

Commercial Vegetable Production in Wisconsin

2008

Asparagus

Bean

Beet

Carrot

Celery

Cole crops

Cucumber

Eggplant

Horseradish

Leafy greens

Melon

Mint

Onion

Pea

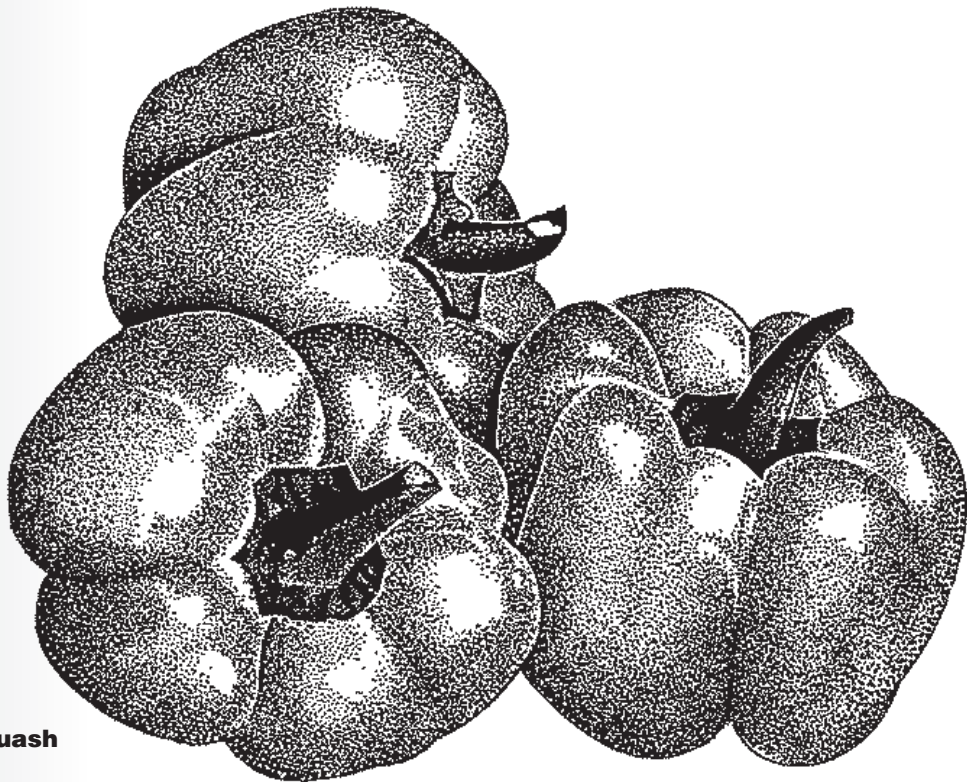
Pepper

Potato

Pumpkin & squash

Sweet corn

Tomato



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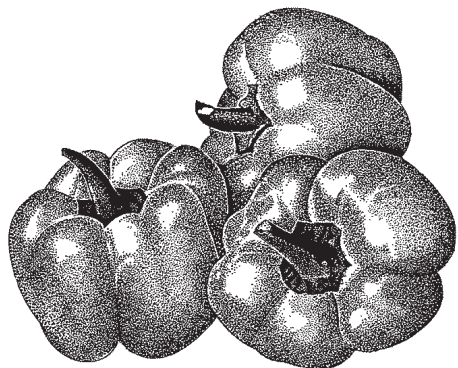
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Information current as of January 1, 2008



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Herbicide information

Some herbicides containing the same active ingredients but having different trade names are marketed by more than one company. Also, some herbicides are produced in several formulations. Products recommended in this bulletin are commonly used formulations of common herbicides. Other products and formulations may be equally good. Check labels on containers to determine that the product is labeled for your intended target crop and the amount of product to use per acre.

Pesticide information

References to pesticide products in this publication are for your convenience and are not an endorsement of one product over other similar products. You are responsible for using pesticides according to the manufacturer's current label directions. Follow directions exactly to protect the environment and people from pesticide exposure. Failure to do so violates the law.

Pesticides sometimes have restricted time periods for use, such as in a product recall or a use deadline. Always check pesticide registration status with Wisconsin DATCP.

To protect yourself, others, and the environment, always read the label before applying any pesticide.

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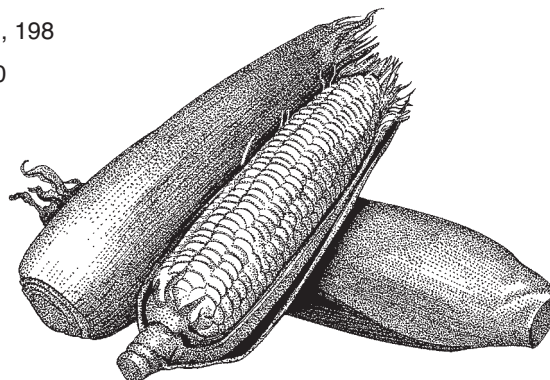
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Best management practices for vegetable production

Vegetable growers must use cultural practices that optimize yields, maximize returns and profits, and minimize environmental impacts. Maximum profits aren't always dependent on maximizing yields. For example, smaller yields of high-quality vegetables may generate a significantly higher profit than a large yield of marginal quality.

Common environmental problems that result from vegetable production include soil erosion from wind and water and groundwater contamination from pesticides and nitrates. Vegetable growers need to assume responsibility for protecting natural resources by reducing harmful impacts. Research has shown that using Best Management Practices (BMPs) can reduce harmful impacts yet sustain profitable production.

BMPs are cultural practices that increase efficiency of inputs such as fertilizers (especially phosphorus and nitrogen), pesticides, and irrigation. By reducing inputs, growers lower their costs and the potential for fertilizer and pesticide leaching. The BMPs reviewed in this publication include crop rotation, tillage practices, fertility management, pest control, and irrigation management.

Crop rotation

Growing the same crop on the same land year after year is considered a poor practice that may lower crop productivity. The decrease in crop yield and quality may result from a buildup of certain crop pests and from changes in soil physical properties, such as compaction. Vegetable growers sometimes try to overcome this productivity loss by increasing fertilizer, pesticides, and irrigation, but increasing these inputs raises both costs and the potential for environmental problems.

Crop rotation is the cultural practice of growing a different crop each year on the same land. One goal of rotation is to avoid growing a given vegetable crop on the same land for at least 3 years. An example of a 3-year rotation program would be a cole crop (broccoli, cauliflower, or cabbage) in the first year, snapbeans or peas in the second year, and sweet corn in the third. The 3-year cycle could then be repeated.

Well-designed crop rotations help suppress pest problems and improve soil physical condition. Crop diversity effectively controls pests that have short survival periods and a narrow host range. Crop diversity and the resultant pesticide-use diversity also help to prevent the buildup of certain pest problems, particularly weed problems.

Adding organic matter from forage legumes or green manures rebuilds soil structure, adds nutrients (particularly nitrogen), and improves the soil's water and air balance. The result is more vigorous crop growth that can better resist pest and environmental stresses.

Potential crops to include in a rotation depend upon the individual grower's situation and will vary from grower to grower. Crop selection should follow these general guidelines:

- include both deep- and shallow-rooted crops;
- avoid crops with common disease or insect problems;
- use agronomic crops (field corn, oats, and soybeans) where possible; and
- include a forage legume (alfalfa, clover) when possible.

Finding the ideal rotation can be difficult. Production and marketing objectives, land availability, and financial conditions may dictate what rotations are feasible. More diversified and longer rotations can be effective in maintaining crop productivity while reducing production costs and the potential for harming the environment, particularly groundwater contamination.

Tillage practices

Intensive soil tillage is often used in vegetable production. Depending on the crop, a given field may be subjected to as many as six different tillage operations in a growing season. Such intensive tillage can damage soil structure and increase compaction, especially when working wet fields. Loss of soil structure also increases the soil's susceptibility to wind and water erosion. Excessive tillage can also dry the soil's upper portions, causing poor germination, emergence, and early seedling growth.

Reducing tillage trips across the field protects the soil resource and reduces costs. Where possible, vegetable growers should try to implement conservation tillage (CT). This practice reduces tillage to maintain previous crop residue on the soil surface, which helps control soil erosion. However, CT can also increase problems with stand establishment, especially with processing vegetables, where a uniform stand is important. Previous crop residue can hinder the mechanical harvesting of vegetables. The effective use of CT requires a high level of management, and growers should initially experiment with CT on a small number of acres.

Fertility management

The goals of effective fertility management are efficient use of soil and fertilizer-applied nutrients. Fertilizer programs should be designed to meet minimum crop needs. Excessive fertilizer applications must be avoided to maximize net returns. Excessive nitrogen and phosphorus applications must be avoided to minimize contamination of ground and surface water.

An efficient fertilizer program considers realistic yield goals to determine phosphate and potash needs. Fertilizing beyond realistic yield goals can reduce returns. Realistic yield goals are usually equal to the average yield for the past 5 years.

Base your fertilizer program on soil test results. These results will indicate the soil's potential for meeting the phosphorus, potassium, and some of the other nutrient needs of the crop. Only add fertilizer when the soil's nutrient supply fails to meet crop needs. In effect, the soil test results determine the fertilizer amount needed to meet yield goals. Adjust the fertilizer amounts to account for nutrient credits from previous crop residues or other nutrient additions such as manure.

Soil pH influences nutrient availability. Also, some crops are sensitive to different soil pH and development of certain diseases may be accelerated depending on the pH. Lime can be used to increase pH, but it must be added 6–18 months before planting crops that require the higher pH to be fully effective.

Fertilizer programs should also take into account fertilizer timing and placement. Generally, leachable fertilizer nutrients (especially nitrogen) should be applied just before the time of greatest crop need. Similarly, fertilizer placement should maximize uptake while minimizing leaching and tie-up by the soil. Row and band-placed fertilizer often minimize soil tie-up while maintaining fertilizer availability. Some crops are sensitive to in-row nitrogen applications.

Finally, consider the fertilizer forms used. Some forms of fertilizer are less usable to crops, while in other cases the form may dictate specific placement or use considerations. For example, elemental sulfur is not available to crops until it is converted to the sulfate form (usually in 1–3 months).

The form of nitrogen fertilizer can be particularly important on sandy soils. Urea nitrogen is highly leachable as a neutral molecule. However, it is usually converted to the nonleachable ammonium form a few days after application. The ammonium is similarly converted to the highly leachable nitrate form over a 2–4 week period. In addition, urea spread on the soil surface, without incorporation, can be lost by volatilization. Conversely, half the nitrogen in ammonium nitrate is immediately leachable, but this form is not lost by volatilization.

Some crops prefer specific forms of nitrogen. Potatoes, for example, show apparent losses in quality if supplied only with ammonium nitrogen. You must consider all the above factors if your fertilizer program is to become more efficient.

See Extension publication *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin* (A2809) for additional information.

Pest management

Effective pest management is essential in vegetable production because quality is as important as yield. Uncontrolled pest problems are a major cause of quality and yield losses in vegetables. To ensure profitable yields and quality, many vegetable growers tend to use more pesticides than are needed. Such excessive use leads to increased costs as well as an increased potential for environmental contamination.

Integrated pest management (IPM) is a BMP that can improve pest management efficiency, reduce pest management costs, and minimize dangers to the environment. IPM is a coordinated management strategy, using all suitable techniques to keep pest populations below economically damaging levels. IPM promotes the use of nonchemical control methods. These include using pest-resistant cultivars, well-designed crop rotations, pest-controlling tillage practices, adjusted planting and harvesting dates, exclusion with row covers, mulches, and plant spacing.

Unfortunately, not all pest problems can be controlled with nonchemical control methods. Chemical controls may be needed in order to achieve profitable yields and quality, but IPM ensures that pesticides are used only when necessary to prevent economic loss. Those using IPM monitor weather, crops, and pests in making pest control decisions.

Irrigation management for vegetables

A significant amount of Wisconsin's vegetable production is irrigated. Most of the irrigated vegetable production is on light sandy soils with shallow depths to groundwater. Such areas are sensitive to groundwater contamination by nitrates and pesticides. Excessive fertilizer (especially nitrogen) or pesticides and over-irrigation can increase groundwater contamination problems. Such overuse also adds unnecessary costs.

Yield and quality losses occur when vegetables are subjected to moisture stresses. To avoid moisture stress, adequate amounts of water must be supplied to the crop throughout the growing season. Rainfall generally provides adequate moisture for vegetables grown on silt and clay loam soils. However, on sandy soils, a well-managed and efficient irrigation program must be used to avoid losses.

Efficient irrigation reduces costs and the potential for groundwater contamination problems. Effective scheduling (timing) of irrigation by using a program such as the Wisconsin Irrigation Scheduling Program (WISP) enhances irrigation efficiency.

Over-irrigation applies more water than the crop can use or the soil can hold. It is this excessive water that leaches nitrates or pesticides to the groundwater. Excessive or untimely rains also leach contaminants to groundwater. An effective irrigation scheduling program eliminates over-irrigation, so crop use of rain is maximized.

WISP uses estimates of crop water use to monitor soil moisture levels. The soil moisture status then determines the irrigation frequency and amount. WISP requires knowledge of four parameters for successful operation:

Allowable depletion (AD)—a measure of the soil's water storage. This is determined by soil type and crop rooting depth. A table is available that provides AD values for many crop/soil systems found in Wisconsin.

Rainfall—all rains must be accounted for in the WISP program.

Irrigation—all irrigations must be recorded.

Evapotranspiration (ET)—a measure of crop water use. During the growing season, daily ET estimates are calculated for Wisconsin's major irrigated areas and are available online at <http://www.soils.wisc.edu/wimnext/>. Estimates should be adjusted to reflect the proportional canopy cover.

WISP uses the above parameters in a simple, checkbook-like accounting format to provide the needed information for making irrigation decisions. Specifically, WISP provides current soil moisture conditions that, in turn, determine the need for and amounts of irrigation. WISP also emphasizes the use of precipitation forecasts in making irrigation decisions. This approach ensures maximum flexibility in scheduling irrigations. Such flexibility is essential in Wisconsin, where weather patterns, particularly rainfall, are variable and changing. For more information about WISP, refer to Extension publication *Irrigation Management in Wisconsin—The Wisconsin Irrigation Scheduling Program (WISP)* (A3600).

Insect identification

Aphids

Aphids are small 1/10–1/5 inch insects with two tail pipe projections (called cornicles) sticking out the abdomen. Both winged and non-winged forms can be found on plants. Large numbers cause plants to wilt and yellow. They also cause distorted and stunted plant growth. Most aphid species will go through numerous generations during the growing season. Aphids also transmit virus diseases to many plants. There are a number of important species in Wisconsin.

The **black bean aphid** is found in clusters on the undersides of succulent bean leaves. Large populations will cause yellowish foliage and poor growth of the crop. Because of the spotty nature of infestations in the field, a number of plants in several areas of the field should be examined. Check 15 consecutive plants (terminals only) in each site. Levels above 5–10% infested would indicate treatment is needed. Scout fields weekly.

Cabbage aphids are gray in color and live in closely packed groups. Heavy infestations cause leaves to curl and may prevent head formation. Aphid damage is most serious on young cabbage and in the seed bed. Once cabbage heads form, this insect is difficult to control.

Corn leaf aphids at first congregate on upper leaves and tassels, but later may be found over all parts of the plant. High numbers may occur on plants during ear filling, but this attack has little effect on yields. Treatment at this late stage will be of little or no benefit.

The **asparagus aphid** is a recent import from Europe that causes a brooming distorted growth of the ferns of asparagus. It's bluish gray in color and the cornicles aren't readily apparent. Normally only isolated plants are affected and can be spot treated.

The **green peach aphid** is the most destructive and insecticide-resistant aphid in Wisconsin. Many crops are attacked including greenhouse transplants of pepper, tomato, and cabbage, along with beet, carrot, broccoli, Brussels sprouts, lettuce, eggplant, and potato. Green peach aphids are 1/8 inch long yellowish green, peach, or dirty red and can be found on the undersides of leaves. This aphid is a very efficient vector of many virus diseases. Scouting is usually done by examining the undersides of leaves and looking for aphid activity.

In potatoes remove 25 leaves per sample from the lower half of 25 different plants—with at least 10 sample sites per field. Treat if more than 10 aphids are found per 100 leaves in seed fields or more than 30 per 100 leaves in table stock or processing potatoes.

Potato aphids are larger than green peach aphids and come in both red and green. They attack eggplant, tomato, and potato and are most often found on young actively growing tissue. To sample for potato aphids, remove leaves from the terminal parts of 35 plants and count the number of aphids. Repeat in at least 10 locations per field. When aphid counts exceed 20 per 100 in seed potato and 50 per 100 leaves in table or processing potatoes, control measures are suggested.

Melon aphid is a small dark aphid that can be found building up on the undersides of leaves of cucumber, squash pumpkin, and melon. They can produce up to 10 generations per year and cause infested plants to yellow and wilt. Low numbers are most often controlled by natural enemies.

Armyworms

Armyworms are dark caterpillars measuring up to 2 inches long. They have a dark stripe running lengthwise on the side with a yellow stripe beneath. Dark and light stripes alternate along their back. Armyworms move up from grassy weeds within corn fields or migrate into corn fields from small grain or forage fields. They may hide in soil crevices and beneath clods by day. At night, they chew corn leaves and weaken plants.

Beetles

The **striped and spotted cucumber beetles** are 1/4-inch, yellow-green beetles that become active in very early spring. Adults feed on developing fruit and foliage and, more importantly, transmit bacteria causing wilt disease. Small numbers of beetles can devastate a planting if they carry the disease, and they must be controlled before the disease appears. In the fall, adults of these beetles can chew holes in the developing fruit of vine crops such as cucumber, melon, pumpkin, and squash.

Flea beetles are frequently a pest of early plantings. These small, shiny black beetles, which jump when approached, chew small circular holes in the leaves. This damage is insignificant on large potatoes and tomatoes but young seedlings can be rapidly killed.

Young seedlings or transplants of cabbage, broccoli, beet, tomato, eggplant and all vine crops should be scouted on a weekly basis when they are young. If flea beetle activity is seen, an insecticide rescue treatment will be needed.

Common asparagus beetles are 1/5 inch long and orange with white dots on a dark background on the back. They overwinter as adults and emerge in April, (earlier than the spotted asparagus beetle) and begin feeding and laying eggs on the spears. **Spotted asparagus beetle** adults may feed on spears, but do not begin laying eggs until the plants have ferned out. When both species are present, both the spears and ferns can be heavily damaged.

Cabbage maggot

The adult **cabbage maggot** is a small gray fly that lays its eggs at the base of crop plants in the cabbage family. The small cylindrical and white eggs hatch into legless white maggots that feed on the roots. Seedling plants can be killed rapidly, while transplants tend to wilt and die slowly. Root crucifers such as radish and turnip show surface tunneling that is often accompanied by soft rots.

Chemical controls require either soil application to seed furrows or transplant drenches. However, these treatments last for only 4–5 days and must be applied when the adults are actively laying eggs.

The cabbage maggot has three generations in Wisconsin. The first emergence of adults from overwintering pupae is the largest and most damaging, therefore you want to plant after the pupae have emerged. This emergence and the egg-laying peak may be predicted accurately by keeping track of the degree days. Cabbage maggots do not develop below 43°F (developmental threshold). Peak emergence of first generation cabbage maggots occurs when 300 degree days have accumulated. For more information, see “Calculating Degree Days.” If planting is necessary during the time of peak emergence, then insecticide treatments are recommended.

Colorado potato beetle

The Colorado potato beetle is the most distinctive pest of potatoes. Both the yellow and black striped adults and the brick-red humped larvae feed on the foliage. Feeding normally is initiated on the terminal growth and can be severe. Adults overwinter and move to emerging potatoes early in the spring (May). The adults lay bright yellow egg masses, and larvae feed for several weeks in the summer before pupating in the soil. Emerging adults then continue feeding throughout the season until no vines remain.

Common stalk borer

Eggs of this cutworm relative are laid in grassy weeds in September. In late May-July the brown and white striped caterpillars migrate into fields and burrow into the stems of tomatoes, potatoes, beans and other thick-stemmed plants. Once inside the stem, the insect cannot be controlled. Fall grass control will prevent egg laying and is the best control method for common stalk borer.

Corn rootworm

Rootworm larvae are white with black heads and grow 1/2 inch long. **Northern and western rootworm** larvae cannot be differentiated in the field. They feed on crown roots from June to August, causing corn to lodge and “gooseneck.”

Rootworms are most serious in loam soils, but of little consequence in muck or non-irrigated sandy soils. The larvae are not a potential problem unless corn is planted on the same ground in a “rootworm area” for 2 or more years in succession. Annual crop rotation controls these insects, because eggs overwinter in the soil.

The adult beetle of the northern rootworm is yellow to green. The western species is yellow with three black strips. Because rootworm adults congregate in ear tips to feed on silks, large populations in August can impair corn pollination. If there are five or more beetles per plant (check silks), corn fields should be treated during the early silk period. This appraisal should be made prior to 75% silking.

Late-season corn borer and earworm treatments reduce adult rootworms and eggs. Other fields may receive an economic population of overwintering eggs if 0.75 or more adults per plant are present around mid-August.

Cutworms

These are the larval stage (caterpillar) of night-flying moths. They are whitish gray to brown worms, ranging from 1/2 to 2 inches long. They feed almost exclusively at night and hide in the soil during the day. All cutworms curl to a characteristic tight ball when exposed, making them easy to identify. Most cutworms cut plants off at or slightly below the soil surface, making recent transplants especially susceptible. Eventually, plants become too thick and tough for cutworms to feed. Adult females are attracted to tall grasses for egg laying, and cutworm numbers tend to be higher in weedy or trashy fields.

Almost all commercial vegetable crops such as asparagus, beets, onions, carrots, celery, and potatoes can be attacked by cutworms. It is very difficult to predict when and where an infestation will spring up, and preplant insecticide treatments will not control heavy cutworm infestations. Scouting fields on a weekly basis is the best method for monitoring cutworm activity. If damaging populations are found, a “rescue” treatment will be needed. Bait

formulations are the preferred treatment if conditions are dry, whereas both baits and sprays can be used when the cutworms are feeding at the soil surface.

Earworms

These varicolored, smooth caterpillars are up to 2 inches long and feed mostly on ear tips. Insecticide treatment is necessary for early market sweet corn and for late-season canning or market sweet corn (silking after August 15).

European corn borer

Corn borers are small, white worms with black heads. In sweet corn, they hatch from egg masses on leaves and can grow to 1 inch. First-generation borers feed on whorl leaves during early summer, making small holes that show as the leaves grow. If uncontrolled, they also feed inside the stalk and ears. Second-generation borers invade ears and hide behind leaf sheaths. They also enter the stalk and ear shank as the shanks mature.

The best procedure for detecting damaging levels of egg-laying adult corn borers is to operate blacklight traps in a field and count trapped moths daily.

Hornworm

The tomato hornworm is a very large green worm (up to 3 inches) with a spine on the posterior end and white side stripes. The larva feeds on both foliage and fruit, and because each larva eats three to four times its weight in food daily, the damage appears dramatic. The adult stage of this insect is a gray hawk moth that is often mistaken for a hummingbird because it feeds on flowers. Because they are usually found in small numbers, hornworms rarely need control.

Leafhoppers

Potato leafhoppers are small (1/8 inch) wedge-shaped, bright green insects that blow up into the state every spring from the southern states. They may arrive anytime from late May to early July. Potato leafhoppers have a toxic saliva that causes injury to many plants. Leafhopper feeding will cause leaf edges to curl, turn yellow, and they may eventually brown and die. This "hopperburn" is most serious on potatoes, dry beans, and snap beans. Fields should be scouted on a weekly basis to monitor for this pest.

Potato leafhoppers are best sampled with a sweep net. For potatoes, 25 sweeps with an insect sweep net per sample site is needed and carefully turn over 25 leaves per sample site. Select leaves from the middle portion of the plant. Use at least 10 sample sites per 100 acres. Control measures are recommended when a field averages one to two adult leafhoppers per sweep AND there are more than 15 nymphs per 25 leaves, OR if three or more adult leafhoppers per sweep AND nymphs are present.

For snap beans, take 25 sweeps per sample site with at least 10 sample sites per 100 acres scattered throughout the field. Nymphs are less mobile and best scouted by leaf samples. Carefully turn over 25 leaves per sample site and count nymphs. Select leaves from the middle of the plant and use at least 10 sample sites per 100 acres. If counts exceed one leafhopper per sweep and one nymph per 10 leaves, then control measures are recommended.

The **aster leafhopper** is an olive, wedge-shaped insect that is 1/6 inch long and has six black spots on the vertex of the head. This leafhopper also migrates from southern states and carries the pathogen that causes carrot (aster) yellows disease. Aster yellows can be a serious problem on carrot, lettuce, celery, onion and potato. For most crops, it is important to control the disease before symptoms show in the field. For susceptible crops such as lettuce and celery, one or two insecticide applications per week may be needed from seedling stage until harvest. (See "Aster Yellows Index.")

Onion maggots

Onion maggots are small whitish larvae found in the bulbs of onions. The adult is a grayish fly which resembles the cabbage maggot. Onion maggots are a problem after a series of cool, wet springs. The most effective way to control these insects is to apply an insecticide in the furrow when planting.

Plant bugs

Plant bugs are 1/4 inch, tan to dark brown oval insects with piercing sucking mouthparts. They attack more than 50 different economic crops but are most damaging to strawberries, peppers, and all bean crops in Wisconsin. Feeding by these insects causes poor fruit set and gnarled fruit due to the toxic saliva they inject into the plant. They are highly mobile insects that overwinter in field debris. Large numbers of adult plant bugs migrate out of alfalfa fields when hay is cut.

For both potatoes and commercial beans, take 25 sweeps with an insect sweep net per sample site with at least 10 sample sites per 100 acres. When counts exceed one tarnish plant bug per sweep on a field average, control measures are recommended in potato and snap bean.

Seed corn maggot

Seed corn maggot is by far the most serious pest of all beans. The white legless maggot burrows into the seed or seedling, causing very poor seed germination and emergence, and/or stems without leaves (snake heads). The adult is a small grayish fly that looks identical to the cabbage maggot. This insect overwinters in the pupal stage in the soil and becomes active early

in the spring. Heaviest plant damage occurs during cool damp weather, in heavy organic soils and after peak adult flights. There are five generations per year, but most severe damage occurs in May and June. Peak activity of each generation can be predicted using degree days (200, 600, and 1,000 degree days—with a base temperature of 39°F—for first, second, and third generations, respectively). But since damage is severe for each of the first three generations, it is seldom possible to avoid activity periods.

You can reduce damage by planting seeds during good germinating weather, using seed treated with insecticide, or sowing seed in higher than normal numbers. Planting seeds too early or directly into manure frequently increases problems with this insect. Other crops attacked include peas, corn, all vine crops and crucifers, but beans are the preferred host. For other hosts, damage is most severe when plants are planted before the recommended date or during cool springs.

Thrips

Thrips are small 1/25-inch insects that cause whitish scratches or brownish blotches on plant leaves. Hot dry weather is correlated with severe thrips problems. Thrips attack cabbage and cause a brownish scarring in the head of processing cabbage. Thrips must be controlled before the plant heads out to assure proper coverage and control. In onions the injury looks similar to both ozone injury and some diseases. Use large volume sprays (100 gal/a) with a wetting agent for thrips control. A second treatment 5–7 days later may be warranted.

White grubs

This insect, which is the larval stage of the June beetle, has up to a 3-year life cycle. Because the adults lay eggs in grassy sodded areas, fields located in plowed down sodded areas are most susceptible. The characteristic C-shaped grubs feed on the roots of most plants. They are most damaging to root crops such as carrots or potatoes. Tilling the soil to expose the larvae during the spring and fall helps reduce numbers. Granular insecticides can be worked in the soil before planting in areas where damage is expected. Established weed-free fields should have few problems.

