount of pesticide product required				
15%	1⅔ lb	3⅓ lb	6½ lb	13 lb	20 lb
25%	1 lb	2 lb	4 lb	8 lb	12 lb
40%	10 oz	1¼ lb	2½ lb	5 lb	7½ lb
50%	8 oz	1 lb	2 lb	4 lb	6 lb
65%	6 oz	12 oz	1½ lb	3 lb	4½ lb
75%	5⅓ oz	11 oz	1⅓ lb	2⅔ lb	4 lb
80%	5 oz	10 oz	1¼ lb	2½ lb	3¾ lb


BEFORE USING ANY
PESTICIDE
STOP
READ THE LABEL