Wireworms

This insect is the larval stage of the click beetle and, like the white grub, lays eggs in grassy areas. Wireworms are also troublesome in low, poorly drained areas. Weed control is the best preventative measure. Control procedures for white grubs will also control wireworms. Potatoes and carrots are the most susceptible crops. Grassy or old sod fields will have high populations of wireworms. A soil insecticide should be worked in pre-plant in these fields.

Natural enemies of insect and mite pests

Biological control is the active utilization of beneficial living organisms to control pests. The beneficial organisms we use are usually referred to as “natural enemies” of the pests, and are placed in three broad groups: predatory insects, parasitic insects, and insect pathogens. In the upper Midwest, literally hundreds of types of natural enemies occur naturally in the environments of agricultural crops, managed forests, and managed urban and suburban landscapes. These have a very major impact on pest populations, and often result in keeping pests below damaging levels. When there is no human activity involved in managing these natural enemies, we refer to the results as “natural control” of the pests. Natural control is of major importance in pest management, but the benefits frequently go unrecognized because the natural enemies are often very small and their activity is easily overlooked.

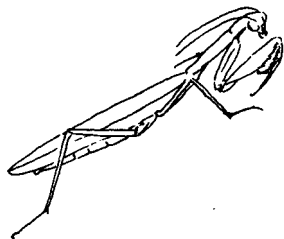
To get the greatest benefit from both natural control and biological control, it is necessary to recognize natural enemies, understand their biological characteristics (such as life cycle, preferred host insects, and efficiency at controlling pests). Some natural enemies, such as lady beetles, are readily recognized in the adult stage by most people, but may not be recognized in the egg, larval, or pupal stages. Other natural enemies, including most parasites, are much more difficult to recognize.

Although birds, mammals, frogs, and other higher animals can be important as natural enemies, they can rarely be effectively managed for biological control. These animals lie outside the scope of this discussion, which deals primarily with the predatory or parasitic insects of pest insects and mites.

Predatory and parasitic insects

There is a very large number of different types of predatory and parasitic insects. A standard reference book about insects lists a total of 328 families. Between one third and one half of these families contain species that are predaceous or parasitic on other insects. Many of these families, however, are of little or no consequence to agriculture. For example, there are seven families of dragonflies. All species of dragonflies are predaceous on small insects, capturing them in flight, and are important regulators of population numbers of small insects such as gnats, midges, and mosquitoes. However, the diet of dragonflies does not usually contain a significant number of agricultural pests. Therefore, a smaller number of families consist of important natural enemies of agricultural pests, and these are the ones that will be covered.

The praying mantids (Order Mantodea)



Chinese mantid

Praying mantids are all predatory on other insects. They have highly modified and strengthened front legs for capturing and subduing their prey, and they have chewing mouthparts. Large mantids can inflict a painful bite if handled. They all belong to the family Mantidae.

Family Mantidae: The praying mantids

Mantids are among the most recognizable of predaceous insects. These are often thought to be highly beneficial. However, they are opportunistic feeders, consuming whatever comes into their grasp, including other natural enemies, pollinators such as honey bees, and completely innocuous insects, as well as occasional pests. They are also cannibalistic and will readily consume each other.

Mantids are not native to areas of extreme winters, and can not naturally be found in Wisconsin. Those that are introduced, such as from commercial suppliers, will not survive northern winters.

Mantids have only one generation per year, and overwinter as eggs in cases which contain from several dozen to several hundred eggs. It is in this form that they are distributed commercially. These purchased egg cases are distributed outdoors to hatch and populate the area through natural movements of the young. Because of their cannibalistic behavior and their rapid dispersal to avoid cannibalism, rarely can more than one or two be found in the vicinity of the original egg case. This in combination with their indiscriminate predation on beneficial and innocuous insects as well as pests, renders them virtually useless as effective natural enemies of garden or crop pests.

The true bugs (Order Hemiptera)

All of the true bugs undergo simple metamorphosis, meaning that the immature stages (called nymphs) look like small, wingless versions of the adults. All have piercing-sucking mouthparts, meaning that they suck body fluids from their prey rather than chewing it up. Some Hemiptera are serious crop pests and others (such as bed bugs) are pests of human health and livestock. Some predatory Hemiptera can inflict painful a bite if mishandled, sometimes resulting in severe inflammation of the area surrounding the bite, which may persist for several days.

In all predatory Hemiptera, both the nymphs and the adults are predaceous, and often can be found in the same general habitat feeding on similar types of insects, although the young nymphs usually require smaller prey. Some predaceous Hemiptera feed to a small extent on plants, sucking plant sap, but there are no indications that this causes plant damage.

Family Anthracoridae: The pirate bugs

These are tiny insects, only 1–2 mm in size. Nymphs and adults feed on mites, small insects, and eggs. They are very common in many agricultural situations, especially where broad-spectrum insecticides are not routinely used, and are considered to be very beneficial general predators.



Minute pirate bug

Orius insidiosus, the minute pirate bug is probably the most important species in our region. It is an important predator of thrips, aphids, and spider mites on many crops. It is also an important predator of insect eggs. It is considered to be one of the more important natural enemies of corn earworm, and can destroy 50% or more of the eggs of this pest. Both the young and adults of *Orius* can consume 30 or more spider mites per day.

Family Reduviidae: The assassin bugs

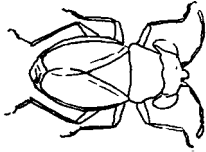
Some assassin bugs are parasitic bloodsuckers of mammals and have been implicated with the transmission of serious human illnesses. However, most species are highly beneficial predators of many serious crop pests. These are medium sized bugs (up to about 1 inch long) and can subdue and kill medium sized caterpillars and similar insects. They are generalist predators frequently found in gardens and fields.



Assassin bug

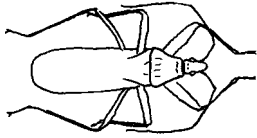
Family Lygaeidae: The seed bugs and bigeyed bugs

This family consists of both plant-feeding insects as well as predators. Many of the plant feeders feed specifically on fruits or seeds, hence the common name. The bigeyed bugs occur in the



Geocoris

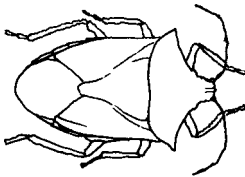
genus *Geocoris*. These are very beneficial predators which occur in many habitats and feed on many types of prey. *Geocoris punctipes* has been noted to feed on as many as 1600 spider mites during the course of its nymphal development, and an additional 80 mites per day as an adult. Bigeyed bugs are found in many agricultural situations, especially where broad-spectrum insecticide use is minimal, and in many non-crop situations.



Damsel bug

Family Nabidae: The damsel bugs

This is a small family of general predators commonly found in many crop and garden situations. Adults are 1/3–1/2 inch in length and slender-bodied. The tan-colored *Nabis ferus* is a common species in our region. It feeds on many types of insects, ranging from leafhoppers to small caterpillars. Some other species of damsel bugs are black in color.



Stink bug

Family Pentatomidae: The stink bugs

Stink bugs are medium-sized insects with a broad, shield-shaped body. They are usually green or brown, but sometimes brightly colored. Many discharge a disagreeable odor, especially when handled, hence their common name. Many are plant feeders and some of these are serious pests on a variety of crops. However, some species, especially in the genera *Podisus* and *Perillus*, are important predators. *Podisus maculiventris* and *Perillus bioculatus* both feed on caterpillars and larvae of leaf-feeding beetles such as Colorado potato beetle and Mexican bean beetle. These are highly efficient predators capable of consuming many prey during the course of their development. *Podisus* has two generations per year and each female can have 1000 or more offspring. The eggs are laid in clusters on leaves. The young are small and round. The youngest nymphs of some predatory pentatomids may feed to a limited extent on leaf sap, but such feeding is not damaging.

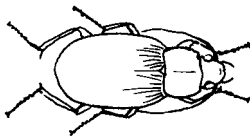
The beetles (Order Coleoptera)

The order Coleoptera is the largest group of insects in the world, constituting about 40% of all known insect species. There are about 30,000 species in the United States. The habits of this group vary considerably: many are aquatic, many are found in the soil, some are parasitic, and many are free-living. Many are plant feeders and some are serious pests. Some feed on fungi or are scavengers. Many are predators of other insects.

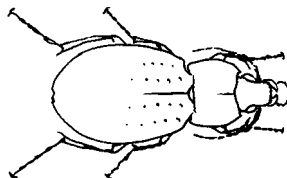
All beetles undergo complete metamorphosis, meaning that the immatures look nothing like the adults; instead they are worm-like or grub-like. Depending on the species, larvae and adults may do similar or very different things. For example, both the adults and larvae of lady beetles are predatory, usually on the same types of prey. However, while blister beetle larvae are parasitic on grasshopper eggs and ground-nesting bees, the adults are generally plant-feeders.

Approximately 40 families of beetles are known to have predatory or parasitic members. In some families, insect feeding may be only incidental, while in other families it is the rule. By far, the two families most important in crop protection are the predaceous ground beetles (family Carabidae) and the lady beetles (family Coccinellidae).

Family Carabidae: The ground beetles



Chlaenius



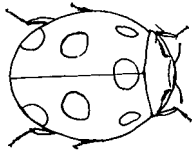
Calosoma

Ground beetles vary in size from a few millimeters to over an inch in length. Most species are brown or black, but a few are metallic blue or green. There is generally one generation per year, but the adults of larger species are known to live 2–4 years. The larvae of some species may require more than one year to complete development. Carabids can be found in most agricultural and garden settings. Most species which have been studied are predaceous as both larvae and adults, although some are scavengers and a few feed on plants. The predatory species feed on insects found in or on the soil, earthworms, and similar small invertebrate animals. Many insects, even leaf feeding insects, spend part of their life cycle in the soil or under leaf litter, especially to pass the pupal stage or to overwinter. Such insects often suffer a high degree of natural mortality at such times, and several studies have shown that ground beetles are important in such mortality.

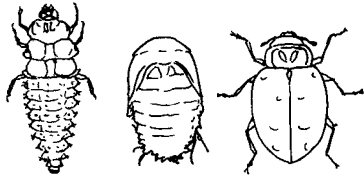
Family Coccinellidae: The lady beetles or ladybirds

Although frequently called “ladybugs,” these insects are not true bugs and therefore the other common names are preferred.

The lady beetles are a large group containing many important natural enemies. Although most



Lady beetle

Larva Pupa Adult
Convergent lady beetle

are predaceous as both larvae and adults, a few are fungus feeders and a few feed on plants, including a couple of important pest species such as the Mexican bean beetle.

Predaceous lady beetles feed primarily on aphids, scale insects, mealybugs, and whiteflies. There are specialized lady beetles that limit their feeding to other prey groups, such as small caterpillars and leaf beetle larvae. Although most common species feed primarily on aphids and similar insects, other types of prey will occasionally be taken. Spider mites can be an important supplemental prey of many species of aphid-feeding coccinellids. Adult lady beetles also tend to feed on nectar and pollen taken from flowers.

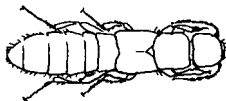
Lady beetles overwinter in the adult beetle stage. Some species, such as our native convergent lady beetle, *Hippodamia convergens*, are known to congregate in enormous clusters. Other species overwinter singly or in small clusters. In spring they seek out the aphids or other hosts that will be both adult and larval food. Eggs are laid adjacent to the prey. Many deposit spindle-shaped eggs, laid on end on the leaf surface. Some species scatter individual eggs while other species lay in compact clusters of 10–20 or more. The eggs of the aphid-feeding species are usually yellow to orange in color, and 1.0–1.5 mm long. Eggs usually hatch in 3–7 days.

Lady beetle larvae are not as frequently recognized as are the adults, an unfortunate circumstance because they are just as important as the adults in natural control. The larvae of the aphid-feeding species are somewhat slender, with the body tapering to a point at the rear. Depending on species and stage of development, they will be 1/8–1/2 inch in length. The color is usually black or dark gray, but there usually are conspicuous, red, yellow, orange, or blue markings. The prominent legs are held to the side. The predators of mealybugs and scale insects may not be as conspicuous, as they are often covered in a white waxy coating similar to that of the prey insects. Larval lady beetles normally consume 500–1000 aphids or similar prey during their growth.

If prey are abundant and temperatures warm, most lady beetle larvae complete development 2–4 weeks after egg hatch. When done feeding, the larvae pupate in the same location. The pupal stage also is unrecognized by most people. The pupal period lasts about 1 week; the entire life cycle takes about 4–6 weeks. Generally, there are two to three generations per year, more in warmer areas with longer growing seasons.

There are many species of beneficial lady beetles in the North Central United States, and only a few brief examples can be discussed here. The convergent lady beetle is one of the most common throughout the United States, and is a very important predator of aphids and other pests. Recently, a large lady beetle from Europe was introduced into the United States for aphid control. *Coccinella septempunctata*, sometimes called C-7 (derived from the scientific name), has rapidly become established and spread throughout much of the region. It is very noticeable because of its large size. The multicolored Asian lady beetle, *Harmonia axyridis*, is another introduced species. It is a specialized predator of aphids infesting trees such as fruit trees. It tends to congregate near buildings in the fall of the year and can sometimes be a bit of a nuisance. This is another reddish orange lady beetle, but the pattern and number of black dots of this species are variable; indeed, some have no black dots at all. Members of the genus *Stethorus* are only a few millimeters long and black in color, and therefore not very conspicuous. As both larvae and adults, these are important predators of spider mites, and are capable of consuming many mites during their lives. The twicestabbed lady beetle is small and shiny black, with a bright red spot on either side of its body, hence the name. It is an important predator of scale insects and other pests, and is frequently seen in association with cottony maple scale and undoubtedly is important in control of this pest of silver maples.

Family Staphylinidae: The rove beetles

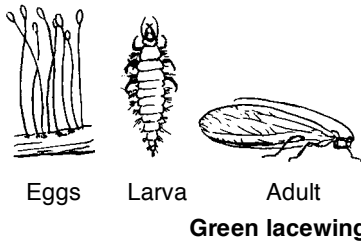


Rove beetle

This is the largest family of North American beetles, with about 2900 species. Most are quite small and of cryptic habits. Most are thought to be predaceous, although many are probably scavengers. Although these are small insects, usually less than 1/4 inch in length, they are quite recognizable because of their slender, usually black body, shortened front wings (elytra), and behavior of curling the tip of the abdomen upwards when disturbed or running.

Most rove beetles are found in association with soil or decaying organic matter. Many are predaceous or parasitic and undoubtedly help reduce populations of filth flies. Several occur in agricultural soils where they probably feed on a variety of types of prey. A few species can be found in vegetation where they feed on many types of small insects.

Lacewings, antlions, and others (Order Neuroptera)



The order Neuroptera contains several small families, most of which are predaceous or parasitic as larvae and predaceous as adults. Most families provide no appreciable benefit to agriculture, but two families of lacewings are quite important.

Family Chrysopidae: Green or common lacewings

Green lacewings are common throughout the United States and are frequently found in fields, orchards, and gardens. Both adults and larvae are important predators of aphids and other small insects. The adults, which are often attracted to lights at night, have pale green bodies about 1 inch long, large, clear, membranous wings with green veins and margins, and long hair-like antennae; the eyes are often golden and the body is slender and soft. The most commonly seen species are in the genus *Chrysoperla*.

The oval, white or greenish eggs are readily recognized because each is attached to a slender hairlike upright stalk, usually about 1/3 inch in length. Although most species lay their eggs singly, some lay their eggs in clusters. The eggs are usually laid on foliage near colonies of aphids or other prey. The eggs hatch into small, gray, slender larvae that are called aphid lions. These larvae have enlarged sickle-shaped mouthparts used to puncture the prey and suck out the internal fluids. The larva ultimately grows to about 1/2 inch in length and then spins a spherical silken cocoon, usually on the underside of a leaf, within which it pupates. The entire development period is about one month, and there can be from one to several generations per year, depending on species and location.

Green lacewings are highly beneficial insects found in many types of crop and garden situations. They are also raised in commercial insectaries and can be purchased for biological control. Usually it is the egg stage that is sold.

Family Hemerobiidae: Brown lacewings

These are similar to green lacewings in general appearance, but are brown in color and smaller. The eggs are not stalked as in green lacewings. Brown lacewings occur both in field and forest situations, but are not as common in agriculture as are chrysopids. Both larvae and adults feed on aphids and other small, soft bodied insects.

Flies, gnats, midges, and others (Order Diptera)

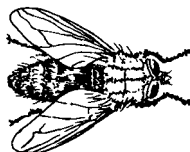
The flies constitute one of the largest groups of insects, and they are very diverse in their habits and habitats. Approximately 35 families are known to contain species that are predatory or parasitic on other insects. Some of these occur primarily in aquatic or semiaquatic environments where they feed on other insects in those areas, including mosquitoes, black flies, and other public health or nuisance pests. Only those families that are commonly encountered or important in pest management are discussed here.

Family Syrphidae: The hover flies

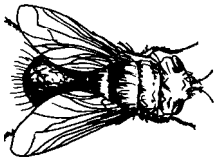


This is a large family of common insects. The adult flies are small to medium in size, with the body often striped yellow and black: some resemble bees or wasps. They are often seen on or hovering near flowers, and the adult flies feed exclusively on flower nectar and pollen. Although the biological habits of the larvae are quite diverse, many are predaceous on aphids, scale insects, and other insects. The aphid predators are quite common. These pale green to yellow maggots have a slug-like appearance and the larger species become 1/2 inch long. Some studies indicate that larvae consume as many as 400 aphids during development. Some larvae pupate on the foliage near the feeding site while others leave the plant and enter the soil to pupate. The puparium is often tear-drop shaped. The life cycle takes 2–4 weeks to complete.

Family Sarcophagidae: The flesh flies



This is a large family of medium to large flies. They somewhat resemble house flies, but are often gray and black striped and distinctly bristly. When they occur in numbers they can be a significant nuisance because of their persistent droning and inclination to land on food and people. The larval habits are diverse, with some species breeding in carrion and others being parasitic on higher animals. Many species, however, are specialized parasites of other insects. Of the parasitic species, the largest group of hosts are the grasshoppers, and both nymphs and adults can be parasitized. Hosts of other sarcophagids include larval and adult bees (including the honey bee and bumble bees), beetles, and caterpillars. One of the most common insect-parasitic sarcophagids in the northern United States attacks the forest tent caterpillar. During outbreaks of the host insect, this large fly occurs in abundance, and is considered by local residents as a nuisance. However, it provides significant control of the pest.



Tachinid fly

Family Tachinidae: The tachinid flies

This family is by far the largest and most important group of flies, with over 1300 species in North America. All species are parasitic in the larval stage, and many are important natural enemies of major pests. Many species of tachinids have been introduced into North America from their native lands to suppress populations of alien pests. Tachinid flies are variable in color, size, and shape, but many resemble house flies. They usually are house fly shaped, either gray, black, or striped, and often with many distinct abdominal bristles.

Tachinids are usually fairly host-specific, and, as a family, most frequently attack caterpillars and adult and larval beetles. Sawfly larvae, various types of true bugs, grasshoppers, and other types of insects are also attacked. Egg formation and oviposition varies considerably, with most species laying eggs on, in, or near the host. Many tachinids exhibit an unusual trait in which the eggs mature within the mother fly, which then lays eggs that immediately hatch. In some species, egg hatching actually occurs within the mother fly, and she gives birth to living young, a behavior called "larviposition." Egg and larval development are rapid for most tachinids, and pupation often occurs within 4–14 days after oviposition. The pupal period generally lasts 1–2 weeks. Many species are capable of several generations per year, but others are restricted to only one generation, especially if their hosts have only a single generation. Most, if not all, tachinids are internal parasites within their hosts. Most species are solitary, but some have anywhere from two or three up to a dozen or more capable of developing from a single host.

Wasps, ants, and bees (Order Hymenoptera)

The order Hymenoptera is divided into two suborders. The smaller consists of the sawflies and hornets. Most of these are plant feeders and many are serious pests of agricultural and horticultural plants and forest trees. The larger group consists of the bees, wasps, and ants. There are several families of bees, and all feed primarily on nectar and honey. The ants are in a single family (Formicidae) of diverse habits, but many species are predaceous on other insects, and some are very important in natural control. The wasps are a very diverse group of over 50 families, most of which feed entirely on other insects. The Hymenoptera is the second largest group of insects. Over 16,000 species are known from the United States and Canada; the majority of species are parasitic on other insects. Many of the parasitic species are very tiny and easily overlooked. These are commonly called "microhymenoptera," and, because of their small size (as small as 0.5 mm, or 1/50 inch), many are as yet unknown to science.

As an order, the Hymenoptera are the most beneficial of all groups of insects. Bees provide honey and wax, and pollinate our crops. The parasitic wasps are the most important group of natural enemies of pest insects. Many different species have been transported around the world for control of alien pests, and several species are commercially available for the control of specific hosts.

All Hymenoptera undergo complete metamorphosis, having egg, larval, pupal, and adult stages. The most important natural enemies are the many families of parasitic wasps, or "parasites." In these the larval stage develops in and kills a single host insect. Some adult parasites also feed on insects, usually the same species which are host to the larval stage; this behavior is called "host feeding." Although it may seem inefficient that each larva kills only one host insect, most females can lay many hundreds of eggs, resulting in the death of an equal number of host insects. By reproducing so rapidly, they efficiently overtake increasing host populations and therefore often are able to suppress pests below injury levels.

The behavior of parasitic Hymenoptera is quite complex. Many are highly selective to a single species of host insect, or a narrow range of related hosts. The adult females often have highly developed means of locating the hosts that they will parasitize. This searching ability is important because it means that adult female wasps can locate and parasitize hosts at low host densities, another important factor in keeping pest populations low.

The hosts of the parasitic Hymenoptera are diverse and include almost all groups of terrestrial insects. The important agricultural groups such as caterpillars, beetles, sawflies, aphids, and scale insects are frequent hosts. Depending on the parasite species, virtually any host stage can be attacked: egg, nymph, larva, pupa, or adult.

Although we have thus far discussed primarily the parasitic wasps which, because of their small size are frequently overlooked, many of the larger wasps that are more frequently recognized because of their bright colors and ability to sting, also kill other insects. These larger wasps usually develop a cell of some sort for their larvae and provision these cells with food. In the predatory species the adults forage for insect prey to take back to the cell to feed the young. Many of the larger wasps are social insects and some can have quite large colonies.



Cryptus



Rogas



Pteromalid

Family Ichneumonidae: Ichneumon wasps

This is one of the largest families of insects. All species are parasitic on other insects. As a group ichneumonid wasps are larger in size than many other parasitic wasps. They parasitize a variety of insects in several insect orders, but the Lepidoptera (moths and butterflies) and Coleoptera (beetles) contain the largest numbers of hosts. Many ichneumonid females have elongate, very noticeable ovipositors.

Family Braconidae: Braconid wasps

Another large group, closely related to the ichneumonids, the braconids also are exclusively parasitic. Many are very important parasites of major agricultural pests, such as caterpillars, various beetles, aphids, fly maggots and other insects.

Superfamily Chalcidoidea: The chalcid wasps

This is actually an assemblage of several specialized families. Most species are insect parasites but a few, such as alfalfa seed chalcid, are plant pests. Most are quite tiny insects and attack fairly small hosts, including aphids, scale insects, fly larvae, leafminer larvae, small caterpillars, and many other types of insects. Some chalcids are so tiny they complete their entire life cycle in the egg stage of their host insect. This is true of all species of the families Mymaridae and Trichogrammatidae. Trichogramma species attack the eggs of many types of serious pests, especially caterpillars. Trichogramma are commercially mass produced and are widely used in biological control programs in Europe and Asia, and to a lesser degree in the United States.

Using blacklight traps and pheromone traps

Trapping is very important to any monitoring and pest management program. Blacklight traps use light to attract nocturnal insects while pheromone traps use “odors” or pheromones to attract certain other insects. Blacklight traps are useful for monitoring European corn borers, armyworms, cutworms, and other nocturnal insects. Vegetable insects that can be monitored with pheromone traps include armyworms, black cutworm, cabbage looper, corn earworm, diamondback moth, and variegated cutworms.

Blacklight traps

The traps will help you determine when nocturnal moths are flying as well as their relative abundance. This information allows pest managers to determine the timing of peak periods of activity and subsequently, pest management activities. Blacklight traps are useful for monitoring pest populations; they are not designed to reduce pest populations. It is not necessary to locate a blacklight trap on every farm. Regional trapping information is available in several printed and electronic newsletters produced by the WDATCP and University of Wisconsin-Extension.

Trap location. Trap placement is important for assuring an accurate representation of the insects you are monitoring. For European corn borers, place traps in “action sites,” grassy areas adjacent to corn fields where the adult corn borer moths congregate. The light should be positioned 3–4 feet above the ground over grassy vegetation. The traps should be no more than 300 feet from corn. The further away from corn fields the traps are placed, the fewer number of moths that will be caught, although they will still show population trends. Trap placement relative to wind direction is not important. Locate traps at least 200 feet away from other sources of light such as post lamps or heavily traveled roads. When placing traps, you may wish to consider the potential for vandalism. Blacklights, as well as 12-volt batteries, if used, are attractive to vandals.

Trap efficiency. Several variables affect moth catches in blacklight traps. Inclement weather, such as cold temperatures, high winds, and rain, will reduce the number of moths caught. Keep in mind that if weather conditions are interfering with moth catches in light traps, those same conditions may also be affecting mating and egg-laying. When the moon is full or nearly full, trap catches may be reduced due to the high amount of background light.

Light traps often don't detect low densities of moths. Therefore it is important to recognize that even though no moths are being caught, active moths may still be in the area.

Trap monitoring. Blacklight traps should be checked frequently—preferably every other day. Fresh specimens are much easier to identify as many of the identifying characteristics become obscure with age. If possible, check and empty traps prior to rain since water in the collection container will destroy the distinguishing characteristics on the wings. In general, moths smaller in size than the diamondback moth (wingspan less than 5/8 inch) and larger than hawk moths (wingspan greater than 3 inches) are not economically important and can be ignored when sorting through a trap catch. Placing a DDVP (dichlorvos) insecticide strip in the funnel portion of the collection container will kill the insects, making them easier to identify. To aid in moth identification, the Extension IPM program has developed a color fact sheet entitled “Identifying Blacklight Trap Catches in the Upper Midwest.” It illustrates each of the economically important nocturnal moths and describes identifying characteristics. Single copies are available free from the UW IPM program, (608) 262-6429.

Pheromone traps

Insects secrete pheromones to alert other insects about information such as the sex of the insect, trail location, alarm, and grouping. Synthetically produced pheromones mimic the chemicals produced by insects and are used to lure specific insect species to specially designed traps. At this time, over 60 different pheromones are commercially available to aid in pest monitoring. The most common vegetable pest monitored with a pheromone trap is the corn earworm. Diamondback moths can be monitored with pheromones as easily as the corn earworm, however most growers haven’t begun to utilize this very useful monitoring tool.

Trapping will take time and additional knowledge to implement. You must learn which type of trap to use, where and when to place the trap, which lure to use, how often to check the trap, and what trap catches mean. However, trapping will save you money in the long run by indicating whether you actually have an insect infestation and whether it is severe enough to require treatment. Trapping will also help you time your treatment efforts to the most susceptible life stage of the pest. By trapping the adult insects, you will realize you have a pest problem long before the damaging larvae are present.

Type of trap. It is important to use the appropriate lure specific to the pest you want to monitor as well as the correct trap. Pheromone traps may be sticky traps such as the delta or winged traps used to monitor gypsy moth and other tree or orchard pests. Some insects such as Japanese beetles and corn earworm moths require specifically designed traps. For example, corn earworm moths must be trapped in a specialized wire mesh trap called a Hartstack trap.

Timing. Traps should be in place at least 2 weeks before the earliest known emergence of the insect in your area. Extension specialists can help you determine when to set out traps. Check traps at least twice a week. Once insects appear in the trap, monitor at least every other day so you don’t miss population trends and peak emergences. Record the number of moths caught at each visit so you can compare trends at a later date if needed.

Location. Trap location is important. Ideally, every susceptible field should have a pheromone trap located in, or near, it. For example, if you are trapping corn earworm moths, you should have an earworm trap in every silking sweet corn field. Traps should be placed level with the crop canopy “upwind” at the field edge so that the pheromone can be dispersed through the field.

Storing lures. Lures, the plastic or rubber strips impregnated with the pheromone, should be kept in the freezer until ready to use. Do not expose lures to heat. Replace according to package directions. For example, earworm lures should be changed every 2 weeks. Because there will still be some pheromone left on the old lure, remove it from the field and dispose of it along with the packaging material for the new lure. Do not leave the used lure in the field as there is enough pheromone remaining to attract (and confuse) the moths.

For information on interpreting your trap catches, contact your county Extension office.

Calculating degree days

Temperature affects the rate of development of plants and insects. Cold weather slows development while warm weather accelerates it. For this reason, it is misleading to describe development in terms of calendar time alone. To monitor crop development and predict pest behavior, professional pest managers often use a system that takes into account the accumulation of heat with passing time. This system is based on degree days.

A degree day (DD) is a unit of measure that occurs for each degree above a base temperature during a 24-hour period. The base temperature is the temperature below which there is no plant or insect development. Specific insects have specific base temperatures. Begin recording degree day accumulations for Wisconsin on March 1.

To monitor plant and insect development using degree days, you will need a maximum/minimum thermometer to obtain the daily high and low temperatures. Calculate degree days using the following equations:

$$(\text{daily high}^a + \text{daily low}^b) \div 2 = \text{daily average temperature}$$

$$\text{daily average temperature} - \text{base temperature} = \text{degree day accumulation}$$

^aUse 86°F if the high temperature for the day is more than 86°F.

^bIf the daily low is less than the base temperature, use the base temperature.

Example: Assume you have accumulated 200 degree days to date using a base temperature of 40°F. If yesterday's high temperature was 75°F and the low temperature was 60°F, then the daily average temperature would be 67.5°F $[(75 + 60) \div 2]$. To calculate the degree day accumulation, subtract the daily average from the base temperature for a total of 27.5DD $(67.5 - 40)$. Add this number of degree days to date $(27.5 + 200)$ for a new total of 227.5.

Calculating degree days as a means of estimating insect pest development works best for pests that overwinter in Wisconsin and that have discrete generations. Pests that migrate into the state, such as the potato leafhopper and corn earworm, have unpredictable arrival times, making degree day calibration difficult. Similarly, pea aphids overwinter here but they reproduce continuously so that generations overlap, making degree day calculations meaningless. By contrast, the European corn borer is a good candidate. It overwinters as a mature larva and has two generations.

Resistance management

Whenever pesticides are used to control pest problems, the potential for the development of pest populations that are resistant to the pesticides used exists. It is therefore important to judiciously use pesticides to prevent, or at least delay, the development of resistant pests.

Resistance management attempts to prevent, delay, or reverse the development of resistance. It is a complex task that involves more than just pesticides. You should incorporate the following practices into a resistance management program:

- **Use an integrated pest management program.** Combine all available control measures (chemical and non-chemical) into a practical pest management program.
- **Use pesticides only when needed.** A pest population will develop pesticide resistance only when you use that pesticide against it. Therefore, if you use the pesticide when you don't need to, you may unnecessarily increase the proportion of resistant individuals.

Likewise, poor timing of a pesticide application can increase the risk of disease development. Fungicides and bactericides are generally more effective as protectants when applied before signs of pathogens (e.g., spore masses, bacterial ooze) are visible. If you apply the pesticide after such signs appear, more individuals will be exposed to the pesticide and there will be a greater chance that at least some of those individuals will be resistant to it. Such resistant individuals will then become predominant and control will be much more difficult to achieve.

- **Apply pesticides at the proper rate.** Using higher pesticide rates to try to eradicate pests not only wastes money (because eradication is usually impossible), but you will also kill an even larger proportion of susceptible pests. As a result, the proportion of resistant individuals among survivors will be even larger.

- **Use pesticides from different chemical families.** Try to do this whether you apply pesticides against a pest once or several times a year. This way, pests resistant to the first pesticide will be killed by the second. The pesticide table that follows includes resistance management information.

Aster yellows index

The incidence of aster yellows disease depends on three things—the crop being grown, the number of leafhoppers present, and the percent of the leafhopper population carrying the disease. With this information, the grower can determine the aster yellows index for the crop and prevent needless insecticide applications.

The aster yellows index is an unbiased method for determining the allowable number of aster leafhoppers on susceptible crops for any aster leafhopper infectivity level. Insecticides are applied when the index exceeds the treatment threshold for that crop, rather than spraying on a strict calendar basis—such as twice a week. The aster yellows index depends on the number of aster leafhoppers collected in 100 sweeps and the percent of the leafhoppers that carry the disease. Call the UW-Madison Entomology Department (608-262-6510) for information about the infectivity level. Compute the index using the following formula:

$$\% \text{ of infectivity in leafhoppers} \times (\text{number of leafhoppers} \div 100 \text{ sweeps}) = \text{aster yellows index}$$

For example, if the leafhopper infectivity level was determined to be 2.5% and field sweeping showed there were 20 leafhoppers per 100 sweeps with a sweep net, then:

$$2.5\% (\text{infectivity rate}) \times 20 (\text{number caught} \div 100 \text{ sweeps}) = 50 (\text{aster yellows index})$$

The aster yellows index is computed to be 50.

The treatment threshold for carrots, celery and lettuce with respect to their aster yellows index is:

Crop	Aster yellows index
Carrots	
Resistant	100
Intermediate	75
Susceptible	50
Celery	35
Lettuce	25

In using the aster yellows index, computed above as an example, the index of 50 has equaled or exceeded the treatment levels for susceptible carrots, celery and lettuce. However, intermediate and resistant carrots do not need treatment at this point and need to be resampled in 2–3 days.

See aster yellows tables in the carrot section.

Significant variation in aster yellows resistance/susceptibility has sometimes occurred within a given cultivar between different seed lots from different companies. If there is concern about the occasional seed lot variation in yellows resistance, use the treatment threshold for the next lower category. For example, resistant carrots would be treated as intermediate resistance and intermediate resistance carrots would be treated as susceptible carrots. Susceptible carrots do not need to be treated more conservatively. The movement of cultivars to the next lower category changes a conservative treatment threshold to a very conservative treatment threshold.

Relative effectiveness and rotational crop restrictions of selected herbicides

The herbicide effectiveness ratings in the table below are based on Wisconsin field research or compiled from similar ratings published by Midwestern weed scientists. Because the performance of herbicides is affected by many variables, actual performance will vary.

The rotational crop restrictions table lists the amount of time required before sweet corn, peas, potatoes, and snap beans can be planted after herbicide application.

Relative effectiveness of vegetable herbicides

Herbicide	Annual broadleaves						Annual grasses			Perennial grass
	Black night-shade	Lambs-quarters	Pigweed	Purslane	Rag-weed	Velvet-leaf	Barn-yard grass	Crab-grass	Foxtail	Quackgrass
Accent	N	P	G*	—	P	F	E*	P	E*	G*
Aim EW	G*	F*	G*	—	P	E*	N	N	N	N
Alachlor/Intro	E*	F	G*	G*	P	P	E*	E*	E*	N
Alanap ^a	F	E	G*	G*	E*	G*	P	G	G	P
Assure II	N	N	N	N	N	N	E*	E*	E*	E*
Atrazine	G*	E*	E*	*	G*	F*	P	P	P	P
Basagran	P	F	P	E*	G	E	N	N	N	N
Bicep Lite II	E*	E*	E*	*	G*	F	E*	E*	E*	P
Bullet/Lariat	E*	E*	E	*	G*	F*	E*	E*	E*	P
Callisto	E*	E*	G*	—	F	G*	P	F	P	N
Camix	E*	E*	E*	—	F	G*	E*	E*	E*	N
Caparol	—	E*	E*	G*	E*	—	G*	G*	G*	P
Command	P	F	P	*	F	G*	F	F	F*	P
Devrinol	P	G*	G*	G*	P	P	E*	E*	E	P
Dual	E*	F	G*	G	P	P	E*	E*	E*	N
Eptam/EPTC ^a	F*	G*	G*	*	F	G	G	E*	E*	F
Fusilade DX	N	N	N	N	N	N	E*	E*	E*	E
G-Max Lite	E*	E*	E*	*	G*	F*	E*	E*	E*	P
Goal	F	G	G*	G*	P	P	P	P	P	P
Impact	G*	E*	E*	—	G	E*	G*	G*	F	P
Laudis	G*	E*	E*	N	G*	E*	G*	G*	G*	P
Lorox	G	E*	E*	E*	E*	G	G*	G*	G*	P
Lumax	E*	E*	E*	—	G	E*	E*	E*	E*	P
Outlook	E*	F	G*	G	P	P	E*	E*	E*	N
Permit/Sandea	N	P	G*	—	G*	E*	N	N	N	N
Poast/Poast Plus	N	N	N	N	N	N	E*	E*	E*	G*
Prefar	P	G	G	G	P	P	E*	E*	E*	P
Princep	E*	E*	E*	E*	E*	E	F*	F*	F*	P
Priority	G*	G*	G*	—	E*	E*	N	N	N	N
Prowl/Pendimax	P	G*	G*	*	N	F	G*	E*	E*	N
Pursuit	E*	P	E*	—	F	G	G	F	G	P
Pyramin	*	G*	G*	G*	G*	P	F	F	—	P
Raptor	E*	F	E*	—	F	G	G	F	G	P
Ro-Neet ^a	P	G	G	G	P	P	E*	E*	E*	P
Sencor	P	E*	E*	G	E*	E	P	G	G	P
Sinbar	E	E*	G*	E	E*	E	E*	E*	E*	F
Sonalan	F	G*	G*	*	P	P	E*	E*	E*	P
Spin-aid	—	G*	P	G*	G*	F	P	P	P	P
Starane	F	P	P	E	E*	G*	N	N	N	N
Stinger	F	P	P	P	G*	P	N	N	N	N
Treflan	P	G*	G*	E*	P	P	E*	E*	E*	P

Abbreviations: E = excellent; G = good; F = fair; P = poor; N = none; — = data not available.

* Manufacturer lists weed as controlled on label.

^aThis material has a relatively short half-life. It should provide initial control as described in the table but not season-long control.

Rotational crop restrictions of selected herbicides

Herbicide	Sweet corn	Peas	Potato	Snap beans
Accent	10 months ^a	10 months	10 months ^b	10 months
Accent Gold	10.5–18 months ^c	10.5 months	18 months	field bioassay after 26 months
Affinity BroadSpec	45 days	45 days	45 days	45 days
Aim EW	0	0	0	0
Assure II	120 days	0	120 days	0
Atrazine	0	2 years	2 years	2 years
Authority First/Sonic	18 months	12 months	18 months	30 months
Autumn	after harvest	18 months	18 months	18 months
Banvel	after harvest	after harvest	after harvest	after harvest
Basagran	no restrictions on label	no restrictions on label	no restrictions on label	no restrictions on label
Basis	10 months	8 months	0	8 months
Beacon	8 months	8 months	8–18 months	8–18 months
Bicep Lite II Magnum	0	2 years	2 years	2 years
Boundary	8 months	8 months	8 months	12 months
Buctril	30 days	30 days	30 days	30 days
Bullet/Lariat	0	2 years	2 years	2 years
Callisto	0	18 months	10 months	18 months
Camix	0	18 months	following year	18 months
Canopy	18 months	12 months	30 months	12 months
Canopy EX	18 months	9 months	30 months	9 months
Celebrity Plus	10 months ^a	10 months	10 months ^b	10 months
Clarity	120 days	120 days	120 days	120 days
Classic	9–18 months	9 months	30 months	9 months
Cobra/Phoenix	no restrictions on label	no restrictions on label	no restrictions on label	no restrictions on label
Command 3ME	9 months ^d	9 months	9 months	9 months
Define	12 months	12 months	1 month	12 months
Degree	0	2 years	following year	2 years
Degree Xtra	0	2 years	2 years	2 years
Distinct	120 days	120 days	120 days	120 days
Dual II Magnum	0	0	0	0
Eptam	after harvest	after harvest	0	0
Express	45 days	45 days	45 days	45 days
Extreme	18 months	4 months	26 months	4 months
Field Master	following year	2 years	2 years	2 years
First Rate	18 months	9 months	18 months	9 months
Flexstar/Reflex	10 months	10 months	18 months	0
FulTime	0	2 years	2 years	2 years
Fusilade DX	60 days	0	0	0
Fusion	60 days	0	0	0
Gangster	18 months	9 months	18 months	9 months
Glyphosate	0	0	0	0
G-Max Lite	0	2 years	2 years	2 years
Gramoxone Inteon	0	0	0	0
Harmony Extra/GT	45 days	45 days	45 days	45 days
Harness	0	2 years	following year	2 years
Harness Xtra	0	2 years	2 years	2 years
Hornet WDG	10.5–18 monthsc	10.5–18 months	18 months	10.5–18 months

(continued)

Rotational crop restrictions of selected herbicides (cont.)

Herbicide	Sweet corn	Peas	Potato	Snap beans
Impact	0	9 months	9 months	18 months
Intrro	following year	2 years	2 years	2 years
Keystone LA	0	2 years	2 years	2 years
Laddok S-12	following year	following year	following year	following year
Laudis	0	10 months	10 months	10 months
Liberty	120 days	120 days	120 days	120 days
Lightning	18 months	9.5 months	26 months	9.5 months
Lorox	4 months	4 months	4 months	4 months
Lumax	0	18 months	18 months	18 months
Marksman	following year	2 years	2 years	2 years
Matrix	10 months	18 months	0	10 months
NorthStar	8 months	8 months	8 months	8 months
Option	7 days	60 days	60 days	60 days
Outlook	0	following year	following year	following year
Permit/Sandea	3 months	9 months	9 months	9 months/2 months
Poast Plus	30 days	30 days	30 days	30 days
Princep	0	2 years	2 years	2 years
Priority	3 months	12 months	12 months	12 months
Prowl H ₂ O	following year	0	following year	0
Pursuit ^e	18 months	4 months	26 months	4 months
Pursuit Plus	18 months	4 months	26 months	4 months
Python	10.5–18 months ^c	4 months	12 months	4 months
Raptor	8.5 months	18 months	9 months ^f	18 months
Resolve	10 months	18 months	0	10 months
Select Max	30 days	0	0	0
Sencor DF	4 months	8 months	12 months	18 months
Sequence	0	0	following year	0
Sonalan	following year	following year	following year	following year
Spartan	18 months	12 months	12 months	12 months
Starane	0	120 days	120 days	120 days
Steadfast	10 months ^a	10 months	10 months ^b	10 months
Steadfast ATZ	10 months	18 months	18 months	18 months
Stinger ^g	10.5 months	18 months	18 months	18 months
Stout	10 months	10 months	10 months	10 months
SureStart	10.5–18 months ^c	2 years	18 months	2 years
Surpass/TopNotch	0	2 years	following year	2 years
Synchrony	9–18 months	9 months	30 months	9 months
Treflan	12 months	0	0	0
Ultra Blazer	100 days	100 days	100 days	100 days
Valor SX	4 months	4 months	field bioassay after 12 months	4 months
Velpar	2 years	2 years	2 years	2 years
Yukon	3 months	9 months	9 months	9 months
2,4-D ^h	3 months	3 months	3 months	3 months

^aThe hybrids Carnival, Merit, and Sweet Success require 15 months.^bIf soil pH is 6.5 or greater, do not plant for 18 months.^cA 10.5-month interval exists for 41 hybrids listed on the label.^dA 12-month interval exists following a 2.67 pt/a rate of Command 3ME.^eAnytime after 0.54 oz/a applied to snap beans or 3 months after 1.08 oz/a applied to peas.^fInterval of 18 months if <18 inches of rainfall or if soil pH is <6.2.^gSee label for bioassay requirements.^hRestrictions vary by label.

Pest management and pesticides

As an alternative to exclusive pesticide use, attention is being directed to the coordinated use of multiple tactics—an approach known as IPM (This is discussed in Best Management Practices).

Federal pesticide-use law

When Congress amended the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in 1972, it included a mandate for the Environmental Protection Agency (EPA) to evaluate all new and existing pesticide products for potential harm they may cause. It also made it illegal to use, except as provided by FIFRA, any pesticide in a manner inconsistent with its labeling. Deviations from the label not recognized by FIFRA are a violation of the law.

The Food Quality Protection Act (FQPA) of 1996 strengthens the system that regulates pesticide residues on food. Recognizing that pesticide residues are present in more sources than just food, the FQPA sets limits on the total exposure from residues found in food, drinking water, and nondietary sources (such as household, landscape, and pet uses). As a result, the more uses a particular pesticide has, the greater the chance its total exposure will be met and, thus, some or all of its uses will be canceled.

If, during the pesticide registration process, the EPA finds a product to generally cause unreasonable adverse effects on the environment, including injury to the applicator, it will be classified as restricted-use. Because restricted-use products can be used only by certified applicators, the FIFRA amendments also called for each state to develop a program for training and certifying pesticide applicators. The certification program is designed to ensure that users of restricted-use products are properly qualified to handle and apply these materials safely and efficiently. A current list of restricted-use pesticides registered for use in Wisconsin may be downloaded from <http://ipcm.wisc.edu/pat/>.

Wisconsin's training and certification program

In Wisconsin, responsibility for training lies with the University of Wisconsin-Extension's Pesticide Applicator Training (PAT) program, while actual certification is the responsibility of the Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP). The Wisconsin Pesticide Law requires that all commercial applicators-for-hire participate in the training and certification process if they intend to use any pesticide in the state of Wisconsin, whether or not it is restricted-use.

Since 1977, the PAT program has trained over 195,000 Wisconsin applicators in the safe handling of pesticides. The training prepares the applicators for the written certification exam administered by the WDATCP, which enforces Wisconsin's pesticide regulations.

The selection, use, and potential risks of pesticides vary depending on the method of application and what it is you want to protect from pests. Therefore, there is a separate training manual and certification exam for 21 pest control categories, including categories for agricultural producers, the agricultural industry, in and around commercial and residential buildings, in right-of-way and surface waters, and preserving wood. Certification is valid for 5 years, after which you can recertify by passing a new exam that is based on a revised training manual.

To become certified or recertified, contact your county Extension office.

Wisconsin pesticide laws and regulations

Operating under the provisions of the Wisconsin Pesticide Law and Administrative Rule, Chapter ATCP 29 (Register, May 1998), the WDATCP has primary responsibility for pesticide use and control in the state. The Wisconsin Department of Natural Resources (WDNR) has responsibility for pesticide use involving "waters of the state," the control of birds and mammals, and pesticide and container disposal. The Wisconsin Division of Emergency Management (WDEM) has responsibility for helping communities evaluate their preparedness for responding to accidental releases of hazardous compounds, including pesticides, under Title III of SARA. The Wisconsin Department of Transportation (WDOT) has responsibility for regulating the transportation of pesticides listed as hazardous materials (shipping papers, vehicle placarding, etc.), and for issuing commercial driver's licenses. It is your responsibility to become familiar with all pertinent laws and regulations affecting pesticide use in Wisconsin.

Pesticides and community right-to-know

To help communities evaluate their preparedness for responding to chemical spills, Congress passed the Emergency Planning and Community Right-to-Know Act. This law is part of a much larger legislation called the Superfund Amendments and Reauthorization Act (SARA) and is often referred to as Title III of SARA. Title III sets forth requirements for reporting of hazardous substances stored in the community and for developing an emergency response plan.

The first step in emergency planning is to know which chemicals can cause health problems and environmental damage if accidentally released. The EPA prepared a list of such chemicals and called them extremely hazardous substances. These substances are subject to emergency

planning and the threshold planning quantity, the smallest amount of a substance which must be reported. Some of the chemicals listed are commonly used in agricultural production (below).

Examples of agricultural chemicals subject to Title III of SARA

Active ingredient	Trade name	Threshold planning quantity (lb or gal of product)
anhydrous ammonia (fertilizer)		610 lb
terbufos	Counter 15G	667 lb
dimethoate	Dimethoate 4EC	125 gal
phosmet	Imidan 70WP	14.3 lb
paraquat	Gramoxone Inteon	5 gal
phorate	Thimet 20G	50 lb

A complete list of EPA's extremely hazardous substances is available from the Local Emergency Planning Committee in your county or from this EPA web site: yosemite.epa.gov/oswer/ceppoehs.nsf/alphabetical_results.

Any facility, including farms, that produces, uses, or stores any of these substances in a quantity at or greater than their threshold planning quantity must notify the WDEM and their Local Emergency Planning Committee (LEPC) that it is subject to the emergency planning notification requirements of Title III of SARA.

In addition to emergency planning notification, agricultural service businesses with one or more employees are subject to two community right-to-know reporting requirements: submission of material safety data sheets (MSDS) and submission of Tier II inventory forms. Tier II forms request specific information on each hazardous chemical stored at or above its threshold.

Worker Protection Standard (WPS) for agricultural pesticides

The federal Worker Protection Standard (WPS) for agricultural pesticides took effect January 1, 1995. Its purpose is to reduce the risk of employee exposure to pesticides. You are subject to the WPS if you have at least one employee who is involved in the production of agricultural plants in a nursery, greenhouse, forest, or farming operation.

The WPS requires employers to do the following:

- Display pesticide safety information in a central location.
- Train uncertified workers and handlers on general pesticide safety principles.
- Provide personal protective clothing and equipment to employees.
- Provide a decontamination site (water, soap, towels, and coveralls).
- Provide transportation to an emergency medical facility for employees who are poisoned or injured by pesticide exposure.
- Provide notification to employees about pesticide applications (see next section).

For more information about the WPS and the training requirements for uncertified workers and handlers, ask for a copy of EPA's *How To Comply* manual from www.epa.gov/agriculture/twor.html.

Oral notification and posting

The WPS requires employers to give notice of pesticide applications to all workers who will be in a treated area or walk within 1/4 mile of a treated area during the pesticide application or during the restricted entry interval (described below). Notification may either be oral warnings or posting of warning signs at entrances to treated sites; both are necessary if the label requires dual (oral and posting) notification. A current list of dual-notice pesticides registered for use in Wisconsin may be downloaded from <http://ipcm.wisc.edu/pat/>.

Wisconsin's ATP 29 posting rule is designed to protect the general public as well as workers. Thus, it requires posting of areas treated with pesticides having a dual notification statement or, for nonagricultural pesticide applications, if the label prescribes a restricted-entry interval for that particular application. Refer to *On-Farm Posting of Pesticide-Treated Sites in Wisconsin* for a flow chart guiding users through a series of questions to determine when posting of treated sites is needed, what warning sign to use, and where the sign should be located. It also covers the separate posting requirements for chemigation treatments. This publication is available from your county Extension office. This publication is available from your county Extension office or it may be downloaded from <http://ipcm.wisc.edu/pat/>.

Restricted entry interval (REI)

A restricted entry interval (REI) is the length of time that must expire after pesticide application before people can safely enter the treated site without using personal protective equipment. Pesticide residues on a treated crop or in a treated area may pose a significant hazard to workers or others who enter the area after treatment. Therefore, nearly all pesticides affected by the WPS (see above) have an REI. Check the Agricultural Use Requirements section on the label for the specific restricted entry interval for your product. These intervals must be strictly observed.

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a			PHI ^c (days)	Common crop uses
					Chemical group	Group code	REI ^b (hours)		
INSECTICIDES									
abamectin	*Agri-Mek	Syngenta	warning	oral	antibiotic	6	12	7	cucumber, melon, pumpkin, squash, tomato
acephate	Orthene,	Valent	caution	oral	organo-phosphate	1B	24	7–21	bean, celery, cole crops, lettuce, pepper
acetamiprid	Assail	Cerexagri	caution	oral	chloro-nicotinyl	4A	12	7	cole crops, eggplant, leafy greens, pepper, potato, tomato
azadirachtin	Azatin XL Plus, Neemix	Thermo Trilogy	caution	oral	triterpenoid	26	4–12	0	asparagus, bean, beet, carrot, celery, cole crops, cucumber, eggplant, horseradish, leafy greens, melon, onion, pea, pepper, potato, pumpkin, squash, sweet corn, tomato
azinphos-methyl	Guthion	Bayer	danger	oral AND posted	organo-phosphate	1B	48	4–14	Brussels sprouts, potato
<i>Bacillus thuringiensis</i> subsp. <i>aizawai</i>	Agree, XenTari	several	caution	oral	microbial	11B1	4	0	bean, celery, cole crops, cucumber, melon, mint, onion, peas, pepper, potato, pumpkin, squash, tomato
<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Biobit, Crymax, Dipel, Javelin, MVP	several	caution	oral	microbial	11B2	4	0	bean, celery, cole crops, eggplant, horseradish, lettuce, mint, potato, sweet corn, tomato
<i>Bacillus thuringiensis tenebrionis</i>	M-Trak, Novodor, Raven	several	caution	oral	microbial	11C	12	0	potatoes
bifenazate	Acramite	Uniroyal	caution	oral	miticide	25	12	3	cucumber, eggplant, melon, pepper, pumpkin, squash, tomato
bifenthrin	*Brigade, *Discipline	FMC, Amvac	warning	oral	synthetic pyrethroid	3	12	1–7	bean, cole crops, cucumber, eggplant, lettuce, melon, pepper, pumpkin, squash, sweet corn

* Restricted-use pesticide

(continued)

^a To delay or prevent the development of resistance, select pesticides from different chemical groups. Newly approved pesticide labels bear the group code, a reference to the specific target site of the chemical. For more details, visit www.irac-online.org (insecticides), www.frac.info (fungicides), and www.plantprotection.org/HRAC/ (herbicides).

^b REI = Restricted entry interval

^c PHI = Pre-harvest interval. A range of days to harvest indicates that there is variability between crops. Refer to the product label for specific information on the number of days to harvest for each crop.

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides (cont.)

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a		REI ^b (hours)	PHI ^c (days)	Common crop uses
					Chemical group	Group code			
carbaryl	Adios, Sevin	Bayer	caution/ warning	oral	carbamate	1A	12 hr to 5 days	0–14	asparagus, bean, beet, carrot, celery, cole crops, cucumber, eggplant, lettuce, melon, pea, pepper, potato, pumpkin, squash, sweet corn, tomato
carbofuran	*Furadan	FMC	danger/ poison	oral AND posted	carbamate	1A	48	14	potato, sweet corn
chlorpyrifos	*Lorsban 4E	Dow Agro- Sciences	warning	oral AND posted	organo- phosphate	1B	24	30–35	asparagus, cole crops, mint, onion, sweet corn
	Lorsban 15G	Dow Agro- Sciences	caution	oral	organo- phosphate	1B	24	21	sweet corn
chlorpyrifos + gamma- cyhalothrin	*Cobalt	Dow Agro- Sciences	danger	oral AND posted	synthetic pyrethroid	1B + 3A	24	21	sweet corn
clothianidin	Poncho 600	Bayer	caution	oral	neonicotinoid	4A	seed treatment		sweet corn
cyfluthrin	*Baythroid XL	Bayer	danger	oral	synthetic pyrethroid	3	12	0–7	carrot, pepper, potato, sweet corn, tomato
cyfluthrin/ imidacloprid	Leverage	Bayer	warning	oral AND posted	synthetic pyrethroid + chloronicotynl	3 + 4A	12	7	potato
cypermethrin	*Ammo, *Cymbush	FMC	caution/ warning	oral	synthetic pyrethroid	3	24	1–15	cole crops, garlic, lettuce, onion
cyromazine	Trigard	Syngenta	caution	oral	insect growth regulator	17	12	0–7	celery, onion, potato
deltamethrin	*Delta Gold	Agrilience	danger/ poison	oral	synthetic pyrethroid	3	12	1–3	cucumber, eggplant, melon, onion, pepper, pumpkin, squash, sweet corn, tomato
diazinon	*Diazinon	many	caution	oral	organo- phosphate	1B	24	1–35	bean, beet, carrot, cole crops, cucumber, lettuce, melon, onion, pea, potato, pumpkin, squash, sweet corn, tomato
dicofol	Dicofol	Gowan	caution	oral	organo- chlorine	UN	12	2–30	cucumber, mint
dinotefuran	Venom	Valent	caution	oral	neonicotinoid	4A	12	1–21	celery, cole crops, cucumber, eggplant, leafy greens, melon, pepper, potato, pumpkin, squash, tomato
dimethoate	Dimethoate	many	warning	oral AND posted	organo- phosphate	1B	48	0–14	bean, cole crop, lettuce, melon, pea, pepper, potato, tomato
disulfoton	*Disyston	Bayer	danger	oral AND posted	organo- phosphate	1B	48	14–75	cole crop, potato
emamectin benzoate	*Proclaim	Syngenta	caution	oral AND posted	antibiotic	6	48	7	celery, cole crops, lettuce
endosulfan	Thiodan	Universal Crop Prot. Alliance	danger/ poison	oral	organo- chlorine	2A	24	0–14	bean, carrot, celery, cole crops, cucumber, eggplant, lettuce, melon, pepper, potato, pumpkin, squash, tomato

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides (cont.)

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a		REI ^b (hours)	PHI ^c (days)	Common crop uses
					Chemical group	Group code			
esfenvalerate	*Asana	DuPont	warning	oral	synthetic pyrethroid	3	12	1–7	bean, carrot, cole crops, cucumber, eggplant, melon, pea, pepper, potato, pumpkin, squash, sweet corn, tomato
ethoprop	*Mocap	Bayer	danger/ poison	oral AND posted	organo- phosphate	1B	48	—	potato
fenpropathrin	*Danitol	Valent	warning	oral	synthetic pyrethroid	3	24	3–7	cole crops, cucumber, melon, pumpkin, squash, tomato
fenpyroximate	Fujimite	Nichino America	warning	oral	miticide	21	12	1	mint
fipronil	*Regent	BASF	warning	oral	phenyl pyrazole	2B	0	90	potato
flonicamid	Beleaf	FMC	caution	oral	selective feeding blocker	9C	12	0–21	celery, cole crops, cucumber, eggplant, melon, pepper, potato, pumpkin, squash, tomato
gamma- cyhalothrin	*Proaxis	Pytech	caution	oral	synthetic pyrethroid	3	24	1–21	bean, cole crops, lettuce, onion, pea, pepper, sweet corn, tomato
imidacloprid	Admire, Provado	Bayer	caution	oral	chloro- nicotinyl	4A	12	7–21	beet, carrot, cucumber, horseradish, lettuce, melon, pepper, potato, pumpkin, squash, tomato
	Gaucho	Bayer	caution	oral	chloro- nicotinyl	4A	12	seed treat- ment	bean, sweet corn
indoxacarb	Avaunt	DuPont	caution			22	12	3	cole crops, eggplant, lettuce, pepper, potato, tomato
lambda cyhalothrin	*Warrior	Syngenta	warning	oral	synthetic pyrethroid	3	24	1–14	cole crops, lettuce, onion, pepper, pea, sweet corn, tomato
malathion	Malathion	Gowan, Platte	caution	oral	organo- phosphate	1B	12	0–7	asparagus, bean, carrot, cole crops, cucumber, eggplant, horseradish, lettuce, melon, mint, onion, pepper, potato, pumpkin, squash, tomato
methamidophos	*Monitor	Bayer & Valent	danger/ poison	oral AND posted	organo- phosphate	1B	24	14–35	potato, tomato
methomyl	*Lannate	DuPont	danger/ poison	oral	carbamate	1A	48	1–10	bean, beet, carrot, celery, cole crops, cucumber, eggplant, horseradish, lettuce, melon, onion, pea, pepper, potato, pumpkin, squash, tomato, sweet corn
methoxy- fenozide	Intrepid 2F	Dow Agro- Sciences	caution	oral	diacyl- hydrazine	18	4	1–3	cole crops, eggplant, lettuce, pepper, sweet corn, tomato
methyl parathion	*PennCap M	Elf Atochem	warning	oral	organo- phosphate	1B	48	4–15	dry bean, onion, potato, sweet corn
naled	Dibrom	AmVac	danger		organo- phosphate	1B	24	1	bean, cole crops

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides (cont.)

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a		REI ^b (hours)	PHI ^c (days)	Common crop uses
					Chemical group	Group code			
novaluron	Rimon	Crompton	warning	oral	benzoylurea	15	12	14	cole crops, potato
oxamyl	*Vydate	DuPont	danger/ poison	oral	carbamate	1A	24	1–7	carrot, cucumber, pepper, potato
oxydemeton- methyl	*Metasystox-R	Gowan	warning		organo- phosphate	1B	48	3–21	cole crops, cucumber, eggplant, lettuce, melon, pepper, pumpkin, squash
permethrin	*Ambush, *Pounce	Syngenta	caution or warning	oral	synthetic pyrethroid	3	12	0–30	asparagus, celery, cole crops, cucumber, eggplant, horseradish, lettuce, melon, onion, pepper, potato, pumpkin, squash, sweet corn, tomato
phorate	*Phorate, *Thimet	BASF	danger/ poison	oral AND posted	organo- phosphate	1B	48	90	bean, potato, sweet corn
phosmet	Imidan	Gowan	warning	oral	organo- phosphate	1B	24	7	potato
potassium salts of fatty acids	M-Pede	Dow Agro- Sciences	warning	oral	insecticidal soap	—	12	0	asparagus, bean, beet, cole crops, cucumber, eggplant, lettuce, melon, pepper, potato, pumpkin, squash, tomato
pymetrozine	Fulfill	Syngenta	caution	oral	—	9B	12	14	cucumber, eggplant, melon, pepper, potato, pumpkin, squash
pyrethrin + rotenone	Pyrellin	Webb- Wright	caution	oral	synthetic pyrethroid	3 + 21	12	0	asparagus
rotenone	Rotenone, Rotacide				botanical	21	12	0–1	asparagus, cole crops, cucumber, horseradish, melon, pumpkin, squash
spinetoram	Radiant	Dow Agro- Sciences	caution	oral	biological	5	4	1–60	asparagus, bean, cole crops, eggplant, horseradish, leafy greens, mint, onion, pea, pepper, potato, sweet corn, tomato
spinosad	SpinTor, Entrust	Dow Agro- Sciences	caution	oral	biological	5	4	1–60	bean, beet, carrot, celery, cole crops, cucumber, eggplant, leafy greens, melon, mint, onion, pea, pepper, potato, pumpkin, radish, tomato, squash, sweet corn
spiromesifen	Oberon 25C	Bayer	caution	oral	miticide	23	12	7	celery, cole crops, cucumber, eggplant, leafy greens, melon, pepper, pumpkin, squash, tomato
tebufenozide	Confirm	Dow Agro- Sciences	caution	oral	diacylhydra- zine	18	4	7	cole crops, eggplant, lettuce, pepper, tomato
tebupirimphos	*Aztec	Bayer, AmVac	warning	oral AND posted	organo- phosphate	1B	48		sweet corn
tefluthrin	*Force 3G	Syngenta, AmVac	caution	oral	synthetic pyrethroid	3A	0		sweet corn
terbufos	*Counter 15G	AmVac	danger	oral AND posted	organo- phosphate	1B	48	60	sweet corn

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides (cont.)

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a		REI ^b (hours)	PHI ^c (days)	Common crop uses
					Chemical group	Group code			
thiamethoxam	Actara, Cruiser, Platinum	Syngenta	caution	oral	neonicotynl	4A	12	0 30	cucumber, eggplant, melon, pepper, potato, pumpkin, squash, sweet corn, tomato
thiodicarb	Larvin	Bayer	warning	oral	carbamate	1A	12	7–14	celery, cole crops, sweet corn
zeta- cypermethrin	*Mustang Max	FMC	warning	oral	synthetic pyrethroid	3	12	1–7	bean, beet, celery, cole crops, eggplant, leafy greens, onion, pea, pep- per, sweet corn, tomato
zeta- cypermethrin + bifenthrin	*Hero	FMC	caution	oral	synthetic pyrethroid	3A	12	3	pea, sweet corn
FUNGICIDES									
azoxystrobin	Amistar, Quadris	Syngenta	caution	oral	strobilurin	11	4	0–14	bean, beet, carrot, celery, cucurbits, eggplant, horseradish, leafy greens, onion, pea, pepper, potato, tomato
azoxystrobin + chlorothalonil	Quadris Opti	Syngenta	caution	oral	strobilurin + substituted benzene	11 + M5	12	0–80	bean, carrot, celery, cucumber, melon, onion, potato, pumpkin, squash, tomato
boscalid	Endura	BASF	warning	oral	anilide	7	12	0–30	bean, carrot, eggplant, lettuce, onion, pepper, potato, tomato
boscalid + pyraclostrobin	Pristine	BASF	caution	oral	anilide + strobilurin	7 + 11	12	0–14	carrot, cucurbits, onion
captan	Captan	many	danger	oral	phthalimide	M4	4 days	seed treat- ment	bean, beet, celery, cucumber, melon, onion, pumpkin, squash, sweet corn, tomato
chlorothalonil	Bravo, Echo, Equus	Syngenta, Sipcam, Griffin, FarmSaver	caution	oral	substituted benzenes	M5	12	0–80	carrot, cole crops, cucum- ber, melon, mint, onion, potato, pumpkin, squash, sweet corn, tomato
chlorothalonil Zn	Bravo Zn, Echo Zn, Equus 500 Zn	Syngenta, Sipcam, FarmSaver	caution	oral	substituted benzenes + zinc	M5	12	7	carrot, potato
<i>Coniothyrium minitans</i>	Contans	Sylvan Bio- products	caution	oral	biological	—	4	0	All crops susceptible to <i>Sclerotinia</i> spp.
copper oxychloride + basic copper sulfate	C-O-C-S	UAP	warning	oral	organo- metallic	M1	24	0	bean, beet, cole crops, carrot, celery, cucurbits, eggplant, lettuce, onion, pepper, potato, spinach, tomato
cyazofamid	Ranman 400SC	FMC	caution	oral	ciano- acetamide	21	12	0–7	cucurbits, potato, tomato
cymoxanil	Curzate	DuPont	caution	oral	acetimide	27	12	14	potato
cymoxanil + famoxadone	Tanos	DuPont	caution	oral	acetimide + strobilurin- like	27 + 11	12	3–14	cucurbits, pepper, potato, tomato

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides (cont.)

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a		REI ^b (hours)	PHI ^c (days)	Common crop uses
					Chemical group	Group code			
cyprodinil + fludioxonil	Switch	Syngenta	caution	oral	anilino- pyrimidine / phenyl- pyrrole	9 + 12	12	7	onion
dimethomorph	Forum	BASF	caution	oral	cinnamic acid derivative	15	12	4	bulb crops, cucurbits, potato, tomato
fenamidone	Reason	Bayer Crop- Science	caution	oral	strobilurin- like	11	12	0–30	bulb vegetables, lettuce, cucurbits, potato, tomato
fixed copper	Kocide, Champ	Griffin, Agtrol	caution	oral	organo- metallic	M1	48	0	bean, beet, carrot, celery, cucumber, eggplant, lettuce, melon, onion, pepper, potato, pumpkin, squash, tomato
fluazinam	Omega	Syngenta	warning	oral	pyridinamine	29	48	14	potato
fludioxonil/ mancozeb	Maxim MZ	Syngenta	caution	oral	phenyl- pyrrole/ mancozeb	12 + M3	24	Seed treat- ment	potato
fluoxastrobin	Evito	Arysta Life Science	caution	oral	strobilurin	11	12	3–7	celery, pepper, potato, tomato
flutolanil	Moncut	Gowan	caution	oral	benzanilide	7	12	40	potato
flutolanil/ mancozeb	Moncoat	UAP	caution	oral	benzanilide/ EBDC	7 + M3	24	Seed treat- ment	potato
fosetyl-al	Aliette	Bayer Crop- Science	caution	oral	phosphonate	33	12 hr	12 hr- 14 days	onion, cucurbits, tomato
iprodione	Rovral	Bayer Crop- Science	caution/ warning	oral	dicarbox- imide	2	12	7–14	bean, carrot, lettuce, onion, potato
mancozeb	Dithane, Manex II, Manzate, Penncozeb	Dow Agro- Sciences, Griffin, DuPont, Cerexagri	caution	oral	EBDC	M3	24	3–180	asparagus, cucumber, melon, onion, potato, pumpkin, squash, sweet corn, tomato
maneb	Maneb, Manex	Cerexagri, Griffin	caution	oral	EBDC	M3	24	3–7	cole crops, cucumber, melon, onion, pepper, potato, pumpkin, squash, sweet corn, tomato
mefenoxam	Ridomil Gold, Ultra Flouranil	Syngenta, Nufarm Americas	caution/ warning	oral	phenyl- amide	4	48	5–21	beet, carrot, celery, cole crops, cucumber, eggplant, horseradish, lettuce, melon, onion, pepper, potato
metalaxyl	Apron	Gustafson, Syngenta	warning	oral	phenyl- amide	4	48	—	beet, carrot
metam-sodium	Vapam	AmVac	danger	oral AND posted	fumigant	—	48	—	carrot, celery, eggplant, horseradish, potato, tomato
myclobutanil	Nova	Dow Agro- Sciences	warning	oral	sterol inhibitor	3	24	0–30	cucurbits, mint, snap beans
PCNB	Blocker	AmVac	caution	oral	substituted benzenes	14	12	—	cole crops, potato

Pesticide class, re-entry and pre-harvest intervals, and registered crops of insecticides and fungicides (cont.)

Active ingredient	Product	Manu- facturer	Signal word	Notifi- cation	Resistance mngmt ^a		REI ^b (hours)	PHI ^c (days)	Common crop uses
					Chemical group	Group code			
propamocarb hydrochloride	Previcur Flex	Bayer Crop- Science	caution	oral	carbamate	28	12	14	potato
propiconazole	Tilt, PropiMax	Syngenta, Dow Agro- Sciences	warning	oral	triazole	3	24	14	celery, sweet corn
propiconazole + trifloxystrobin	Stratego	Bayer Crop- Science	warning	oral	triazole + strobilurin	3 + 11	24	14	sweet corn
pyraclostrobin	Cabrio	BASF	caution	oral	strobilurin	11	12	0-7	beet, carrot, celery, cole crops, cucurbits, eggplant, garlic, horseradish, leek, onion, pepper, radish, tomato, turnip
	Headline	BASF	caution	oral	strobilurin	11	12	3-30	dry beans, potato, sweet corn
pyrimethanil	Scala	Bayer Crop- Science	caution	oral	anilino- pyrimidine	9	12	1-7	bulb vegetables, potato, tomato
streptomycin sulfate	Agri-mycin 17	Syngenta	caution	oral	antibiotic	25	12	0	bean, pepper, tomato
thiabendazole	Mertect	Syngenta	caution	oral AND posted	benzi- midazole	1	12		potato
thiophanate- methyl	Topsin, Topsin-M	Cerexagri, Farm Saver, Micro Flo,	caution	oral	benzi- midazole	1	12	0-14	bean, celery, cucumber, melon, potato, pumpkin, squash
thiram	Thiram	Gustafson	caution	oral	dithio- carbamate	M3	—	seed treat- ment	bean, beet, celery, cucumber, melon, onion, pumpkin, squash, sweet corn, tomato
TPTH	*Super-Tin, Agri-Tin	DuPont	danger	oral AND posted	organo- metallic	30	48	7-21	potato
trifloxystrobin	Flint	Bayer Crop- Science	caution	oral	strobilurin	11	12	0	beet, carrots, celery, cucumber, horseradish, melon, pumpkin, squash
	Gem	Bayer CropSci.	caution	oral	strobilurin	11	12	7	potato
triflumizole	Procure	Uniroyal Chemical	caution	oral	imidazole	3	12	0	cucurbits
zoxamide/ mancozeb	Gavel	Dow Agro- Sciences	caution	oral	benzamide/ EBDC	22	48	3	cucurbits, potato, tomato

Herbicide common and product names, formulations, manufacturers, safety information, and mode of action

Active ingredient	Product	Formulation(s)	Manufacturer	Signal word	Resistance management ^a		REI ^b (hrs)
					Mode of action	Group code	
2,4-D	2,4-D Amine	various	several	danger	growth regulator	4	48
	2,4-D Ester	various	several	caution	growth regulator	4	12
alachlor	*Intro	4EC	Monsanto	danger	shoot growth inhibitor	15	12
	*Micro-Tech	4ME	Monsanto	caution	shoot growth inhibitor	15	12
atrazine	*many	90DF, 4L	many	caution	photosynthesis inhibitor (systemic)	5	12
bensulide	Prefar	4E	Gowan	caution		8	12
bentazon	Basagran	4S	BASF	caution	photosynthesis inhibitor (contact)	6	48
bentazon + atrazine	*Laddok S-12	2.5 + 2.5L	Sipcam	danger		6 + 5	12
bromoxynil	Buctril	4EC, 2EC	Bayer	warning	photosynthesis inhibitor (systemic)	6	12–24
carfentrazone	Aim EW	1.9L	FMC	caution	cell membrane disruptor	14	12
carfentrazone + halosulfuron	Priority	62.5DF	Tenkoz	caution		14 + 2	12
clethodim	Select	2EC	Valent	warning	lipid synthesis inhibitor	1	24
clomazone	Command	3ME	FMC	warning	pigment inhibitor	13	12
clopyralid	Stinger	3S	Dow AgroSciences	caution	growth regulator	4	12
cycloate	Ro-Neet	6E	Syngenta	caution	shoot growth inhibitor	8	12
dimethenamid-P	Outlook	6EC	BASF	warning	shoot growth inhibitor	15	12
dimethenamid-P + atrazine	*G-Max Lite	2.25 + 2.75L	BASF	caution		15 + 5	12
EPTC	Eptam	7EC, 10G	Syngenta	caution	shoot growth inhibitor	8	12
	Eradicane	6.7EC	Gowan	warning	shoot growth inhibitor	8	12
ethalfuralin	Sonalan, Curbitt	3EC	Dow AgroSciences, Platte Chemical	warning/danger	root growth inhibitor	3	24
fluazifop	Fusilade DX	2EC	Syngenta	caution	lipid synthesis inhibitor	1	12
flumioxazin	Chateau	WDG	Valent	caution	cell membrane disruptor	14	12
fluroxypyr	Starane	1.5S	Dow AgroSciences	warning	growth regulator	4	12
fomesafen	Reflex	2LC	Syngenta	danger	cell membrane disruptor	14	24
glyphosate	several		several	caution	amino acid inhibitor	9	4–12
halosulfuron	Permit, Sandea	75DF	Gowan	caution	amino acid synthesis inhibitor (ALS)	2	12
imazamox	Raptor	1S	BASF	caution	amino acid synthesis inhibitor (ALS)	2	4
imazethapyr	Pursuit	2S 70DF	BASF	caution warning	amino acid synthesis inhibitor (ALS)	2	4 12
imazethapyr + pendimethalin	Pursuit Plus	0.2 + 2.7EC	BASF	caution		2 + 3	12
linuron	Lorox	50DF	Griffin	caution	photosynthesis inhibitor (systemic)	7	24
MCPA	MCPA Amine	various	several	danger	growth regulator	4	48
	MCPA Ester	various	several	warning	growth regulator	4	12
MCPB	Thistrol	2S	NuFarm	caution	growth regulator	4	12
mesotrione	Callisto	4L	Syngenta	caution	pigment inhibitor	27	12

*Restricted-use pesticide

^aREI = restricted entry interval

(continued)

Herbicide common and product names, formulations, manufacturers, safety information, and mode of action

Active ingredient	Product	Formulation(s)	Manufacturer	Signal word	Resistance management ^a		
					Mode of action	Group code	REI ^b (hrs)
metribuzin	Sencor	75DF	Bayer	caution	photosynthesis inhibitor (systemic)	5	12
napropamide	Devrinol	50DF	United Phosphorus	caution	shoot growth inhibitor	15	12
naptalam-sodium	Alanap	2L	Uniroyal	warning		19	48
nicosulfuron	Accent	75DF	DuPont	caution	amino acid synthesis inhibitor (ALS)	2	4
oxyfluorfen	Goal	2EC	Dow AgroSciences	warning	cell membrane disrupter	14	24–48
paraquat	*several		several	danger	cell membrane disrupter	22	12–24
pendimethalin	Pendimax, Prowl, Prowl H ₂ O	3.3EC, 3.8CS	Dow AgroSciences, BASF	caution	root growth inhibitor	3	24
prometryn	Caparol	4L	Syngenta	caution	photosynthesis inhibitor (systemic)	5	24
pyrazon	Pyramin	4.4FL, 65 DF	BASF	caution	photosynthesis inhibitor (systemic)	5	12
quizalofop	Assure II	0.88EC	DuPont	danger	ACCCase inhibitor	1	12
rimsulfuron	Matrix	25DF	DuPont	caution	amino acid synthesis inhibitor	2	4
sethoxydim	Poast	1.5EC	BASF	warning	ACCCase inhibitor	1	12
sethoxydim	Poast Plus	1EC	BASF	caution	ACCCase inhibitor	1	12
simazine	Princep	90DF, 4L	Syngenta	caution	photosynthesis inhibitor (systemic)	5	12
s-metolachlor + safener	Dual II Magnum, Cinch	7.64EC	Syngenta, DuPont	caution	shoot growth inhibitor	15	24
s-metolachlor + atrazine + safener	*Bicep Lite II Magnum	3.33 + 2.67L	Syngenta	caution		15 + 5	24
s-metolachlor + mesotrione	Camix	3.34 + 0.33L	Syngenta	warning		15 + 27	24
s-metolachlor + mesotrione + atrazine	*Lumax	2.68 + 0.268 + 1L	Syngenta	caution		15 + 27 + 5	24
tembotrione	Laudis	3.5L	Bayer	caution	pigment inhibitor	27	5 days
terbacil	Sinbar	80WP	DuPont	caution	photosynthesis inhibitor (systemic)	5	12
topramazone	Impact	2.8L	Amvac	caution	pigment inhibitor	27	12
trifluralin	Treflan	4EC, 10G, HFP	Dow AgroSciences	caution	root growth inhibitor	3	12

*Restricted-use pesticide

^a To delay or prevent the development of resistance, rotate among herbicides from different chemical groups. Newly approved labels bear the group code, a reference to the specific target site of the chemical. For more details, visit www.plantprotection.org/HRAC/.

^b REI = restricted entry interval

Pesticide toxicity

There are four common ways in which pesticides enter the human body—through the skin (dermal), the mouth (oral), the lungs (inhalation), and the eyes. Absorption through the skin is the most common route of poisoning of agricultural workers.

Perhaps the greatest hazard for the applicator is in loading and mixing the pesticide concentrate, which presents a significant risk of exposure to the chemical in its most toxic form. Although hazards associated with the actual application are frequently much less severe, they can still be substantial, especially if there is significant drift or if appropriate precautions are ignored. A pesticide may be toxic as a result of exposure to a single dose (acute toxicity) or as a result of repeated exposures over time (chronic toxicity).

Acute toxicities are normally expressed as the amount of pesticide required to kill 50% of a population of test animals (usually rats or rabbits). For oral and dermal exposure, this is referred to as the LD₅₀ or “lethal dose to 50%” in milligrams of toxicant per kilogram of body weight (mg/kg). For inhalation exposure, it is expressed as the LC₅₀ or “lethal concentration to 50%” in parts per million (ppm) of toxicant in the total volume of air when the toxicant is a gas or vapor, and in milligrams per liter (mg/l) of air or water when the toxicant is a dust or mist. ***Pesticides with greater acute toxicities have lower LD₅₀ and/or LC₅₀ values; that is, it takes less of the chemical to kill 50% of the test population.***

Labels indicate the relative level of acute toxicity through the use of signal words and symbols that reflect general categories of toxicity (see toxicity table). The toxicity category is assigned on the basis of the highest measured toxicity, be it oral, dermal, or inhalation; effects on the eyes and external injury to the skin are also considered.

In the event of human pesticide poisoning, the pesticide label is your first source of first-aid information. Always bear in mind, however, that first-aid response to pesticide exposure is not a substitute for professional medical help. Seek medical attention promptly, and always be sure that the label or labeled container is given to the doctor. The product's Material Safety Data Sheet (MSDS) is a more technical document than the label, and it often contains additional treatment instructions for the attending medical professional.

Poison Control Center (1-800-222-1222). You may call the Poison Control Center at any hour for information regarding proper treatment of pesticide poisoning. While other hospitals and medical facilities may have some information, the Poison Control Center has the most complete and current files and their personnel are specifically trained to deal with poison cases.

Most labels also list a phone number that you (or medical personnel) can call for specific information on poisoning (or other accidents) involving that particular product.

Toxicity categories of pesticides

Measure of toxicity	Toxicity category			
	I High toxicity	II Moderate toxicity	III Slight toxicity	IV Low toxicity
Oral LD ₅₀ (mg/kg)	0–50	50–500	500–5,000	> 5,000
Dermal LD ₅₀ (mg/kg)	0–200	200–2,000	2,000–20,000	> 20,000
Inhalation LC ₅₀ gas/vapor (ppm)	0–200	200–2,000	2,000–20,000	> 20,000
dust/mist (mg/l)	0–0.2	0.2–2	2–20	> 20
Eye effects	corrosive	irritation persists for 7 days	irritation reversible within 7 days	no irritation
Skin effects	corrosive	severe irritation	moderate irritation	mild irritation
Signal word	DANGER ^a	WARNING	CAUTION	CAUTION

mg/kg = milligrams per kilogram; ppm = parts per million; mg/l = milligrams per liter; < = less than; > = greater than.

^a Products assigned to Category I due to oral, inhalation, or dermal toxicity (as distinct from eye and skin local effects) also must have the word “poison” and the “skull and crossbones” symbol on the label.

Pesticide safety

Before you handle pesticides, ***stop and read the label***. Labels contain human safety precaution statements and list the specific personal protective clothing and equipment that you need to wear. Some of the following may be label requirements; others are commonsense guidelines that will help minimize pesticide exposure to you, your co-workers, and your family and neighbors.

- Wear a long-sleeved shirt, long pants, shoes, and socks when handling pesticides.
- Wear coveralls (fabric or chemical-resistant) over your work clothes for an added layer of protection.
- Unless the label states otherwise, always wear chemical-resistant gloves whenever you work with pesticides.
- Wear chemical-resistant footwear, gloves, eyewear, and respirator (if the label requires one) when mixing, loading, or applying pesticides.
- If you wear fabric coveralls, also wear a chemical-resistant apron when mixing and loading pesticides.
- Stand in the crosswind when mixing or loading pesticides.
- Never apply pesticides when there is the likelihood of significant drift.
- Never leave a spray tank containing pesticide unattended.
- Avoid back-siphoning into the water source.
- Never eat, drink, or smoke when handling pesticides.
- Wash hands thoroughly after handling pesticides.
- If you splash pesticide on yourself, remove contaminated clothing immediately and wash yourself thoroughly.
- Wash contaminated clothes separately from other household laundry.
- Keep pesticides in original containers.
- Store and lock pesticides out of the reach of children.
- Observe restricted entry intervals on a treated crop or area.

Pesticide accidents

Pesticide spills. Regardless of the magnitude of a spill, the objectives of a proper response are the same—you must **control** the spill, you must **contain** it, and you must **clean it up**. A thorough knowledge of appropriate procedures will allow you to minimize the potential for adverse effects.

Spills of any compound need to be reported to the WDNR. However, you do **not** need to report the spill if it is completely confined within an impervious secondary containment, and the spilled amount can be recovered with no discharge to the environment. On the other hand, a spill of any amount is reportable if it occurred outside of secondary containment and it harmed or threatens to harm human health or the environment (e.g., back siphoning). The spill is exempt from the WDNR reporting requirements if you deem the spill will not harm, or threaten to harm, and the amount spilled would cover less than 1 acre if applied at labeled rates, and if a SARA pesticide, is less than the reportable quantity.

Reportable spills involving SARA substances (see “Pesticides and Community Right-to-Know,” above) are also to be reported to the WDEM and to your LEPC. To simplify emergency notification requirements to state agencies, call the WDEM spill hotline (1-800-943-0003, 24-hour number) whenever a spill of any compound occurs. Calling this hotline will not, however, remove your responsibility of notifying your LEPC.

Spills of some compounds may require that you notify federal authorities by calling the National Response Center (1-800-424-8802). Your call to the WDEM spill hotline should provide you with assistance in determining whether federal authorities need to be notified.

Pesticide fires. In the event of a fire, call the fire department and clear all personnel from the area to a safe distance **upwind** from smoke and fumes. Isolate the entire area. Always inform the fire department of the nature of the pesticides involved and of any specific information that may help them in fighting the fire and protecting themselves and others from injury. For information on cleanup and decontamination, contact the WDEM and the pesticide manufacturer(s).

Livestock poisoning. When you suspect animal poisoning by pesticides, first call your veterinarian. If the cause of poisoning cannot be determined, call the WDATCP’s Animal Toxic Response Team at 608-224-4500.

Wildlife poisoning or water contamination. Contact the WDNR district office. District offices are located in Spooner, Rhinelander, Eau Claire, Green Bay, Milwaukee, and Fitchburg.

Pesticide drift

It is impossible to totally eliminate pesticide drift. Drift occurs because of unforeseen wind variations and other factors, many of which are beyond the applicator's control. People living in areas subject to pesticide drift worry about the acute and chronic effects of exposure to pesticides. State rules governing pesticide drift attempt to strike a balance between the intended benefits of pesticide use and the potential risks to those exposed to pesticide drift.

According to state law, people living adjacent to land that is aerially sprayed with pesticides can request to be notified at least 24 hours before application. Beekeepers also are entitled to notification of applications that occur within a 1.5-mile radius of their honey-bee colonies. Both ground and aerial pesticide applications are subject to advance notification requirements to beekeepers who request such notification.

For ground applications, you can minimize drift by following these recommendations:

- Follow all label precautions for specific drift-reduction measures.
- Spray when wind speed is low.
- Use the maximum nozzle orifice without sacrificing pest control activity.
- Keep pressure at the lowest setting possible without distorting spray pattern and distribution.
- Use drift-control agents when permitted by product label.
- Consider using nozzles specifically designed to reduce drift.
- Leave an untreated border strip next to adjacent property.

For more information about drift—what it is, how it occurs, and drift management principles—ask for *Managing Pesticide Drift in Wisconsin: Field Sprayers* from your county Extension office. This publication also describes the critical role the pesticide applicator plays in deciding whether to spray when arriving at the site.

Pesticides and groundwater

Trace amounts of pesticides are appearing in our nation's groundwater. To minimize further contamination, many pesticide labels contain precautionary statements either advising against or prohibiting use in areas vulnerable to groundwater contamination. Besides the product labels, a summary of these precautionary statements is also included under "Remarks" for each pesticide in this publication.

To protect our state's water resources, Wisconsin's Groundwater Law created two guidelines to limit the presence of fertilizer and pesticides in groundwater: enforcement standards are maximum chemical levels allowed in groundwater and preventive action limits are set at a percentage of the enforcement standard. When contamination approaches preventive action limits, the responsible party must implement corrective measures to prevent further contamination.

Through groundwater monitoring studies, the most commonly found pesticide is atrazine. Consequently, Wisconsin implemented Chapter ATP 30 to help minimize further contamination of our groundwater by atrazine. Under this rule, statewide rate restrictions have been implemented and, in some geographic areas, the use of atrazine is prohibited.

Mixing and loading pesticides. Mixing and loading pesticides pose a high risk of point source contamination of ground- and surface water because of the concentration, quantity, and type of pesticides that are usually handled at a mixing and loading site. To minimize this risk of environmental contamination, Wisconsin requires that certain mixing and loading sites have secondary containment.

Both private and commercial applicators are required to have a mixing and loading pad if more than 1,500 lb of pesticide active ingredient are mixed or loaded at any one site in a calendar year, or if mixing and loading occurs within 100 feet of a well or surface water. In-field mixing is exempt from the pad requirements provided mixing or loading at the site of application occurs 100 feet or more from a well or surface water.

Agricultural chemical cleanup program. Cleanup of contaminated soil or of contaminated groundwater itself is costly. The agricultural chemical cleanup program helps ease the financial burden for facilities and farms by reimbursing them for eligible costs associated with the cleanup of sites contaminated with pesticides or fertilizers. For more information, contact the WDATCP at 608-224-4519.

Calibrating pesticide equipment

Accurate and uniform pesticide application is basic to satisfactory pest control. Too frequently a grower does not know exactly how much pesticide has been used until the application is completed. This leads to substantial monetary losses due to unnecessary pesticide and labor costs, unsatisfactory pest control resulting in reduced yields, and crop damage. Good pesticide application begins with accurate sprayer or granular applicator calibration. One method of calibration is contained in the *Training Manual for the Private Pesticide Applicator*. It also is found in the *Training Manual for the Commercial Applicator: Field and Vegetable Crops*.

Cleaning pesticide sprayers

Thorough sprayer cleaning is necessary when switching from pesticide application on one crop to the application of a different pesticide on another crop. This is especially important when the second crop is quite sensitive to the first pesticide. For example, residue of dicamba left in a sprayer may damage soybeans and other dicamba-sensitive crops during subsequent insecticide application. No cleaning method is 100 percent foolproof. If you apply significant quantities of different types of pesticides, reserve one sprayer for herbicides only and another for insecticides and fungicides.

Check the label for specific cleaning instructions. If none are listed, follow these guidelines for cleaning spray equipment.

1. Park the sprayer on a wash pad and flush the tank, lines, and booms thoroughly with clean water and apply the pesticide-contaminated rinsate to sites listed on label. Simpler still, mount a clean water source on your sprayer and flush the system while in the field.
2. **Hormone-type herbicides (e.g., 2,4-D, Banvel):** Fill the sprayer with sufficient water to operate adding 1 quart household ammonia for every 25 gallons of water. Circulate the ammonia solution through the sprayer system for 15 to 20 minutes and then discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight. (Please note: household ammonia will corrode aluminum sprayer parts.)
- Other herbicides, insecticides and fungicides:** Fill the sprayer with sufficient water to operate adding 1/4 to 2 lb powder detergent (liquid detergent may be substituted for powder at a rate to make a sudsy solution) for every 25 to 40 gallons of water. Circulate the detergent solution through the sprayer system for 5 to 10 minutes and then discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight.
3. Flush the solution out of the spray tank and through the boom.
4. Remove the nozzles, screens, and strainers and flush the system twice with clean water.
5. Scrub all accessible parts with a stiff bristle brush.

Preparing pesticide sprayers for storage

Before storing the sprayer at the end of the season:

1. Clean the sprayer per label instructions or as specified above.
2. Fill the sprayer with sufficient water to operate adding 1 to 5 gallons of lightweight emulsifiable oil, depending upon the size of the tank. Circulate the oil/water solution through the sprayer system for 5 to 10 minutes.
3. Flush the solution out of the spray tank and through the boom; the oil will leave a protective coating on the inside of the tank, pump, and plumbing.
4. Remove the nozzles, screens, and strainers and place them in diesel fuel or kerosene to prevent corrosion. Cover the nozzle openings in the boom to prevent dirt from entering.
5. As an added precaution to protect pumps, pour 1 tablespoon of radiator rust-inhibitor antifreeze in each of the inlet and outlet ports. Rotate the pump several revolutions to completely coat the interior surfaces.

Pesticide disposal

It is the legal responsibility of all pesticide users to properly dispose of pesticide waste in an environmentally acceptable manner (it is illegal to bury or burn any pesticide containers in Wisconsin). Disposal is the final act of safe and judicious pesticide use.

Some pesticides are considered "hazardous" by the EPA. Disposing waste or excess resulting from use of these pesticides comes under stringent regulations of the Resource Conservation Recovery Act (RCRA). This federal law and the accompanying state law (NR 600) regulate generators of hazardous waste—those who need to dispose of hazardous pesticides.

The simplest way to avoid becoming a hazardous-waste generator is to triple rinse all pesticide containers and apply rinsates to labeled sites. If you must generate hazardous waste, disposal procedures may differ depending on the volume of waste generated and its characteristics.

You can reduce the amount of pesticide waste (hazardous or not) by following these steps:

- Determine whether the pesticide you intend to use is considered hazardous by the EPA. A list of these pesticides is available from your WDNR regional office. If listed, check for alternative pesticides that are not hazardous and will provide equivalent pest control.
- Mix only the amount of pesticide needed and calibrate equipment so all solution is applied.
- Attach a clean water supply to the sprayer unit so the tank can be rinsed and the rinsate applied to the labeled site while still in the field.
- Triple rinse all pesticide containers. Even if the pesticides were hazardous, a triple-rinsed container is not hazardous waste and you can dispose of it in a sanitary landfill.
- Don't mix hazardous waste with other pesticide waste. This will result in the entire mixture being considered hazardous.

Wisconsin Clean Sweep Program. This program (formerly Pesticide Clean Sweep) offers a way to dispose of most kinds of pesticide waste including liquids, dry formulations, and hazardous pesticides. It isn't available in every county every year so check with your Extension office or WDATCP (608-224-4545) for details on when a site will be held in your area. Wisconsin Clean Sweep has two components: an agriculture program and a household program.

Plastic pesticide container recycling program. The best way to dispose of plastic containers is to recycle them. The Wisconsin Crop Production Association (WCPA)—formerly the Wisconsin Fertilizer and Chemical Association—sponsors this program and sets up collection sites throughout the state. This program accepts triple-rinsed plastic pesticide containers dropped off at designated sites. Dirty containers will not be accepted. The containers are then transported to a granulation site where they are pelletized for recycling. Check with WCPA (608-249-4070) or your county Extension office to find out when a collection site will be in your area.

Please note that this recycling program is not a Wisconsin Clean Sweep program; waste pesticides will not be accepted at container collection or granulation sites.

Recycling mini-bulk tanks. In addition to small containers, Wisconsin dealers and growers also may recycle mini-bulk tanks (60 gallons and larger). Only dealers are allowed to bring tanks to the collection site, although the program will accept farmers' tanks if they are brought to the site by a dealer. There is a nominal fee and tanks must have all metal removed. Collection and recycling of mini-bulk tanks are held in odd-numbered years; please check with WCPA (608-249-4070) for details.

Asparagus

Permanent asparagus plantings in Wisconsin are usually started with year-old crowns. Direct-seeding has had limited success in Wisconsin. Plug production of seedlings is also being done on a limited basis and will likely increase in future years as male hybrid seed becomes increasingly available.

Hybrid male cultivars cost more than the open-pollinated varieties, but yields are 1.5–2 times that of the traditional cultivars.

Planting

Field transplant production

Rows—18–20 inches;

seeds in row—2 inches (1 inch deep). Use 4–5 lb seed/a.

Each pound produces about 10,000 plants, enough for about an acre. (Sidedress with 75–100 lb/a ammonium nitrate about mid-June.) To speed germination, soak seeds in warm water (about 90°F) for 4–5 days before planting. Add a few radish seeds to provide early plants to mark rows for cultivation. The following spring, lift and reset plants in a permanent location.

Indoor transplant production

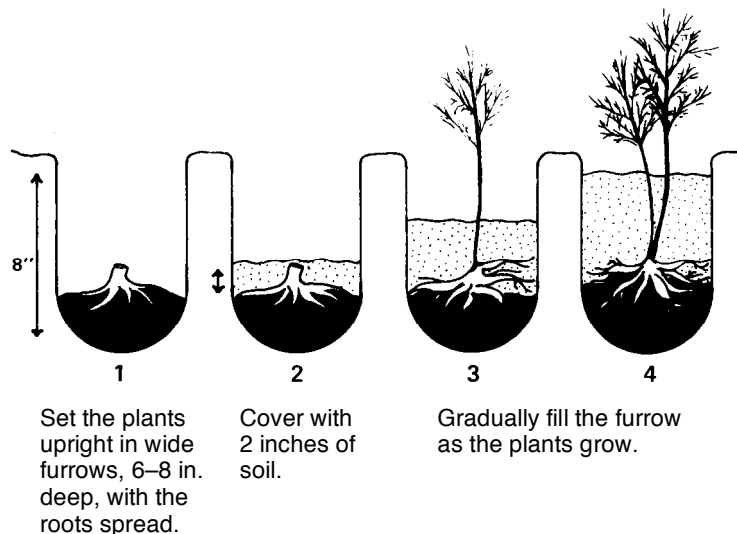
You can also start seeds indoors around the first of March for transplanting the middle of May. This way you do not need to replant them the following year. Use the same spacing for transplants as recommended for 1-year-old crowns.

Permanent plantings from 1-year-old crowns or from transplants

Rows—4–6 ft;

crowns in row—9–15 inches (6–8 inches deep). Cover the crowns or transplants with 2–3 inches of soil and gradually fill furrows as plants grow. Poor stands result if plants are covered too deeply at the start. Ridge the soil moderately over the rows after the plants are well established.

Avoid planting asparagus in fields infested with perennial weeds such as Canada thistle, quackgrass, and field bindweed (creeping Jenny) or eliminate these weeds before planting.



Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.0 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations before planting. Use annual nitrogen, P_2O_5 , and K_2O recommendations in table below each year asparagus is grown. Take credits for previous legume crops and manure.

Application: Broadcast and work in before spears begin to grow in early spring.

Nitrogen: On sandy soils, apply half of the nitrogen early in spring and the remaining half after the last harvest.

Annual nitrogen, phosphate, and potash recommendations for asparagus

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P ₂ O ₅	K ₂ O
— % —	— lb/a —	— — — — —	— lb/a — — — — —	— — — — —
<2	80	2,000–4,000	10	20
2.0–9.9	60			
10–20	40			
>20	20			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in asparagus

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Fusarium root rot	<i>Field choice is very important so that plant stress in subsequent years is avoided.</i>			
Rust	chlorothalonil	2.0–4.0 pt Bravo Weather Stik, Echo 720, Equus 720 3.0–5.75 pt Echo Zn, Equus 500 Zn 1.8–3.6 lb Bravo Ultrex, Equus 90DF	190	Do not apply more than 9.0 lb ai/a chlorothalonil per growing season. Post-harvest application only.
	mancozeb	1.6 qt Dithane F-45 2.0 lb Dithane 75DF Rainshield NT 2.0 lb Manzate 200 75DF 2.0 lb Penncozeb 75DF, 80WP	180	Use rust-resistant varieties. Do not apply more than 6.4 lb ai/a per season. Apply as a postharvest spray on ferns after spears have been harvested. Cut infected plants at ground level in late fall or winter and destroy infected debris.
	myclobutanil	5.0 oz Nova 40W	180	Do not apply to harvestable spears. Do not make more than six 5-oz applications of product per growing season. Do not exceed 30 oz/a product (0.75 lb ai/a) per year.

Insect control in asparagus

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Asparagus aphid	<i>Natural enemies will often eliminate this insect; spot treat when populations are increasing rapidly and biological control is ineffective. Treat when 5% of ferns show injury. New plantings tolerate less injury.</i>			
	azadirachtin	10.0–21.0 oz Azatin XL Plus 0.5–2.0 gal Neemix 0.25EC 0.25–1.0 pt Neemix 4.5EC	0	Apply at 7-day intervals when pests first appear. May apply every 3–4 days for heavy infestations.
	1.0 lb chlorpyrifos	1.33 lb Lorsban 75WG 2.0 pt Lorsban 4E	1	Apply at fern stage only. Do not exceed two applications.
	0.5 lb dimethoate	1.0 pt dimethoate 400	180	Apply after the last harvest. Wait at least 7 days between applications. Do not exceed 5 pt/a per year or apply within 180 days before harvest.
	0.9–1.25 lb malathion	1.5–2.0 pt (various brands) 57%EC	1	Apply as needed. Aphid colonies appear in late summer.
	1–2% potassium salts of fatty acids	2.0 gal M-Pede/ 100 gal water	0	Primarily a contact spray. Apply every 7–14 days as needed.
	0.004–0.05 lb pyrethrin	1.0–12.0 fl oz Pyrenone 0.5 EC	0	Primarily a contact spray.

*Restricted-use material.

(continued)

Insect control in asparagus (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Common and twelve-spotted asparagus beetles, Japanese beetle	1.0–2.0 lb carbaryl	2.0–4.0 lb Sevin 50WP 1.25–2.5 lb Sevin 80S 1.0–2.0 qt Sevin XLR Plus	1	Apply when 5–10% of the plants are infested with adults or 2% of the spears have eggs or 10% of the plants are defoliated by larvae or 50–75% of the plants have larvae.
	1.0 lb chlorpyrifos	Lorsban (several formulations)	1	Apply at fern stage only. See label for rate.
	0.5 lb dimethoate	1.0 pt dimethoate 400	180	Apply after the last harvest. Wait at least 7 days between applications. Do not exceed 5 pt/a per year or apply within 180 days before harvest.
	0.9–1.25 lb malathion	1.5–2.0 pt (various brands) 8 F	1	Apply as needed.
	0.5–1.0 lb methomyl	1.5–3.0 pt *Lannate LV	1	Do not exceed 4.5 lb ai/a or eight applications per crop.
	0.05–0.1 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Do not apply more than 0.4 lb ai/a per season.
	1.0–2.0 pt pyrethrin	Pyrellin EC	0	Primarily a contact spray.
	0.25 lb rotenone	Rotenone WP, D		
	0.031–0.063 lb spinetoram	4.0–8.0 oz Radiant SC	60	Do not apply more than 24.0 oz/a of Radiant (0.188 lb a.i.) or exceed three applications per crop. Wait at least 4 days between treatments.
	0.062–0.094 lb spinosad	1.25–2.0 oz Entrust 4.0–6.0 fl oz SpinTor	60 60	Apply to ferns only. Do not make more than three applications/crop. Do not exceed 5.6 oz/a Entrust or 18.0 oz/a SpinTor per season.
Cutworms	0.5–1.5 lb <i>Bacillus thuringiensis</i>	0.5–1.0 lb Dipel DF	0	
	2.0 lb carbaryl	Sevin bait (several formulations)	1	Apply when 5–10% of the plants show cutworm damage.
	1.0 lb chlorpyrifos	1.33 lb Lorsban 75WG 2.0 pt Lorsban 4E	1	Apply when soil is moist and worms are active.
	0.45–0.9 lb methomyl	1.5–3.0 pt Lannate 2.4LV 0.5–1.0 lb 90SP	1	Do not exceed 4.5 lb ai/a or eight applications.
	0.05–0.1 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Do not apply more than 0.4 lb ai/a per season.
	0.062–0.094 lb spinosad	4.5–6.0 oz SpinTor 2SC	60	For protection of ferns only.

*Restricted-use material.

Weed control in asparagus

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.5–2.0 lb trifluralin	1.0–4.0 pt Treflan HFP or registered equivalent		Apply to established asparagus as a single or split application, before or after harvest. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours.
Annual broadleaves	0.8–1.6 lb terbacil (seeding year only)	1.0–2.0 lb Sinbar 80W		Plant seed 1.0–1.5 inches deep. Spread a band of activated charcoal over the seeding row and follow with a single application of Sinbar. Use the lower rate on coarser soils.
	1.2 lb terbacil	1.5 lb Sinbar 80W	5	Apply before spears and weeds emerge or to small weeds (less than 2 inches tall). Do not exceed 2.5 lb/a per year. Do not use on plants that are diseased or lacking in vigor as crop injury may result. Do not plant to any other crop within 2 years of application.

(continued)

Weed control in asparagus (cont.)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual grasses and broadleaves	0.5–2.0 lb linuron	1.0–4.0 lb Lorox DF	1	Lorox DF is registered for use on newly planted asparagus and on established beds. Before treating a newly seeded bed, place a 1-inch band of activated charcoal (300 lb/a) directly over the seed. A single 2–4 lb/a preemergence or multiple 1–2 lb/a postemergence applications can be made. See label for crop height and weed size restrictions. Do not apply more than 4 lb/a per year in a maximum of 3 applications. Do not add surfactant to spray mix.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.5 oz Sandea	1	Sandea controls several broadleaf weeds and nutsedge. It will not control grasses. It may be applied before weeds emerge as a postemergent broadcast treatment before or during the harvest season or as a post-harvest directed spray using drop nozzles to direct the spray below the ferns. Spray contact with the fern may cause temporary yellowing. Wait to treat first-year transplants until at least 6 weeks after fern emergence. Do not exceed 2 oz/a per crop season in a maximum of two applications. Do not use soil- or foliar-applied organophosphate insecticides on asparagus that has been treated with Sandea or serious crop injury may occur. Consult label for other important usage information and precautions.
Germinating annual weeds in established beds	0.8–3.2 lb diuron	1.0–4.0 lb Karmex DF 0.8–3.2 qt Direx 4L		Do not use on newly planted or seeded asparagus during the first growing season. If making two applications in one season, do not exceed 3 lb/a of Karmex or 2.4 qt/a of Direx per application. Moisture is needed to activate the herbicide. See label for specific application information and precautions.
	1.0–2.0 lb metribuzin	2.0–4.0 pt Sencor 4 1.33–2.66 lb Sencor DF	14	Sencor is registered for a single preemergence application or a split application preemergence and post-harvest. Do not exceed 2 lb ai/a per year. Do not apply to plants during the first growing season after setting crowns or to newly seeded beds. Apply in early spring before spears or ferns emerge. For split applications, apply half in early spring before spears or ferns emerge and half after the last harvest of spears but before ferns emerge.
	4.0 lb napropamide	8.0 lb Devrinol 50-DF		Apply in early spring after disking but before weeds emerge. Do not apply to frozen ground or to ground with more than 10% organic matter. Incorporate or irrigate within 24 hours if no rainfall occurs. Treat only once per season. Do not plant crops not specified on the label within 12 months of the last application.

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Weed control in asparagus (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged broadleaves	2,4-D (see label for rate)	several manufacturers		Apply to actively growing weeds, usually in April or May. If spears are present, treat right after cutting. No more than two applications during the harvest season, and these should be at least 1 month apart. Contact by spray may cause malformed spears; cut and discard. Postharvest sprays require ground equipment using drop nozzles to avoid spraying the ferns.
	0.25–0.5 lb dicamba	8.0–16.0 oz Clarity	24 hours	Apply after cutting, but at least 24 hours before next cutting to actively growing weeds. Multiple applications per season allowed, but do not exceed 16 oz/a per year.
	2.0–4.0 lb norflurazon	2.5–5.0 lb Solicam DF	14	Do not apply to asparagus in the first growing season. See label for correct application rate as determined by soil type. Before application, remove or incorporate crop debris. Rain or irrigation needed within 4 weeks of application for activation.
Emerged grasses	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	1	Add nonionic surfactant at a rate of 0.25% v/v. Wait at least 14 days before repeating treatment. Do not apply more than 64 oz/a per season.
	0.124–0.188 lb fluazifop-P-butyl	8.0–12.0 oz Fusilade DX	1	Make postemergence application to actively growing grasses; check label for size range and treatment rate. Always add either crop oil concentrate or nonionic surfactant to final spray mix. Do not apply more than 48 oz/a per season.
	0.094–0.47 lb sethoxydim	0.5–2.5 pt Poast	1	Apply postemergence to actively growing grasses. Always add 2 pt/a of crop oil concentrate to the spray mix. Apply no more than 5 pt/a of Poast per season. Do not apply if rain is expected within 1 hour.
Emerged weeds	glyphosate	several manufacturers and formulations	5	See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Apply at least 1 week before the first spears emerge or apply as a spot treatment after cutting spears or after all spears have been removed. Do not spot treat more than 10% of the field. Direct contact with the crop will cause serious injury.
	*paraquat (rate varies by label)	*several manufacturers	6	Application will kill emerged crop, so apply to dormant asparagus before emergence or after last harvest. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.

*Restricted-use pesticide.

Bean

lima, navy, red kidney, snap

Planting

Lima bean **Rows**—18–36 inches. Rows narrower than 30 inches can increase the incidence of white mold. Wider rows allow cultivation and better air circulation, making them less prone to the disease. **Seed**—Target stand density of 100,000 plants/acre: for 30-inch rows, 5–6 plants/foot; for 18-inch rows, 2–3 plants/foot. Depends upon seed size, germination, row spacing.

Navy and red kidney bean **Rows**—28–32 inches. **Seed**—Plant 2 inches apart and 1.0–1.5 inches deep in heavy soil and 2 inches in sandy soil. Use 75–100 lb/a of red kidney; 35–45 lb/a navy bean; depends on seed size, germination, row spacing.

Snap bean The between-row and in-row spacings for snap beans depends on whether the conventional or close row spacing system is being used.

Conventional rows are spaced 30–36 inches apart. The in-row spacing should result in a final plant stand of 7–9 plants/ft of row for irrigated fields and 6–8 plants/ft of row for non-irrigated fields.

Close row systems have rows spaced 18–24 inches apart. In-row spacing should result in a final stand of 3–4 plants/ft for irrigated and non-irrigated fields. Carefully manage close row spacings because such systems can increase the potential for white mold disease.

Seed—75–90 lb/a; depends upon seed size, germination, row spacing. Plant seed 1/2–2 inches deep depending on soil conditions. Plant shallow if soil is cool and moist, but deeper in dry, warm sandy soils.

Planting considerations (date, field selection)

Plant snap beans from May 10–July 15. They prefer growing season temperatures of 60–70°F and soil temperatures above 50°F. Temperatures above 85°F can result in poor pollination and “split set.” Plant navy and red kidney beans June 1–June 9. Lima beans germinate best at soil temperatures of 65°F. All bean seeds are subject to planter damage. Select planter plates to fit seed and reduce planter speed to minimize cracking of seed coat.

Grow on well-drained soils. Beans should follow corn on farms that use a corn-oats-forage rotation. Don’t use atrazine on the crop preceding the beans; it may leave a soil residue that will injure the beans. Select fields without major weed problems. On sandy soil, plow under rye cover crops before they deplete soil moisture. Allow at least 2 years between bean crops because disease organisms may live in the soil or on plant residue.

Irrigation

Snap and lima beans require a constant supply of moisture, especially during the blossom/pod-set period. Moisture stress during blossom/pod-set period may cause blossom and pod drop. This causes split pod set and reduces yields. An effective irrigation program can ensure high yields and high pod quality, particularly on sandy soils. Proper irrigation management should promote uniform germination and emergence, plant development, and harvest maturity—all are important in mechanical harvesting. If the WISP program is used to schedule irrigations, the AD value for snap and lima beans on sands is 1.3 inches, and on silt loams the AD value is about 2.5 inches.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.0 for dry beans. Snap beans should be limed to 6.8 on mineral soils and 5.6 on organic soils to help avoid certain diseases.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in table below. Take credits for previous legume crops and manure.

Application: Fertilizer may be applied broadcast or in a band 2 inches below seed and 2 inches to the side. Be sure seed does not contact fertilizer. Beans are salt-sensitive; contact with fertilizer can reduce germination.

Nitrogen: Apply broadcast or sidedress at trifoliate. Split applications on sandy soils. Check with processor for optimum N timing for each variety. On irrigated sands, apply the N in two applications to reduce leaching. In years with leaching due to excess rain, an extra 30–40 lb N/a may be needed on sandy soils. Research has shown that applications to snap beans greater than 100–120 lb N/a resulted in yield reductions.

Magnesium: Correct deficiencies on acid soils with dolomitic limestone. If pH is above 6.5, use magnesium sulfate or potassium-magnesium sulfate to apply 10–20 lb/a of magnesium in row fertilizer.

Zinc: Deficiency may occur on sands or eroded soils. To correct, add 2–4 lb/a of zinc (as sulfate, oxide, or frits) to row fertilizer or broadcast 4–8 lb/a of zinc. Add 0.5–1 lb/a if using zinc chelates. You can also apply zinc in a foliar spray (1 lb/a Zn as sulfate or 0.15 lb/a Zn as chelate).

Annual nitrogen, phosphate, and potash recommendations for bean crops

Crop	Nitrogen		Phosphate and potash		
	Organic matter	Amount to apply	Yield goal	Amount to apply ^a	
				P ₂ O ₅	K ₂ O
	— % —	— lb/a —	— — — — — lb/a — — — — —		
Lima bean	<2	60	2,000–3,000	20	40
	2.0–9.9	40	3,001–4,000	30	60
	10–20	20	4,001–5,000	40	80
	>20	10			
			— cwt/a —		
Navy & red kidney bean	<2	40	10–20	20	20
	2.0–9.9	30	21–30	30	40
	10–20	20	31–40	40	60
	>20	10			
			— ton/a —		
Snap bean	<2	60	1.5–2.5	10	40
	2.0–9.9	40	2.6–3.5	15	60
	10–20	20	3.6–4.5	20	80
	>20	0	4.6–5.5	25	100
			5.6–6.5	30	120

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in bean — lima, navy, red kidney, snap

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Angular leaf spot (Fungal pathogen — <i>Phaeoisariopsis griseola</i>)	<i>Practice a 2-year break between bean crops to permit decomposition of crop debris. Infested residue should be thoroughly incorporated into the soil to hasten decomposition.</i>			
Bacterial blights (brown spot, common blight, fuscous blight, and halo blight)	copper oxychloride plus basic copper sulfate	2.0–4.0 lb C-O-C-S	0	Rotating crops, deep-plowing debris, and planting disease-free seed are very effective controls.
	copper salts of fatty and rosin acids	3.0 pt Tenn-Cop 5E	0	
	copper hydroxide	0.66–2.0 pt Champ Formula 2 4.6F	0	Apply at 7- to 14- day intervals when conditions are favorable for disease development.
		1.5–3.0 lb Champion 77WP	0	Not effective when disease pressure is severe.
		1.5–3.0 lb Kocide 101 77WP	0	
		1.5–3.0 lb Kocide DF	0	
		1.3–4.0 pt Kocide LF	0	
		0.67–2.0 pt Kocide 4.5 LF	0	
		0.75–2.25 lb Kocide 2000DF	0	
	streptomycin sulfate	30,000 ppm (3%) solution streptomycin sulfate 62.5%	NA	Treat seed with streptomycin sulfate to help inactivate bacteria on the seed surface.

(continued)

Disease control in bean—lima, navy, red kidney, snap (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Botrytis gray mold and Sclerotinia white mold	<i>Rotate bean fields with nonhost crops. Both fungi infect a broad range of crop and weed hosts. Plant on well-drained soil. In areas prone to disease, avoid excessive irrigation before and during the bloom period. A computer program that aids in assessing the risk from white mold is available. Contact W. Stevenson, Plant Pathology Department, University of Wisconsin, Madison 53706.</i>			
	boscalid	8.0–11.0 oz Endura 70 WDG	7 (succulent); 21 (dry)	Do not exceed two sprays and 22 oz/a of Endura per season.
	thiophanate-methyl (snap & dry beans)	1.0–1.5 lb Topsin M WSB 20–30 fl oz Topsin 4.5 FL	14 14	Apply spray at 25–50% bloom and again 7 days later at 100% bloom. Do not graze or feed treated vines to livestock.
	thiophanate-methyl (snap & dry beans)	1.5–2.0 lb Topsin M WSB 30–40 fl oz Topsin 4.5 FL	14 14	Apply once at 50–75% bloom. Do not graze or feed treated vines to livestock.
	thiophanate-methyl (lima beans)	1.0–2.0 lb Topsin M WSB	14	Begin application at 10–30% bloom. Do not exceed 4 lb product per acre per season. Do not graze or feed treated vines to livestock.
	iprodione	1.5–2.0 lb Rovral 50WP 1.5–2.0 pt Rovral 4F	14 14	Apply spray at 10% bloom and again at 5–7 days later or at 100% bloom, if necessary. Last application should be made no later than full bloom. Do not graze or feed treated vines to livestock.
Common mosaic virus and bean yellow mosaic virus	<i>Common mosaic is seedborne. Yellow mosaic overwinters in perennial legumes and other hosts. Both are transmitted in the field by aphids. These virus diseases are not controlled by fungicides or seed treatments.</i>			
Root rots (Fusarium, Pythium, Rhizoctonia)	<i>Rotate nonlegume crops with beans, and use cover crops between plantings and over winter. When symptoms appear, timely irrigation can promote new feeder root development and produce an acceptable crop. Subsoiling 20–22 inches can promote deep rooting and improve yields. Wet soil conditions during emergence may increase root rot losses.</i>			
Rust	<i>Bury all bean debris after harvest. If rust does not appear within 4 weeks of harvest, fungicides are unnecessary.</i>			
	chlorothalonil	1.3–3.0 pt Bravo Weather Stik, Echo 720, Equus 720	14	Do not apply more than 9 lb ai/a chlorothalonil per season.
		1.25–2.7 lb Bravo Ultrex 82.5WDG, Equus DF	14	Do not graze treated areas or feed treated plant parts to livestock.
		1.125–2.5 lb Echo 90DF	14	
		2.0–4.25 pt Echo Zn	14	
	myclobutanil	4.0–5.0 oz Nova 40W	0	Do not exceed 1.25 lb/a product (0.5 lb ai/a) per year. Observe a 30-day plantback interval between last application and planting new crops.
Rust, anthracnose, alternaria leaf spot, alternaria blight	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 6.2–15.4 fl oz Quadris Flowable	0	Amistar, Quadris, and Headline belong to the Group 11 (strobilurin) fungicide category. Do not exceed more than one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four foliar applications of strobilurin fungicides per crop per year. Do not exceed 1.88 lb/a Amistar, 1.44 qt/a Quadris, or 18 fl oz/a Headline per season. Do not use pyraclostrobin on lima beans. Do not feed bean forage or hay treated with these products earlier than 14 days after the last application.
	pyraclostrobin	6.0–9.0 fl oz Headline	7 (edible pod) 21 (dry)	
	azoxystrobin + chlorothalonil	1.6–2.4 pt Quadris Opti	14	For use on beans to be harvested dry with pods removed. Quadris Opti belongs to Group 11 (strobilurin) and M fungicide categories. Do not apply more than one foliar spray of Quadris Opti or other Group 11 fungicides before alternating with a fungicide having a different mode of action. Do not exceed four foliar of Quadris Opti or other Group 11 fungicides per acre per year. Do not apply more than 1.5 lb ai azoxystrobin or 6 lb ai chlorothalonil per acre per year.

(continued)

Disease control in bean—lima, navy, red kidney, snap (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Sclerotinia white mold	<i>Coniothyrium minitans</i>	1.0–4.0 lb Contans WG	0	Apply post-harvest to fields with white mold infection before incorporating crop debris or apply 3–4 months before disease onset. Immediately incorporate product into top 1–2 inches of soil. Do not plow before planting. This product is a biological material that should be kept cool before use. Intercept WG helps to reduce the soil-borne inoculum of Sclerotinia
Seed decay, rot, preemergence damping-off	captan chloroneb thiram			Most seed is treated with fungicide/insecticide. Do not use treated seed for food or feed.
Virus complex (transmitted by aphids)	<i>A combination of cucumber mosaic virus and alfalfa mosaic virus continues to cause plant stunting, foliage mosaic, blossom abortion, misshapen and discolored pods, and significant yield reductions. The soybean aphid appears to be the primary vector. Planting early to avoid high populations of the soybean aphid that appear in mid-July helps to reduce losses. Field trials continue in an effort to identify cultivars with field tolerance. Insecticide treatments of foliage or seed do not appear to offer cost-effective control at this time.</i>			

Scouting calendar for insect pests of beans

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
	Seed maggot				
	European corn borer				
		Potato leafhopper			
		Tarnished plant bug			
			Soybean aphid		
			Corn earworm		

Insect control in bean—lima, navy, red kidney, snap

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Bean aphid and soybean aphid	<i>Phorate and disulfoton treatments at planting will also control aphids (see leafhopper section for rates).</i>			
	0.25–1.0 lb acephate	0.33–1.33 lb Orthene 75S 0.25–1.0 lb Orthene 97S	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.
	0.025–0.10 lb bifenthrin	1.6–6.4 fl oz Brigade 2EC	3	Do not apply more than 0.2 lb ai/a or 12.8 oz/a of product per season.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	0	Do not use at bloom. Do not feed treated vines to livestock.
	1.0–2.0 lb endosulfan	2.0–4.0 lb Thiodan 50WP	3	Apply every 5 days as needed. Do not exceed 3 lb ai/a per season. Do not apply to lima beans.
	0.025–0.05 lb esfenvalerate	5.8–9.6 oz Asana	3 (snap) 21 (dry)	Do not exceed 0.2 lb ai/a per season.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.

*Restricted-use pesticide

(continued)

Insect control in bean—lima, navy, red kidney, snap (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Bean aphid and soybean aphid (<i>cont.</i>)	imidacloprid	2.0–4.0 fl oz Gaucho 480/ hundredweight of seed	—	Snap and lima beans only. Preplant commercial seed treatment. There is a 12-month rotational plantback restriction for crops not listed on label.
		7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on the plant row within 14 days of planting.
		3.5 fl oz Provado 1.6	7	Apply every 7 days as needed. Do not exceed 10.5 fl oz/a Provado per season and do not exceed a total of 0.5 lb ai/a imidacloprid per season (any formulation).
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 lb *Warrior EC	7	Do not apply more than 0.12 lb ai/a per season. Do not feed treated foliage to animals.
	1.0–1.25 lb malathion	1.5–2.0 pt Malathion EC	1	A short residual contact insecticide. Do not apply more than once every 7 days.
	1.0 lb naled	1.0 pt Dibrom 8E	1	Short-lasting residual contact insecticide.
	thiamethoxam	0.765–1.28 fl oz Cruiser 5FS/ hundredweight of seed	—	Seed treatment only. There is a 120-day plantback restriction for crops not listed on the label.
	zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
Bean leaf beetle	0.25–1.0 lb acephate	0.33–1.33 lb Orthene 75S 0.25–1.0 lb Orthene 97S	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz Brigade 2EC	3	Do not apply more than 0.2 lb ai/a or 12.8 oz/a of product per season.
	1.0 lb carbaryl	Sevin	3	
	0.0125–0.019 lb cyfluthrin	1.6–2.4 fl oz Baythroid XL	7	Do not exceed four applications or 6.4 fl oz/a per year.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	0	Do not use at bloom. Do not feed treated vines to livestock.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.
	imidacloprid	2.0–4.0 fl oz Gaucho 480/ hundredweight of seed	—	Snap and lima beans only. Apply as a commercial seed treatment before planting. There is a 12-month rotational plantback restriction for crops not listed on the label.
		16.0–24.0 fl oz Admire Pro	21	Apply in a narrow band centered on the plant row, 1–2 inches below the seed depth. Apply within 14 days before planting.
		3.5 fl oz Provado 1.6	7	Apply every 7 days as needed. Do not exceed 10.5 fl oz/a Provado per year.
	thiamethoxam	0.765–1.28 fl oz Cruiser 5FS/ hundredweight of seed	—	Seed treatment only. There is a 120-day plantback restriction for crops not listed on the label.
	zeta-cypermethrin	2.72–4.0 oz *Mustang Max	1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
Corn earworm	acephate	1.0–1.33 lb Orthene 75S, 75WSP 0.75–1.0 lb Orthene 97PE	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.
	azadirachtin	10.0–21.0 oz Azatin XL Plus 0.5–2.0 gal Neemix 0.25, 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed. May treat heavy infestations every 3–4 days.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.

*Restricted-use pesticide

(continued)

Insect control in bean—lima, navy, red kidney, snap (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Corn earworm (<i>cont.</i>)	0.025–0.10 lb bifenthrin	1.6–6.4 fl oz Brigade 2EC	3	Do not apply more than 0.2 lb ai/a or 12.8 oz/a of product per season.
	1.5 lb carbaryl	Sevin WP, L, XLR Plus	0	See label for rates. Apply at first sign of damage.
	0.0125–0.019 lb cyfluthrin	1.6–2.4 fl oz Baythroid XL	7	Do not exceed four applications or 6.4 fl oz/a per year.
	0.015–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3 (snap) 21 (dry)	Do not graze or feed treated vines to livestock. Do not exceed 0.2 lb ai/a per season.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior	7	Do not exceed 0.12 lb ai/a per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	3	Three days to feed vines; 7 days to feed hay.
	0.031–0.063 lb spinetoram	4.0–8.0 oz Radiant SC	3	Do not apply more than 28.0 oz/a (0.219 lb ai/a) or exceed four applications per crop.
	0.047–0.094 lb spinosad	1.25–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	3 3	Use higher rates for larger larvae. Apply in adequate spray to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent.
	zeta-cypermethrin	3.0–4.3 oz *Mustang, *Fury 2.72–4.0 oz *Mustang Max	1 1	Apply every 5 days as needed. Do not exceed 25.8 oz/a Mustang or Fury, or 24 oz/a Mustang Max per season.
Cutworm	<i>Spot treat when numbers exceed 2 larvae per row foot.</i>			
	0.5–1.0 lb acephate	0.67–1.33 lb Orthene 75S, 75WSP 0.49–0.97 lb Orthene 97PE	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.
	azadirachtin	10–21 oz Azatin XL Plus, 0.5–2.0 gal Neemix 0.25, 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed. May treat heavy infestations every 3–4 days.
	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR	—	Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not apply more than 0.1 lb/a Capture LFR per season as an at-plant application.
	carbaryl	1.0–1.5 lb Sevin 50WP 1.25–1.88 lb Sevin 80S 1.0 qt Sevin XLR Plus	0	See label for rates. Apply at first sign of pests. Repeat at 7- to 10-day intervals.
	0.0065–0.0125 lb cyfluthrin	0.8–1.6 fl oz Baythroid XL	7	Do not exceed four applications or 6.4 fl oz/a per year.
	0.015–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3 (snap) 21 (dry)	Do not exceed 0.2 lb ai/a per season. Do not graze or feed treated vines to livestock.
	0.0075–0.0125 lb gamma cyhalothrin	1.92–3.20 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.
	zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
European corn borer	<i>Apply insecticide when beans are in the early bloom stage AND moth catches in nearby blacklight traps exceed 15 moths/night for first generation or 100 moths/night for second generation. Once moth catches drop, delay applications until beans are 1-inch long.</i>			
	0.25–1.0 lb acephate	0.33–1.33 lb Orthene 75S 0.25–1.0 lb Orthene 97S	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.

Insect control in bean—lima, navy, red kidney, snap (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
European corn borer (<i>cont.</i>)	0.75–1.0 lb acephate	Orthene SP	0 (lima) 14 (dry, snap)	Do not feed treated vines.
	1.0–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.025–0.10 lb bifenthrin	1.6–6.4 fl oz Brigade 2EC	3	Do not apply more than 0.2 lb ai/a or 12.8 oz/a of product per season.
	1.0 lb carbaryl	Sevin WP, S, L, XLR Plus	0	
	0.015–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3 (snap) 21 (dry)	Do not exceed 0.2 lb ai/a per season. Do not graze or feed treated vines to livestock.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior	7	Do not exceed 0.12 lb ai/a per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	3 (snap) 21 (dry)	Wait 14 days before grazing or feeding hay.
	0.023–0.063 lb spinetoram	3.0–8.0 oz Radiant SC	1	Do not apply more than 28 oz/a Radiant (0.219 lb ai/a) per crop and do not exceed six applications per year.
	0.047–0.094 lb spinosad	1.25–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	3 3	Use higher rates for larger larvae. Apply in adequate spray to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent.
	zeta-cypermethrin	2.72–4.0 oz *Mustang Max	1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
Loopers and green cloverworm	<i>Treat when numbers exceed 2–4 larvae per row foot.</i>			
	0.25–1.0 lb acephate	0.33–1.33 lb Orthene 75S 0.25–1.0 lb Orthene 97S	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.
	azadirachtin	10.0–21.0 oz Azatin XL Plus, 0.5–2.0 gal Neemix 0.25, 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed. May treat heavy infestations every 3–4 days.
	<i>Bacillus thuringiensis</i> subsp. <i>aizawai</i>	0.5–2.0 lb Ketch DF	0	Use lower rate for light infestations and small larvae; use higher rate for larger larvae and heavy pressure.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Dipel 2X, L, WP, Bactospeine F, WP, Biobit FC, WP	0	See label for rate.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.025–0.10 lb bifenthrin	1.6–6.4 fl oz Brigade 2EC	3	Do not apply more than 0.2 lb ai/a or 12.8 oz/a of product per season.
	0.019–0.025 lb cyfluthrin	2.4–3.2 fl oz Baythroid XL	7	Do not exceed four applications or 6.4 fl oz/a per year.
	0.025–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3 (snap) 21 (dry)	Do not exceed 0.2 lb ai/a per season. Do not feed treated vines.
	0.0075–0.0125 lb gamma cyhalothrin	1.92–3.20 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.

Insect control in bean—lima, navy, red kidney, snap (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Loopers and green cloverworms (<i>cont.</i>)	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	3 (snap) 14 (dry)	Three days to feed vines; 14 days to feed hay.
	1.0–1.5 lb naled	1.0 pt Dibrom 8E	1	A short residual contact insecticide. Do not apply more than once every 7 days.
	0.031–0.063 lb spinetoram	4.0–8.0 oz Radiant SC	1	Do not apply more than 28 oz/a Radiant (0.219 lb ai/a) per crop and do not exceed six applications per year.
	0.062–0.094 lb spinosad	1.25–2.0 fl oz Entrust 4.0–6.0 fl oz SpinTor 2SC	3 3	Use higher rates for larger larvae. Apply in adequate spray to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent.
	zeta-cypermethrin	<i>cloverworms:</i> 2.72–4.0 oz *Mustang Max <i>loopers:</i> 3.2–4.0 oz *Mustang Max	1 1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
Potato leafhopper and plant bug	<i>Treat potato leafhoppers when they exceed an average of 1 adult/sweep or 1 nymph/10 leaves. If plants are younger than the two-true-leaf stage, reduce thresholds to 1 adult/2 sweeps (nymphs will not be present yet). Treat tarnished plant bugs when they exceed an average of 1 bug/sweep.</i>			
	acephate	0.67–1.33 lb Orthene 75S, 75WSP 0.49–0.97 lb Orthene 97PE	0 (lima) 14 (dry, snap)	Do not exceed 2 lb ai/a per season. Do not feed treated vines.
	azadirachtin	10.0–21.0 oz Azatin XL Plus, 0.5–2.0 gal Neemix 0.25, 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed. May treat heavy infestations every 3–4 days.
	0.025–0.10 lb bifenthrin	1.6–6.4 fl oz *Capture 2EC, *Discipline 2EC	3	Do not apply more than 0.2 lb ai/a or 12.8 oz/a of product per season.
	1.0–2.0 lb carbaryl	4.0 lb Sevin 50WP 2.5 lb Sevin 80S 1.0 qt Sevin XLR Plus	0	See label for rate.
	0.019–0.025 lb cyfluthrin	2.4–3.2 fl oz Baythroid XL	7	Do not exceed four applications or 6.4 fl oz/a per year.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	0	Do not use at bloom. Do not feed treated vines to livestock. Also controls mites.
	1.0–2.0 lb disulfoton	*Di-Syston 8–15%	60	Place granules in a 7-inch band directly behind planter shoe in front of the press wheel at planting time only. Apply liquid in a water emulsion or with liquid fertilizer as a soil injection on each side of the seed furrow at planting. Do not apply directly on seed. Do not apply more than once per season. Do not feed vines or hay to livestock. If adequate rainfall does not occur within 10–14 days of treatment, irrigate to activate the product.
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	3 (snap) 21 (dry)	Do not exceed 0.2 lb ai/a per season. Do not graze or feed treated vines to livestock.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	7–21	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. Do not graze treated area or feed vines to livestock. The 21-day PHI applies only to dried, shelled legumes.

Restricted-use pesticide

(continued)

Insect control in bean—lima, navy, red kidney, snap (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Potato leafhopper and plant bug (<i>cont.</i>)	imidacloprid	2.0–4.0 fl oz Gaucho 480/ hundredweight of seed	—	Snap and lima beans only. Apply as a commercial seed treatment before planting. There is a 12-month rotational plantback restriction for crops not listed on the label.
		16.0–24.0 fl oz Admire Pro	21	Apply in a narrow band centered on the plant row 1–2 inches below the seed depth. Apply within 14 days before planting.
		3.5 fl oz Provado 1.6	7	Apply every 7 days as needed. Do not exceed 10.5 fl oz/a Provado per year.
	1.0–1.25 lb malathion	1.5–2.0 pt Malathion EC	1	
	0.45–0.9 lb methomyl	1.5–3.0 pt Lannate 2.4LV 0.5 lb Lannate 90SP	3	Do not graze within 3 days after application or use for hay within 7 days.
	1.0 lb naled	1.0 pt Dibrom EC	1	A short residual contact insecticide. Do not apply more than once every 7 days.
	0.06–0.09 lb/1000 ft row phorate	4.5–7.0 oz/1000 ft row *Thimet 20-G	60	Minimum 30-inch row spacing. Apply granules in a band over the row at planting but do not contact seed. Do not graze or feed treated forage to livestock.
	thiamethoxam	0.765–1.28 fl oz Cruiser 5FS/ hundredweight of seed	—	Seed treatment only. There is a 120-day plantback restriction for crops not listed on the label.
Seed corn maggot	0.017–0.25 lb zeta-cypermethrin	2.72–4.0 oz Mustang Max	1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
	<i>Plant during fly-free periods or use an insecticide at planting. First-generation adults emerge at 200 DD₃₉ while second-generation adults emerge at 600 DD₃₉. Fields with fresh green manure are more attractive for egg laying.</i>			
	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR	—	Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not apply more than 0.1 lb/a Capture LFR per season as an at-plant application.
	chlorpyrifos			Use seed pretreated with chlorpyrifos (Lorsban) and a fungicide. Seed can be purchased pretreated.
	imidacloprid	2.0–4.0 fl oz Gaucho 480/ hundredweight of seed	—	Snap and lima beans only. Preplant commercial seed treatment. There is a 12-month rotational plantback restriction for crops not listed on label.
	0.06–0.09 lb/1000 ft row phorate	4.5–7.0 oz/1000 ft row *Thimet 20-G	60	Same as for leafhoppers above.
	thiamethoxam	0.765–1.28 fl oz Cruiser 5FS/ hundredweight of seed	—	Seed treatment only. There is a 120-day plantback restriction for crops not listed on the label.
	0.017–0.25 lb zeta-cypermethrin	2.72–4.0 oz Mustang Max	1	Apply every 5 days as needed. Do not exceed 24 oz/a Mustang Max per season.
Wireworms	<i>Rotate with nonsusceptible crops to reduce wireworm populations.</i>			
	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR	—	Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not apply more than 0.1 lb/a Capture LFR per season as an at-plant application.
	3.0–4.0 lb diazinon	Diazinon G, WP, EC, D	—	Preplant broadcast incorporated, 4–8 inches.
	imidacloprid	2.0–4.0 fl oz Gaucho 480/ hundredweight of seed	—	Snap and lima beans only. Apply as a commercial seed treatment before planting. There is a 12-month rotational plantback restriction for crops not listed on the label.

*Restricted-use pesticide.

Weed control in bean — lima, navy, red kidney, snap

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Weeds	<i>Till several times before planting to control early germinating weeds. After planting, but before beans emerge, kill emerging weeds with a rotary hoe or spike-toothed harrow. Cultivate beans at least twice before plants cover the middle of the row. Do not cultivate when plants are wet because this may spread disease. Several of the following herbicides can be tank-mixed with each other or with liquid fertilizer for simultaneous application. Check specific herbicide labels for mixing directions and application details.</i>			
Annual weeds	2.0–3.0 lb alachlor	4.0–6.0 pt *Micro-Tech, *Intro, or registered equivalent		Lima and red kidney beans only. Preplant-incorporated alachlor controls most annual grasses and many broadleaf weeds, including black nightshade but is weak on velvetleaf, mustards, smartweed, and common lambsquarter. Preplant treatment also provides reasonable yellow nutsedge control. Apply preplant treatment within 7 days before planting and shallowly incorporate. Do not make more than one application per cropping season. Can lower yields if wet, cold conditions prevail. Can be used on peat and muck soils.
	0.15–0.25 lb clomazone	0.4–0.67 pt Command 3ME	45	Succulent beans only. For suppression and control of annual grasses and broadleaves, make a single pre-emergent soil application before seeding or after seeding but before crop emergence. Place seed or roots of transplants below the chemical barrier when planting. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read and understand the Vegetable Disclaimer section of the label; the end user of this product assumes all liability for failure to perform and any crop injury resulting from its use.
	dimethenamid-P	10.0–21.0 fl oz Outlook 6.0	70	Dry beans only. Outlook controls most annual grasses and pigweed and suppresses nightshade. It is weak on velvetleaf, lambsquarters, ragweed, and smartweed. Can cause stunting if wet, cold conditions occur during bean germination or emergence. Preplant-incorporated: Apply to dry soil within 14 days before planting and blend into the top 1–2 inches of soil. Provides reasonable yellow nutsedge control at the highest rate recommended by soil type. Preemergence: Apply before or after planting but before weed emergence. Provides only limited control of yellow nutsedge. Postemergence: Although Outlook will not control emerged grasses, it can be applied to beans with 1–3 trifoliolate leaves. Postemergence applications can speckle bean leaves.
	3.0–4.0 lb EPTC	3.5–4.5 pt Eptam 7E 15.0–20.0 lb Eptam 20G		Navy, red kidney, and snap beans only. Preplant-incorporated treatment controls most annual grasses and broadleaf weeds. Weak on smartweed and black nightshade. Incorporate 2–3 inches deep immediately after application. Can stunt beans if cool weather follows application. Do not exceed 3.5 pt/a Eptam 7E or 15 lb/a Eptam 20G when treating snap beans on sandy soils or on small white navy bean varieties. Ineffective on peat and muck soils.

*Restricted-use pesticide.

(continued)

Weed control in bean—lima, navy, red kidney, snap (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds (<i>cont.</i>)	0.56–1.68 lb ethalfluralin	1.5–4.5 pt Sonalan HFP (dry beans) 1.5–2.0 pt (dry peas)		Dry beans and dry peas only. Preplant-incorporated treatment controls annual grasses and broadleaf weeds but is weak on wild mustard, smartweed, common ragweed, and velvetleaf. Some black nightshade suppression. Incorporate 2–3 inches deep within 2 days of application and before planting beans. May carry over in soil. Ineffective on peat or muck soils.
	0.03 lb imazamox	4.0 oz Raptor		Dry beans and dry peas: Apply to dry beans with at least one fully expanded trifoliate leaf and to dry peas with at least three pairs of leaves and before the bloom stage. Application may reduce crop growth, quality, and yield; cause temporary yellowing; and delay maturity. Raptor applications may be made with or without the addition of a fertilizer. A nitrogen-based fertilizer may improve weed control, but it will also increase the likelihood of crop damage. When nitrogen and/or crop oils are added to the mixture, include 6–16 oz/a Basagran to minimize injury. For application to dry peas, always include Basagran in the Raptor spray mixture, regardless of additives. Only one application of Raptor may be made per crop season. Read the label for more specific directions, precautions, and restrictions. Lima (succulent) and snap beans: Apply to lima or snap beans between first- and second-trifoliate leaf stages when weeds are less than 3 inches tall. Treatments made before the first-trifoliate leaf stage may cause temporary yellowing, stunt growth, and hurt crop quality and yield. Do not apply to beans during flowering. Raptor must be applied as a tank mixture with Basagran to minimize crop response. Using more than 16 oz/a of Basagran may reduce grass control. A nonionic surfactant containing at least 80% active ingredient must be added at a rate of 1 qt/100 gal spray solution. Do not tank-mix Raptor with any pesticides other than Basagran. Do not apply Raptor more than once per year.
	<i>lima and dry beans:</i> 0.0475 lb imazethapyr	3 fl oz Pursuit 1.08 oz Pursuit DG	30 (lima) 60 (dry beans)	Certain dry beans, lima, and snap beans only. May reduce crop growth, quality, yield and/or delay maturity. Since maturity may be delayed, timing of harvest may need to be adjusted. Pursuit may be used in combination with a registered grass herbicide.
	<i>snap beans:</i> 0.0238 lb imazethapyr	1.5 fl oz Pursuit 0.54 oz Pursuit DG	30 (snap)	Do not apply Pursuit in the following situations: —if cold and/or wet conditions are present or predicted to occur within 1 week of application; —by air or irrigation; —after July 31 for snap beans; or —postemergence to lima and snap beans. See label for specific instructions for postemergence application information for certain dry beans. Sensitive crops may be injured by this product; spray equipment should be thoroughly cleaned with water before being used to apply other products. Follow rotational crop guidelines printed on the label or injury may result to subsequent crops.

*Restricted-use pesticide.

(continued)

Weed control in bean—lima, navy, red kidney, snap (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds (<i>cont.</i>)	imazethapyr + pendimethalin	30.0 oz Pursuit Plus EC	30 (lima) 60 (dry beans)	Lima and certain dry beans only. Apply as a preplant-incorporated treatment within 1 week before planting. May be tank-mixed with other registered herbicides. Do not apply more than once per year and do not use after June 30. Follow label for rotational crop guidelines.
	0.5–1.5 lb pendimethalin	1.2–3.6 pt Prowl 3.3EC or Pendimax 2.0–3.0 pt Prowl H ₂ O		Controls most annual grasses and certain broadleaf weeds. Rate varies depending on soil texture and organic matter. Make one preplant incorporated application. Incorporate 1-inch deep using equipment capable of giving uniform incorporation. Incorporating in two passes gives better results.
	s-metolachlor	1.0–2.0 pt Dual II Magnum or Dual Magnum		Apply as a preplant treatment within 14 days of planting and shallowly incorporate or apply as a preemergence treatment. Controls most annual grasses and annual broadleaf weeds. Weak on velvetleaf, wild mustard, smartweed, and common lambsquarters. Preplant treatment gives reasonable yellow nutsedge control. Can delay maturity and reduce yields if wet, cold conditions occur after planting. Ineffective on peat or muck soils. Choose product rate for specific soil texture, organic matter classification and weed species expected.
	0.5–0.75 lb trifluralin	1.0–1.5 pt Treflan HFP or registered equivalent		Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies depending on soil texture and organic matter. Incorporate 2–3 inches deep within 24 hours of application. See label for plantback restrictions. Ineffective on peat or muck soils.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea (rate varies by crop use and application timing—see label)	30 (snap and lima)	<p>Preemergence timing (dry beans, snap beans, lima beans): Apply after planting but prior to soil cracking. Use the lower rate on lighter texture soils with low organic matter. Apply uniformly with ground equipment in a minimum of 15 gal/a water.</p> <p>Postemergence timing (snap and lima beans only): Apply after the crop has reached the two- to four-trifoliate leaf stage, but before flowering.</p> <p>Use the lower rate on lighter texture soils with low organic matter. Directed sprays will limit crop injury. May be applied between rows. Avoid herbicide contact with the planted crop. See restrictions on the label if plastic is used on the planted row. Do not apply more than 1 oz/a Sandea per crop cycle, and 2 oz/a Sandea per 12-month period. Use of soil or foliar-applied organophosphate insecticides on Sandea-treated crops may increase potential for and severity of crop injury. Consult label for important usage information and precautions.</p>

*Restricted-use pesticide.

(continued)

Weed control in bean—lima, navy, red kidney, snap (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged weeds	glyphosate	several manufacturers and formulations available		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations available		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding should be performed with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.25 lb clethodim	6.0–16.0 oz Select 2EC	30	See label for specific bean types. Apply to actively growing grasses. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by the label. Do not apply if rain is expected within 1 hour. See label for tank-mix instructions.
	clethodim	Select Max (see label for rate—varies by bean type)	30 (dry beans) 21 (succulent)	
	0.094–0.47 lb sethoxydim	0.5–2.5 pt Poast	15 (snap) 30 (dry beans)	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rates and for information on quackgrass control. Do not exceed 4 pt/a Poast per crop season. Always add 2 pt/a of oil concentrate. Do not cultivate 5 days prior to or within 7 days following application.
	0.034–0.08 lb quizalofop	5.0–12.0 oz Assure II or Targa	15 (snap) 30 (dry beans)	
Emerged annual broadleaves	0.75–1.0 lb bentazon	1.5–2.0 pt Basagran	30	Suggested as a postemergence spray when annual broadleaf weeds escape an earlier treatment. Controls velvetleaf, mustard, and purslane. Partial control of black nightshade, common lambsquarter, and redroot pigweed when applied in the very small seedling stage. Does not control grasses. Snap beans are more sensitive to foliar burn than dry beans. Include 1 qt/a of crop oil concentrate in the spray mixture. Some oil concentrates cause excessive leaf burn, particularly during warm, humid weather. Apply when beans have at least the first trifoliate leaves expanded and annual broadleaf weeds are small and actively growing. Do not cultivate within 7 days before or after Basagran application. Must thoroughly cover weeds. Use minimum of 20 gal/a of water and 40 psi pressure. Apply through flat fan or hollow cone nozzles not more than 20 inches apart. Do not apply more than 4 pt per season. Do not apply to beans under stress or if rainfall is expected within 4 hours of treatment. Do not tank-mix with fertilizers or other pesticides.

*Restricted-use pesticide.

(continued)

Weed control in bean—lima, navy, red kidney, snap (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged annual broadleaves (<i>cont.</i>)	fomesafen	Reflex (rate varies by location; check label)	30 (snap beans)	Reflex is rate restricted by location and prohibited from use in some areas of Wisconsin. Check label to determine if it can be used in your area. Apply postemergence broadcast to control broadleaves, including eastern black nightshade, pigweeds, common ragweed, and common purslane. See label for application timing based on crop and weed growth stage.
			45 (dry beans)	
Preharvest and spot treatment of emerged weeds	glyphosate	several manufacturers and formulations available	varies by bean type	Certain dry beans only—see label. May be applied as an over-the-top broadcast spray to control labeled weeds before harvest. The crop should be in the hard dough stage (<30% moisture). Only one application can be made per year. Do not combine spot treatment with a preharvest spray. Do not use if the crop is for seed or will be fed to livestock. Allow 30 days between treatment and replanting with any crop not listed on the herbicide label. Some formulations may also be used as a spot treatment for troublesome weeds such as Canada thistle or quackgrass. Any crop receiving spray in the treated area will be killed.
Dry bean and dry pea harvest aid	*paraquat	several manufacturers and formulations available	7	Treat when at least 80% of the pods are yellowing and mostly ripe, and no more than 40% (bush peas and beans) or 30% (vine peas and beans) of the leaves should be green. For vining beans or bush beans with lush growth, use a single application at the higher rate. Gramoxone Inteon may be applied as a split application, but do not make more than two or exceed a total of 2.0 pt/a. Add nonionic surfactant at 1 qt/100 gallons spray mix. See label for precautions. Not all paraquat formulations are registered for this use.
	0.015–0.03 lb carfentrazone	1.0–2.0 oz Aim EW or EC	0	Applications should be made when the crop is mature and the grain has begun to dry down. Use sufficient spray volume to provide complete foliage coverage. See label for adjuvant recommendations and maximum allowable use rates.

*Restricted-use pesticide

Beet

Planting

Plant in well-drained soil, high in organic matter. Use minimum tillage to maintain good soil structure. Crusting seriously reduces seedling emergence. Rotating crops will help prevent damping-off.

Rows—12–30 inches; 15–20 plants/ft of row.

Seed—10–15 lb/a.

Beets can be planted in paired rows 14 inches apart with 1.5 inches between paired rows. Use size-graded seed of monogerm varieties or multigerm varieties spaced 1 inch apart in each paired row. Smaller seed sizes of multigerm varieties are recommended, since a relatively higher percentage of the “seedballs” will contain a single germ as compared to the larger seed sizes. Use 16–20 lb/a of seed. Plant seed no deeper than 1/2–3/4 inch in moist soil.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.0 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations before planting. Annual nitrogen, P_2O_5 , and K_2O recommendations are shown in the table below. Take credits for previous legume crops and manure.

Application: Broadcast fertilizer or apply in a band 2 inches to the side of the row and 2 inches below seed depth.

Nitrogen: Apply before planting or sidedress early in the growing season. On sandy soils, split the nitrogen into two or three applications over the growing season.

Boron: Apply 2–3 lb/a of boron with broadcast fertilizer before planting if boron soil test is very low (VL) or low (L). Omit application if boron soil test is in the excessively high (EH) range. During extended periods of dry weather, make foliar applications of boron (see black spot under Disease Control).

Annual nitrogen, phosphate, and potash recommendations for beets

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P_2O_5	K_2O
— % —	— lb/a —	— t/a —	— — — lb/a — — —	— — —
<2	120	5–10	10	30
2.0–9.9	100	10.1–15	15	50
10–20	80	15.1–20	25	70
>20	30			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in beet

Disease	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphanomyces root rot	<i>Poor soil structure and compaction contribute to this problem. Well-drained soil in good tilth and rotation aid in control. Grass sod, cover crops, and plant residue (especially corn stubble) improve soil structure.</i>			
Black spot (boron deficiency)	<i>More of a problem on calcareous soils having a high pH and when periods of dry weather occur during the growing season.</i>			
	18–20 lb borax	8.0–12.0 lb Solubor		Apply at planting. Also make two applications 2–4 weeks apart beginning before midseason (spray with 10–20 lb borax or 6–11 lb Solubor/100 gal water per acre).

(continued)

Disease control in beet (*cont.*)

Disease	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cercospora leaf spot	azoxystrobin	6.2–15.4 fl oz Quadris Flowable	0	Amistar, Quadris, Cabrio, and Flint belong to the strobilurin group of fungicides. Do not exceed one application from this group before alternating with a fungicide that has a different mode of action. Do not exceed four applications of strobilurin fungicide per crop per year. Do not exceed 2.5 lb/a Amistar, 46.2 fl oz/a of Quadris, 48 oz/a of Cabrio EG, or 12 oz/a Flint per crop per season.
		2.0–6.5 oz Amistar 80 WDG	0	
	pyraclostrobin	8.0–12.0 oz Cabrio EG	0	
	trifloxystrobin	2.0–3.0 oz Flint	7	
	copper hydroxide copper sulfate	2.0–5.0 lb Kocide 101 77WP, DF 1.5–3.75 Kocide 2000 DF 1.3–3.3 pt Kocide 4.5 LF 2.0–3.0 lb Tri-Basic Copper Sulfate	0 0 0 0	Spray weekly at first sign of infection. Follow a 3-year rotation between beet crops.
Pythium damping-off	mefenoxam	1.0–2.0 pt Ridomil Gold EC 1.0–2.0 lb Ridomil Gold WSP		Preplant incorporated application or surface application at planting.
	metalaxyl	1.0 oz Apron 50W/ 100 lb seed 0.32–0.64 fl oz Apron XL LS/ 100 lb seed		Follow manufacturer's directions. Do not use treated seed for feed or food.
Rhizoctonia dry rot and seed rot	<i>Control black spot. Remove the crop promptly from the field; chop and work old plant refuse into the soil.</i>			
	thiram seed protectant captan seed protectant			Follow manufacturer's directions. Do not use treated seed for feed or food.
	azoxystrobin	0.4–0.8 fl oz Quadris Flowable/1000 row ft 0.125–0.25 oz Amistar 80 WDG/1000 row ft	0 0	Use at planting. Follow manufacturer's directions.

Insect control in beet

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	azadirachtin	10.0–21.0 oz Azatin XL Plus 0.5–2.0 gal Neemix 0.25EC 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed.
	0.012–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	7	
	imidacloprid	0.31–0.74 fl oz Admire Pro/ 1000 ft of row	21	Admire may only be applied once per season.
		4.4–10.5 fl oz Admire Pro	21	Apply Provado every 5 days as needed. Do not exceed 3 applications per season.
		3.5 fl oz Provado	7	Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
	thiamethoxam	1.5–3.0 fl oz Actara	7	Apply before pests reach damaging levels. Use higher rate for heavy infestations. Do not exceed 8 oz/a per season.
		5.0–12.0 fl oz Platinum	0–30	Apply as an in-furrow spray or as a surface band at seeding. For surface-banded applications, irrigate within 24 hours to seeding depth using trickle or drip watering.
Cutworms	azadirachtin	10.0–21.0 oz Azatin XL Plus 0.5–2.0 gal Neemix 0.25EC 0.25–1 pt Neemix 4.5EC	0	Apply every 7 days as needed.

(continued)

Insect control in beet (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cutworms (<i>cont.</i>)	1–2 lb carbaryl	Sevin Bait, WP, SP	3	Fourteen days to harvest if tops used for food or feed. Can only be used with mechanical harvest.
	2–4 lb diazinon	several formulations	14	Preplant broadcast application. Work into top 2–6 inches of soil before planting.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	0	If tops are used for food or feed, 14 days.
	0.05 lb zeta-cypermethrin	4.3 oz *Mustang	50	Apply at planting to the soil surface in a 5- to 7-inch band or broadcast in a minimum of 3–5 gal/a. Do not exceed 0.15 lb ai/a per season.
Flea beetles	<i>Treat when flea beetles are so numerous on small plants that feeding is causing stand reduction.</i>			
	1 lb carbaryl	Sevin (several)	3	If tops used for food or feed, 14 days. Can only be used with mechanical harvest.
	0.018–0.028 lb deltamethrin	*Delta Gold	3	Apply every 3 days as needed.
	imidacloprid	0.7–1.7 fl oz Admire 2/1000 ft of row	21	Admire may only be applied once per season.
		10.0–24.0 fl oz Admire 2	21	Apply Provado every 5 days as needed. Do not exceed 3 applications per season.
		3.5 fl oz Provado	7	Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
	thiamethoxam	1.4–3.0 fl oz Actara	7	Apply before pests reach damaging levels. Use higher rate for heavy infestations. Do not exceed 8 oz/a per season.
	0.028–0.05 lb zeta-cypermethrin	2.4–4.3 oz *Mustang Max	50	Do not exceed 0.15 lb ai/a per season.
Leafminers	<i>Plants past the eight-leaf stage can compensate for damage caused by average leafminer populations.</i>			
	0.25–0.5 lb diazinon	several formulations	14	Will not control organophosphate-resistant leafminers.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	7	
	0.075–0.15 lb spinosad	1.5–3.0 fl oz Entrust	3	Apply to small larvae or at egg hatch. Do not exceed 3 applications in 21 days. Do not exceed 6.5 oz/a Entrust or 21 oz/a SpinTor per season.
		4.5–6.0 fl oz SpinTor	3	
	thiamethoxam	5.0–8.0 fl oz Platinum	0–30	Apply as an in-furrow spray or as a surface band at seeding. For surface-banded applications, irrigate within 24 hours to seeding depth using trickle or drip watering.
	0.028–0.05 lb zeta-cypermethrin	2.4–4.3 oz *Mustang Max	50	Do not exceed 0.15 lb ai/a per season.

Weed control in beet

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual grasses and some broadleaf weeds	3.0–4.0 lb cycloate	0.5–0.66 gal Ro-Neet 6E		Apply before planting and incorporate immediately, preferably by double disking. (Use on mineral soils only.) For broader spectrum of weed control, cycloate can be tank-mixed with Pyramin.
	1.88 lb ethofumesate	60 fl oz Nortron SC		Apply alone or in a tank-mix preemergence at time of planting or shortly after, but before weed germination. Where table beets are grown in beds, apply after bedding and incorporate. Do not exceed a total of 96 fl oz/a Nortron SC in a single growing season.

(continued)

Weed control in beet (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual broadleaves	3.10–3.65 lb pyrazon	5.5–6.5 pt Pyramin SC or 4.6–5.4 lb Pyramin DF		Make preemergence applications after beet seeds are planted but before beets or weeds emerge. Pyramin is also registered for early postemergence treatment on beets. Apply after beets have two leaves and before weeds have more than two to four leaves. This is usually within 2 weeks of planting. Do not incorporate. Irrigate if there is no rain within 5–10 days of application or use shallow cultivation before weeds are 2 inches tall. (Do not use on sands, loamy sands, or soils with more than 5% organic matter.)
	0.5–1.0 lb phenmedipham	3.0–6.0 pt Spin-Aid in 11–22 gal water	60	Make postemergence applications when beets are past the four- to six-leaf stage and weeds are in the two-true-leaf stage. Controls small annual broadleaves but not redroot pigweed. Do not apply if beets are under stress. Do not spray if dew is present. Rainfall within 6 hours may reduce effectiveness.
Emerged weeds	glyphosate	several manufacturers and formulations available		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	30	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	30	
	0.164–0.328 lb ethofumesate	5.25–10.5 fl oz Nortron SC		Apply postemergence for enhanced weed control. Use lower rates for beets with two to four leaves; apply at 10.5 fl oz/a rate for beets with six to eight leaves.
	0.094–0.47 lb sethoxydim	0.5–2.5 pt Poast	60	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rate and for information on quackgrass control. Do not exceed 2.5 pt per application or 5 pt/a per season. Always add 2 pt/a of crop oil concentrate. Do not cultivate within 5 days before or 7 days after treatment.
Emerged broadleaves	0.187 lb clopyralid	0.5 pt Stinger	30	Effective on common ragweed and black, eastern black, cutleaf, hairy nightshade. Make only 1 broadcast application per year. May be tank-mixed with other labeled beet herbicides.
	0.164–0.328 lb ethofumesate	5.25–10.5 fl oz Nortron SC		Apply postemergence for enhanced weed control. Use lower rates for beets with two to four leaves; apply at 10.5 fl oz/a rate for beets with six to eight leaves.

Carrot

Planting

Mid-April to early June. Treat seed with thiram 75% WP to prevent damping-off. Choose deep, fertile soils and provide adequate drainage. Soils should not be subject to compaction or high water tables during growing season. Excess moisture can cause forked roots, reducing quality. If plow pans are a concern, deep rip below the seed row before planting.

Carrots are susceptible to wind damage when first emerging from the soil. You can protect young seedlings by spreading oat seed over the soil just after planting. When carrots are several inches tall, use a selective postemergence grass herbicide to kill the oats.

Rows—15–30 inches; use 2–4 lb seed/a (1–2 lb seed/a for ‘Chantenay’).

Carrots can be grown on raised beds. Beds should be 3–4 feet wide with 3–4 rows per bed.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 5.6 or higher in organic soils and at least 5.8 in other soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations listed in the table below. Take credits for previous legume crops and manure.

Application: Broadcast and work in before seeding. Where possible, avoid fall potash applications on organic soils.

Nitrogen: Apply preplant or sidedress. Split nitrogen into two or more applications on sandy soils.

Micronutrients: Carrots need moderate amounts of manganese, boron, and copper. Use soil and plant analyses to check for deficiencies of these nutrients. Foliar or banded micronutrient applications will likely be most effective on organic soils. Apply 1–3 lb Mn/a and 1–12 lb Cu/a, depending on soil and method of application.

Annual nitrogen, phosphate, and potash recommendations for carrot

Nitrogen		Phosphate and potash	
		Yield goal	Amount to apply ^a
Organic matter	Amount to apply		P_2O_5 K_2O
— % —	— lb/a —	— t/a —	— — — lb/a — — —
<2	120	20–30	45 240
2.0–9.9	100		
10–20	80		
>20	40		

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Irrigation

Early irrigation helps establish stands in hot, dry weather and is particularly important in the seedling stage. Carrots should not be under moisture stress at any time. Be sure to moisten soil to rooting depth when irrigating.

Resistance/susceptibility of some carrot cultivars to aster yellows and their action thresholds (aster yellows index)

Resistant cultivars (aster yellows index of 100)

Amtou	Gold King	Nanton	Raoleta	Scarlet Nantes ST	Tahoe*
Bercaro*	Growers Choice	Nimrod	Revo*	Sierra*	Texsun*
Charger	GT 26 Dicer	PrimeCut 59	Rona*	Sirocco	Toudo
El Presidente	Hi Color 9	Prospector	Royal Chantenay	Six Pak	Triple Play
Enterprise	Impak	PY 60**	Scarlet Nantes	Spearhead	

Intermediate cultivars (aster yellows index of 75)

Baby 657*	Cupar	Hipak*	Lucky B	Nuggeteer*	Spartan Winner*
Bolero	Cutlass*	Interceptor	Midas Touch	Pakmor	SugarSnax 54
Bradford	Flavor Pak*	Javelin*	Morecuts	Pioneer*	Thor*
Bremen	Florida	Karotan*	Nagadir	Prodigy	Triple Gold
Canada	Goldpak 28, G	King Midas*	Nanco	Prospector	Trophy 301
Casey	Harvestmore*	Lance*	Nikki	Sabre 78*	
Columbia	Heritage	Long Imperator 58	Noveno	Spartan Fancy	

Susceptible cultivars (aster yellows index of 50)

Aristopak*	Carson	Fancipak*	Nandor*	Scarla*	Tamino*
Arrowhead	Clairon Corona	Fina*	Nantes	Spartan Bonus	Tip Top*
Belikumar*	Dandy	Flacaro*	Nantes ST	Spartan Bonus 80	Touche
Bersky	Danver's Gold*	Flakkese	Nantes Superior	Spartan Delite*	Woodland*
Bonanza	Danvers 126	Giganta	Orlando Gold	Super Sprite	
Candy Pak	Dessert Danvers*	Goldpak	Red Cored Chantenay	Sweet N Crisp*	
Caromba	Early Gold	Lucky's Gold	Regina*	Sytan	

*Cultivars evaluated for 1 year only.

**In thick stands only.

Disease control in carrot

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria leaf blight and Cercospora leaf blight	azoxystrobin	3.0–5.0 oz Amistar 80 WDG	0	Amistar, Quadris, Quadris Opti, Cabrio, and Flint belong to the Group 11 (strobilurin) fungicide category. Do not exceed one application of these products before alternating with a fungicide having a different mode of action. Do not exceed three applications of Group 11 fungicides per crop per year. Do not exceed 1.88 lb/a Amistar 80 WDG, 36.9 fl oz/a Quadris Flowable, 3 gal/a Quadris Opti, 48 oz/a Cabrio, or 12 oz/a Flint per crop per season.
		6.2–12.3 fl oz Quadris Flowable	0	
	azoxystrobin + chlorothalonil	2.4 pt Quadris Opti	0	
	pyraclostrobin	8.0–12.0 oz Cabrio EG	0	
	trifloxystrobin	2.0–3.0 oz Flint	7	For control of Alternaria leaf blight only. Endura belongs to the Group 7 (anilide) fungicide category. Do not exceed two sequential applications of Endura before alternating to a labeled fungicide with a different mode of action. Do not exceed five applications per season. Do not exceed 22.5 oz/a Endura per season.
	boscalid	4.5 oz Endura WDG	0	
	boscalid + pyraclostrobin	8.0–10.5 oz Pristine WDG	0	
	chlorothalonil	1.5–2.0 pt Bravo Weather Stik, Echo 720, Equus 720	0	
		1.4–1.8 lb Bravo Ultrex	0	Apply at first sign of infection. Do not use tops for food or feed. Do not exceed 15 lb ai/a chlorothalonil per season.
		82.5WDG, Equus DF	0	
		1.3–1.5 lb Echo 90DF	0	
		2.25–2.75 pt Bravo Zn, Echo Zn, Equus 500 Zn	0	

(continued)

Disease control in carrot (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria leaf blight and Cercospora leaf blight <i>(cont.)</i>	copper hydroxide	1.3 pt Champ Formula 2 4.6F	0	For control of Alternaria leaf blight only. Note label for rotational crop restrictions.
		2 lb Kocide 101 77WP, DF	0	
		2.6 pt Kocide LF 2.4F	0	
		1.3 pt Kocide 4.5 LF	0	
		1.5 lb Kocide 2000 DF	0	
	iprodione	1–2 lb Rovral 50WP	0	
1–2 pt Rovral 4F		0		
Aster yellows^a	<i>Use an insecticide recommended for aster leafhopper. Treat from the seedling stage to 30 days before harvest.</i>			
Bacterial blight	<i>The best control is prevention. Use hot water treatment of seed at 122°F for 15 minutes.</i>			
Damping-off, Pythium root die-back, and seed rot	mefenoxam	1–2 pt Ridomil Gold EC 1–2 lb Ridomil Gold WSP		Preplant incorporated or at-planting surface applications. Rotate with less-susceptible crops. Use raised beds and precision seeding.
	metalaxyl	0.5–1.0 oz Apron 50W/100 lb seed 0.32–0.64 fl oz Apron XL LS/100 lb seed		Follow manufacturer’s directions. Do not use treated seed for feed or food.
Rhizoctonia seedling infection and crown rot	azoxystrobin	0.4–0.8 fl oz Quadris Flowable/1000 row ft	0	Follow manufacturer’s directions.
		0.125–0.25 oz Amistar 80 WDG/1000 row ft	0	
Root-knot nematodes	metam-sodium	Vapam HL, Metam, Sectagon 42		Growing corn or sod for at least 3 years and then growing carrots for 1 year helps starve out root-knot larvae. Soil fumigation is effective but expensive on muck soils. Apply soil fumigants in the fall when soil temperatures are at least 50°F.

^aSee treatment index for aster leafhopper.

Insect control in carrot

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	<i>Treat when 25% of plants are infested.</i>			
	azadirachtin	10.0–21.0 oz Azatin XL Plus 0.5–2.0 gal Neemix 0.25EC 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.5 lb diazinon	1 pt Diazinon AG500 1 lb Diazinon 50WP	14	Do not exceed five applications per season. Allow at least 7 days between applications.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan 3EC, 1.0–2.0 lb Thiodan 50WP	7	Only one application per season.
	imidacloprid	0.31–0.74 fl oz Admire Pro/ 1000 ft of row	21	Admire may only be applied once per season. Apply Provado every 5 days as needed. Do not exceed 3 applications per season. Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
		4.4–10.5 fl oz Admire Pro	21	
		3.5 fl oz Provado	7	
	0.94–1.25 lb malathion	Malathion EC, WP, D	7	See label for rate.
	thiamethoxam	1.5–3.0 fl oz Actara	7	Apply before pests reach damaging levels. Use higher rate for heavy infestations. Do not exceed 8 oz/a per season.

(continued)

Insect control in carrot (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids (<i>cont.</i>)	thiamethoxam (<i>cont.</i>)	5.0–12.0 fl oz Platinum	0–30	Apply as an in-furrow spray or as a surface band at seeding. For surface-banded applications, irrigate within 24 hours to seeding depth using trickle or drip irrigation.
	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Aster leafhopper ^a	1.5 lb carbaryl	Sevin WP, D	7	See label for rate. Apply at 5- to 7-day intervals. Can only be used with mechanical harvest.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 7 days; do not exceed five applications.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan 3EC, 1.0–2.0 lb Thiodan 50WP	7	Only one application per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Do not exceed 0.5 lb ai/a per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	1	Apply at 5- to 7-day intervals. Do not exceed 6.3 lb/a of product per season.
	thiamethoxam	1.5–3.0 fl oz Actara	7	Apply before pests reach damaging levels. Use higher rate for heavy infestations. Do not exceed 8 oz/a per season.
		5.0–12.0 fl oz Platinum	0–30	Apply as an in-furrow spray or as a surface band at seeding. For surface-banded applications, irrigate within 24 hours to seeding depth using trickle or drip irrigation.
	0.011–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Black cutworms	<i>Spot treat when numbers exceed 2 larvae per row foot.</i>			
	azadirachtin	10.0–21.0 oz Azatin XL Plus 0.5–2.0 gal Neemix 0.25EC 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed.
	1.0–2.0 lb carbaryl	Sevin Bait	7	Broadcast bait formulation. See label for rate. Can only be used with mechanical harvest.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 7 days; do not exceed five applications.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Do not exceed 0.5 lb ai/a per season.
	0.008–0.025 lb zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Carrot weevil	<i>Carrot weevil populations are easily managed by spraying every 3–5 days for 2 weeks once eggs are found.</i>			
	0.044 lb cyfluthrin	2.8 fl oz *Baythroid XL	0	Apply every 7 days; do not exceed five applications.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Direct spray at crown. Apply higher rate when weevils are active.
	0.5–1.0 lb oxamyl	2.0–4.0 pt *Vydate L	14	Apply as directed spray. Do not apply more than 4 gal/a per season.

*Restricted-use pesticide.

^aFor treatment thresholds, see “Aster Yellows Index” (in the pest management section at the beginning of the publication).

Weed control in carrot

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual broadleaves and some grasses	0.75–1.5 lb linuron	1.5–3.0 lb Lorox DF	14	Treat after carrots are at least 3 inches tall but before broadleaf weeds are 6 inches tall and before grassy weeds exceed 2 inches. Do not incorporate. Do not apply when temperatures exceed 85°F. Do not tank-mix with other pesticides. Additional applications may be made, but do not exceed 4 lb/a Lorox DF annually.
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or registered equivalent		Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies depending on soil texture and organic matter. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat or muck soils.
Annual grasses and some broadleaves	0.95 lb pendimethalin	2.0 pt Prowl H ₂ O	60	Apply preemergence as a broadcast treatment within 2 days after planting or at layby as a directed spray to the soil between rows. Emerged weeds will not be controlled. Do not allow the spray to contact carrot plants or injury may occur.
Marestail or pineappleweed	0.5–1.5 lb linuron	1.0–3.0 lb Lorox DF		A single preemergence treatment is registered for Wisconsin and Michigan. Apply after planting but before carrots emerge. Plant seed at least 1/2 inch deep. Excessive rainfall or irrigation may cause carrot injury.
Emerged weeds	glyphosate	several manufacturers and formulations available		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations available		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Minimize soil disturbance during seeding. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	30	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	30	
	0.13–0.19 lb fluazifop-P-butyl	0.5–0.75 pt Fusilade DX	45	Make postemergence applications when actively growing grasses are in the size ranges specified on the label. Always add one of the following to the finished spray volume: 1% crop oil concentrate or 0.25% nonionic surfactant. Multiple applications may be made to control late germinating grasses but do not exceed 3 pt Fusilade DX/a in one crop season.
	0.094–0.47 lb sethoxydim	0.5–2.5 pt Poast	30	Apply postemergence to actively growing grasses. Always add 1 qt/a of crop oil concentrate to the spray mix. Multiple applications may be made allowing 14 days between applications, but do not apply more than 5 pt/a of Poast per season. Do not apply if rain is expected within 1 hour.

(continued)

Weed control in carrot (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged annual broadleaves	0.25 lb metribuzin	0.5 pt Sencor 4 0.33 lb Sencor DF	60	Postemergence applications may be made after carrots have formed five to six true leaves but before weeds are 1 inch in height or diameter. If needed, a second application may be made after an interval of at least 3 weeks but do not exceed 0.5 lb ai/a in one crop season. Check rotational restrictions prior to use. Excessive crop injury may occur if applications are made on very hot days, to drought-stressed carrots, or within 3 days after periods of cool, wet or cloudy weather. Do not apply Sencor within 3 days of any other chemical or within 14 days of any other pesticides when carrots are under stress. For carrots with unknown tolerance to Sencor, treat a small area initially.

*Restricted-use pesticide.

Celery

Planting Plant treated seed in late April or transplants in mid-May. Avoid early planting that would expose young plants to temperatures below 55°F for a week or more. This can cause “bolting” (seed stalk development). Choose deep, fertile soils and provide adequate drainage. Celery needs abundant available moisture during the growing season. Rotate celery with other vegetable crops but not with carrots.

Direct seedings **Rows**—18–40 inches;
seeds in row—2 inches apart, later thinned to 6–8 inches apart. Use 6–8 oz seed/a (1 oz seed produces 10,000 plants).

Transplants **Rows**—18–40 inches;
plants in row—6–8 inches. Set 30,000–45,000 plants/a.

Lime and fertilizer **Lime:** Use dolomitic limestone to maintain a pH of 5.6 or higher in organic soils and at least 6.0 in other soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in table below. Take credits for previous legume crops and manure.

Application: Broadcast and work in lime and fertilizer requirements before planting.

Nitrogen: Apply preplant or sidedress. At higher rates, split recommendations into two or more applications during the season.

Micronutrients: Celery has a high boron requirement and medium requirements for manganese and copper. Use soil and plant analyses to check for deficiencies of these nutrients. Apply 2–3 lb/a of boron with fertilizer each year if boron soil test is very low (VL) or low (L). Omit application if boron test is in the excessively high (EH) range. Apply 1–5 lb Mn/a or 1–12 lb Cu/a, depending on fertilizer source, soil, and method of application.

Annual nitrogen, phosphate, and potash recommendations for celery

Nitrogen		Phosphate and potash	
		Yield goal	Amount to apply ^a
Organic matter	Amount to apply		P_2O_5 K_2O
— % —	— lb/a —	— t/a —	— — — — lb/a — — — —
<2	140	25–35	100 300
2.0–9.9	120		
10–20	100		
>20	50		

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in celery

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aster yellows	<i>Control aster leafhopper. See “Aster Yellows Index” in Pest Management section at beginning of book.</i>			
Basal stalk rot <i>(Rhizoctonia)</i>	azoxystrobin + chlorothalonil	2.4–3.7 pt Quadris Opti	7	Quadris Opti contains Group 11 (strobilurin) and M5 fungicides. Do not apply more than 2 sequential foliar applications of these materials before alternating with a fungicide with a different mode of action. Do not exceed 4 foliar applications and 3.0 gal/a Quadris Opti per season.
	chlorothalonil	1.0–1.5 pt Bravo Weather	7	Spray before infection occurs. Rotate celery with non-susceptible crops.
	(3- to 5-day spray schedule)	Stik, Echo 720, Equus 720	7	
		0.9–1.4 lb Bravo Ultrex 82.5WDG, Equus DF 0.8–1.2 lb Echo 90DF	7	Do not exceed 18 lb ai/a chlorothalonil per season.

(continued)

Disease control in celery (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Basal stalk rot (<i>Rhizoctonia</i>) (<i>cont.</i>)	chlorothalonil (7-day spray schedule)	2.0–3.0 pt Bravo Weather Stik, Echo 720, Equus 720	7	Spray before infection occurs. Rotate celery with non-susceptible crops.
		1.8–2.7 lb Bravo Ultrex 82.5WDG, Equus DF	7	Do not exceed 18 lb ai/a chlorothalonil per season.
		1.7–2.4 lb Echo 90DF	7	
Bacterial blight (<i>Pseudomonas</i>)	copper hydroxide	1.3 pt Champ Formula 2 4.6F, Kocide 4.5 LF	0	Use a 2- to 3-year crop rotation and hot water seed treatment (118°F for 30 minutes) to control bacterial diseases. Spray during wet periods and when disease is anticipated.
		2.3 pt Kocide LF 2.4F	0	
		1.5 lb Kocide 2000 DF	0	
		2.0 lb Champion 77WP, Kocide 101 77WP, Kocide DF	0	
Cercospora (early blight) and Septoria (late blight)	Hot water treatment			Hot water seed treatment will eliminate Septoria spores on the seed.
	azoxystrobin	3.0–5.0 oz Amistar 80 WDG	0	Amistar, Quadris, Cabrio, and Flint are Group 11 (strobilurin) fungicides; Quadris Opti contains Group 11 and M5 fungicides. To prevent disease resistance, do not apply more than one application of these products before alternating with a fungicide having a different mode of action. Do not exceed three applications of strobilurin fungicides per crop per year. Do not exceed 1.88 lb/a Amistar, 2.88 qt /a Quadris, 3 gal/a Quadris Opti, 64 oz/a Cabrio, or 12 oz/a Flint per season.
		9.2–15.4 fl oz Quadris Flowable	0	
	azoxystrobin + chlorothalonil	2.4–3.7 pt Quadris Opti	7	
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	trifloxystrobin	2.0–3.0 oz Flint	7	
	thiophanate-methyl	0.5 lb Topsin-M WSB	7	Alternate or tank-mix with another fungicide such as chlorothalonil.
	chlorothalonil (3- to 5-day spray schedule)	1.0–1.5 pt Bravo Weather Stik, Echo 720, Equus 720	7	Start sprays when transplants are set in the field.
		0.9–1.4 lb Bravo Ultrex 82.5WDG, Equus DF	7	Do not exceed 18 lb ai/a chlorothalonil per season.
		0.8–1.2 lb Echo 90DF	7	
		1.5–2.125 pt Echo Zn, Equus 500 Zn	7	
	chlorothalonil (7-day spray schedule)	2.0–3.0 pt Bravo Weather Stik, Echo 720, Equus 720	7	Start sprays when transplants are set in the field.
		1.8–2.7 lb Bravo Ultrex 82.5WDG, Equus DF	7	Do not exceed 18 lb ai/a chlorothalonil per season.
		1.7–2.4 lb Echo 90DF	7	
		3.0–4.25 pt Echo Zn, Equus 500 Zn	7	
	chlorothalonil (seedbed)	1.5–2.0 pt/100 gal Bravo Weather Stik, Echo 720, Equus 720 1.4–1.8 lb/100 gal Bravo Ultrex 82.5WDG, Equus DF 1.3–1.6 lb/100 gal Echo 90DF		For seedbeds, apply 125 gal of spray suspension weekly or as needed for control.
	propiconazole	4.0 fl oz Tilt 41.8% EC	14	Do not apply more than 16 fl oz in 4 applications per acre per season. Consult the label for crop rotation (plantback) restrictions.
Damping-off	mefenoxam	1.0–2.0 pt Ridomil Gold EC 1.0–2.0 lb Ridomil Gold WSP		Preplant incorporated application or surface application at planting.
	metam-sodium	Vapam HL, Metam, Sectagon 42		Use disease-free soil. Use steam or chemicals to sterilize contaminated soil.
	thiram	1.5 lb Thiram 65% WP/ 100 gal water		Seed treatment. Do not use treated seed for food or feed.
Rhizoctonia root rot	azoxystrobin	0.4–0.8 fl oz Quadris Flowable/1000 row ft	0	Use at planting. Follow manufacturer's directions.
		0.125–0.25 oz Amistar 80 WDG/1000 row ft	0	

Insect control in celery

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	acetamiprid	0.8–1.2 oz Assail 70W 2.0–4.0 oz Assail 30SG	7 7	Begin treatment when thresholds are reached. Apply every 7 days as needed. Do not exceed five applications or 0.375 lb ai/a per season.
	0.25–0.37 lb imidacloprid	7.0–10.5 fl oz AdmirePro 4.6F 16.0–24.0 fl oz (several formulations) 2F	21	Apply via chemigation into the root zone, as an in-furrow spray at-planting on or below the seed, or as a post-seeding or transplant drench.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Aster leafhopper ^a	<i>Treat celery when the aster yellows index reaches 35. (See “Aster Yellows Index” at beginning of book for calculations.)</i>			
	0.25–0.37 lb imidacloprid	7.0–10.5 fl oz AdmirePro 4.6F 16.0–24.0 fl oz (several formulations) 2F	21	Apply via chemigation into the root zone, as an in-furrow spray at-planting on or below the seed, or as a post-seeding or transplant drench.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	7	Do not apply more than 9 lb methomyl/season.
	0.05–0.2 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Apply at 3- to 5-day intervals. Do not exceed 2 lb ai/a per season.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Do not exceed 0.15 lb ai/a. Apply every 7 days as needed. Use higher rate for heavy infestations.
Cutworms	<i>If more than 4 weeks before harvest, treat if you see eggs or larvae. Within 4 weeks of harvest, preventatively treat approximately weekly.</i>			
	0.05–0.2 lb permethrin	*Ambush, *Pounce	1	Apply at 3- to 5-day intervals. Do not exceed 2 lb ai/a per season.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Do not exceed 0.15 lb ai/a. Apply every 7 days as needed. Use higher rate for heavy infestations.
Leafminers	0.009–0.019 lb abamectin	8.0–16.0 fl oz Agri-Mek 0.15EC	7	
	0.12 lb cyromazine	2.66 oz Trigard 75WP	7	
	0.045–0.268 lb dinotefuran	foliar rate: 1.0–3.0 oz Venom 70SG soil rate: 5.0–6.0 oz Venom 70SG	7 —	Use only one application method. See product label for application directions. Foliar applications: Do not exceed 4.5 oz/a per year. Soil applications: Do not follow soil application with foliar treatment of any other neonicotinoid insecticide. Do not exceed 6.0 oz/a per season.
Loopers	<i>If more than 4 weeks before harvest, treat if you find two or more larvae per 100 plants; within 4 weeks of harvest, preventative cutworm treatments should provide control.</i>			
	0.5–1.0 lb acephate	0.66–1.33 lb Orthene 75S, 0.5–1.0 lb Orthene 97S	21	Do not use tops for food or feed. Do not apply more than 2 lb ai/a per season.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat treatment as needed.
		Bactospeine FC or WP, Biobit, Cutlass WP, Dipel DF, Javelin WG	0	See label for rate.
	0.0075–0.015 lb emamectin benzoate	3.2–4.8 oz *Proclaim	7	Apply when larvae first appear. Use higher rate for larger larvae or severe outbreaks. Do not exceed 28.8 oz/a per season. Highly toxic to bees.

(continued)

Insect control in celery (*cont.*)

Insect	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Loopers (<i>cont.</i>)	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, 1.0–2.0 lb Thiodan WP	4	Apply only once per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV 0.25–1.0 lb *Lannate SP	7	Do not exceed 9 lb ai/a per season.
	0.06–0.16 lb methoxyfenozide	10.0 oz Intrepid 2F	1	Apply 4–8 oz only for early applications use higher rates for heavy infestations. Do not exceed 64 oz/a.
	0.05–0.2 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Apply when needed, but no more than 2 lb ai/a per season.
	0.047–0.125 lb spinosad	1.0–2.0 fl oz Entrust 1.3–6.0 fl oz SpinTor 2SC	1 1	Use higher rate for larger larvae. Apply in adequate spray volume to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not apply to seedlings grown for transplant.
	0.6–0.75 lb thiodicarb	24.0–30.0 fl oz Larvin F	14	Do not exceed 1.5 lb ai/a per season.
	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Do not exceed 0.15 lb ai/a. Apply every 7 days as needed. Use higher rate for heavy infestations.
Tarnished plant bug	<i>For plants shorter than 4 inches, treat if you find at least 20 insects per 20 plants. For plants taller than 4 inches, treat if you find 4 or more plant bugs per 20 plants if there are more than 3 weeks until harvest; within 3 weeks of harvest, treat if you find 2 insects per 20 plants.</i>			
	0.5–2.0 lb carbaryl	Sevin	14	Apply every 5–7 days as needed.

*Restricted-use pesticide.

^a For treatment thresholds see “Aster Yellows Index” (section precedes vegetable listings).

Weed control in celery

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.75–1.5 lb linuron	1.5–3.0 lb Lorox DF	45	Make a single post-transplant application after celery is established but less than 8 inches tall. Apply before broadleaf weeds are 6 inches tall or grassy weeds exceed 2 inches. Do not tank-mix with surfactants, fertilizer, or other pesticide.
	1.6–2.0 lb prometryn	3.2–4.0 pt Caparol 4L		Transplanted celery only. Do not incorporate. Do not apply when temperatures exceed 85°F. Do not tank-mix with other pesticides. Make a single postemergence treatment 2–6 weeks after transplanting, before weeds are 2 inches tall. Use only on fine-textured soils. Do not disturb the soil following treatment.
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or other registered trifluralin formulation		May be applied before, during, or immediately after direct-seeding or transplanting celery. Controls annual grasses and some broadleaves, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat or much soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting and incorporate 1–2 inches deep to avoid loss due to volatilization. Use on mineral soils only.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	30	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	30	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	30	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for early and rescue treatment rates. Do not apply more than 3 pt/a Poast in one crop season. Always add 2 pt of oil concentrate/a. Check the label for additional precautions and restrictions.

Cole crops

broccoli, brussels sprouts, cabbage, cauliflower

Cauliflower is relatively difficult to grow compared to cabbage. Failure to head properly and poor curd quality are common problems. Curds need to be protected from sunlight to ensure good color and quality. For success, cauliflower needs a fertile, moist soil relatively high in organic matter and nitrogen. Good soil drainage and a cool, humid climate are essential. If producing cauliflower on a light-textured soil, it must be irrigated to keep moisture continuously available to the crop. Broccoli and brussels sprouts are not as exacting in their requirements as cauliflower and, therefore, can be produced over a wider range of soil and climatic conditions. Cabbage is the most easily grown of the cole crops. It is adaptable but does best under a temperate climate, ample moisture, and good fertility with a relatively high nitrogen supply.

Planting

From mid-April through mid-June. Cole crops grow best on well-drained, fertile, loam soils with adequate organic matter. Sandy loams are better for early crops. Harrow to control weeds. Do not overwork seedbed.

Transplants	Plant spacing:	Between rows	Between plants
	Broccoli and cauliflower	18–36 inches	12–24 inches
	Brussels sprouts	24–30 inches	12–18 inches
	Cabbage	24–36 inches	12–24 inches

Transplants—8,300–29,000/a; depends upon row spacing, variety, soil fertility, pest control methods, irrigation, crop use, and harvesting.

Direct seeding

Plant no deeper than 1/2 inch. Use size-graded seed and select size to fit planter.

Single seeding

Plant single seed 3–4 inches apart. After emergence, remove excess plants by thinning.

Cluster seeding

Plant three seeds per cluster, spacing seed 2 inches apart. Thin to remove all but one plant per cluster. Thin when plants are 2 inches high.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.0 or higher on mineral soils and 5.6 on organic soils.

Fertilizer rates: Determine fertilizer needs by soil test. Use annual nitrogen, P₂O₅, and K₂O recommendations in table below. Take credits for previous legume crops and manure.

Application: Broadcast and work in fertilizer before planting.

Annual nitrogen, phosphate, and potash recommendations for cole crops

Crop	Nitrogen		Phosphate and potash		
	Organic matter	Amount to apply	Yield goal	Amount to apply ^a	
				P ₂ O ₅	K ₂ O
Broccoli	— % —	— lb/a —	— t/a —	— — — lb/a — — —	
	<2	100	4–6	10	20
	2.0–9.9	80			
	10–20	60			
Brussels sprouts	>20	25			
	<2	100	4–6	15	45
	2.0–9.9	80			
	10–20	60			
Cabbage	>20	25			
	<2	180	8–12	15	70
	2.0–9.9	140	12.1–20	25	115
	10–20	100	20.1–30	40	180
Cauliflower	>20	40			
	<2	120	6–8	20	50
	2.0–9.9	100			
	10–20	80			
	>20	40			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Nitrogen: Apply preplant or sidedress early in growing season. On sandy soils, split the nitrogen into two or more applications during the season. Excessive nitrogen can promote tipburn occurrence in susceptible cabbage varieties.

Micronutrients: Cole crops have relatively high or medium boron requirements and medium requirements for copper and manganese. Use soil and plant analyses to check for deficiencies of these nutrients. If boron soil test is very low (VL) or low (L), apply 2–3 lb/a of boron with fertilizer each year cauliflower is grown and 1–2 lb/a of boron for each broccoli, cabbage, or brussels sprouts crop. Omit these applications if the boron soil test is in the excessively high (EH) range. Apply 1–3 lb Mn/a or 1–12 lb Cu/a, depending on soil and application method.

Disease control in cole crops — broccoli, brussels sprouts, cabbage, and cauliflower

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria leaf spot	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 6.2–15.4 fl. oz. Quadris Flowable	0 0	Amistar, Quadris, and Cabrio belong to the Group 11 (strobilurin) fungicide category. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed three applications of strobilurin fungicides per crop per year. Do not exceed 0.93 lb/a Amistar, 1.44 qt/a Quadris Flowable, or 64 oz/a Cabrio per crop per season.
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	boscalid	6.0–9.0 oz Endura WDG	0	
Alternaria leaf spot and downy mildew	chlorothalonil	1.5 pt Bravo Weather Stik, Echo 720, Equus 720	7	Apply as foliar spray when conditions favor disease. A 7-day preharvest interval has been proposed by the manufacturer.
		1.4 lb Bravo Ultrex 82.5WDG, Equus DF	7	
		1.3 lb Echo 90DF	7	
	maneb	1.5–2.0 lb Maneb 80WP	7	Consult labels for limits on the amount of maneb products allowed per acre per season.
		1.2–1.6 qt Maneb plus Zinc F4 1.2–1.6 qt Manex F4	7 7	
	mefenoxam/chlorothalonil	1.5–2.0 lb Ridomil Gold Bravo	5	Consult the label for crop rotation restrictions before using this product
Black rot (bacterial), blackleg (fungal)	<p>□ Use seed grown in western United States. □ Use hot water seed treatment (details below). □ Use plant bed sanitation. □ Do not use compost from diseased plants or manure from animals that have eaten diseased plants. □ Use care in purchase and handling of plants. □ Rotate crops (3-year rotation). □ Select black-rot resistant cultivars. □ Use disease-free soil or treat soil with an approved soil fumigant.</p> <p>Hot water seed treatment: Place the seed in a mesh bag and dip it into water heated to 122°F. Treat cauliflower and broccoli seed for 20 minutes; treat cabbage and brussels sprouts seeds for 25 minutes. Transfer the bag to cold water immediately to cool the seed. There will be some reduction in the germination rate of treated seed. You may wish to sow additional seed to compensate.</p>			
Clubroot	PCNB	2.0–6.0 lb Blocker 75% WP/ 100 gal transplant water; use 0.5–0.75 pt/plant		Add hydrated lime in spring to reach a soil pH of 7.2. PCNB may also be applied as a band or broadcast.
Internal tipburn	Avoid overfertilizing, especially with nitrogen. Plant tolerant or resistant cultivars. If you find tipburn, harvest crop before full maturity to reduce losses.			
Rhizoctonia basal stem and root rot, wirestem	azoxystrobin	0.4–0.8 fl oz Quadris Flowable/1000 row ft	0	Use at planting. Follow manufacturer's directions.
		0.125–0.25 oz Amistar 80 WDG/1000 row ft	0	
	PCNB	15–20 lb Blocker 75% WP/50 gal water per acre OR 1 level tablespoon/gal water/50 sq ft of seed bed.		Broadcast drench application.
Seed rot	Maintain a disease-free plant bed and use sanitation measures listed for black rot.			

Insect control

Caterpillars cause varying amounts of damage depending on the maturity of the plant, so thresholds change as the crop grows through the different developmental stages (see table below). The three caterpillars—imported cabbage worm, cabbage looper, and diamondback moth larvae—are considered together as a single caterpillar complex. Weekly crop scouting and treatment based on larval infestation threshold levels provides the most effective management of this pest complex. To monitor, walk along a W-shaped path through the field and examine randomly selected plants every few yards; examine 25–50 plants, depending on the field size, and record the percentage of infestation. A plant is infested if the eggs or caterpillars of any species are present.

Treatment thresholds for the caterpillar complex on major cole crops.

Crop	Growth stage	Threshold (% infestation)
Cabbage	Seed bed	10%
	Transplant to cupping	30%
	Cupping to early head	20%
	Mature head	10%
Broccoli	Seed bed	10%
	Transplant to first flower	50%
	Flower bud to harvest	10%
Cauliflower	Seed bed	10%
	Transplant to first curd	50%
	Curd present	10%

Note: Diamondback moths have developed resistance to insecticides and Bt in areas of the southern United States. Be cautious when using transplants from the South, which may harbor this insect. Bt resistance has been found only in southern Florida so far.

Scouting calendar for insect pests of cole crops

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
						Seed maggot											
						Cabbage maggot											
Flea beetles																	
						Diamondback moth											
						Imported cabbageworm											
						Cabbage looper											
						Cabbage aphid and turnip aphid											
						Onion thrips											

Insect control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cabbage aphid	<i>Natural enemies will often eliminate this insect, especially if <i>Bacillus thuringiensis</i> (which does not kill beneficial insects) is used for caterpillar control. Treat broccoli and cauliflower before heading if there are more than 100 aphids per plant; after heading, treat if there are more than 5 aphids per plant. Treat cabbage if 1–2% of the plants are infested.</i>			
	acetamiprid	0.8–1.2 oz Assail 70WP	7	Begin treatment when thresholds are reached.
		2.0–3.0 oz Assail 30SG	7	Apply every 7 days as needed. Do not exceed 5 applications or 0.375 lb ai/a per season.

*Restricted-use pesticide.

(continued)

Insect control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cabbage aphid (cont.)	azadirachtin	10.0–21.0 oz Azatin XL, XL Plus 0.5–2.0 gal Neemix 0.25EC 0.25–1.0 pt Neemix 4.5EC	0	Apply every 7 days as needed.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz Brigade 2EC	7	Do not exceed 0.5 lb ai/a or 5 applications per year. Wait at least 7 days between treatments.
	1.0 lb chlorpyrifos	2.0 lb Lorsban 50W 1.33 lb Lorsban 75WG	21	Apply to foliage as insects appear. Repeat as needed but do not exceed more than six applications per season.
	0.25–0.5 lb diazinon	several formulations	5–14 ^a	
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	7–14 ^a	
	0.045–0.268 lb dinotefuran	<i>foliar rate:</i> 1.0–4.0 oz Venom 70SG <i>soil rate:</i> 5.0–6.0 oz Venom 70SG	21	Do not follow applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 12 oz/a per season using soil applications. See product label for application directions.
	1.0 lb disulfoton	1.1–7.4 fl oz/1000 ft row *Di-Syston 8–15%	14–42 ^a	Apply in furrow at planting. Not for use on kale, collards, or chard.
	0.75–1.0 lb endosulfan	1.5–2.0 lb Thiodan WP, 1.0–1.33 qt Phaser EC	7–21 ^a	Do not exceed 2 applications per season. Only 1 application for kale, collards, chard, and mustard.
		1.0–1.33 qt Thiodan EC	7–21 ^a	Do not exceed 4 applications or 3.0 lb ai/a per season. Only 1 application for kale, collards, chard, and mustard.
	0.2–0.3 lb fenpropathrin	10.66–16.0 fl oz Danitol 2.4EC	7	For use on brussels sprouts and cauliflower only. Treat when pests first appear. May repeat every 7 days as needed. Do not exceed 0.8 lb ai/a per season. May be tank-mixed with Orthene 75S to improve control.
	0.0075–0.015 lb gamma cyhalothrin	1.92–3.84 oz Proaxis	1	For suppression only. Apply every 5 days as needed. Do not exceed 1.92 pt/a (0.12 lb ai/a) per season.
	imidacloprid	4.4–10.5 fl oz Admire Pro 3.75 fl oz Provado F	21 7–21 ^a	Also controls whitefly. Soil application. Apply Admire in a narrow band centered on the row. Treat within 14 days before planting. Apply Provado every 5 days as needed. Do not exceed 18.75 fl oz/a Provado per season and do not apply more than a total of 0.5 lb/a imidacloprid in any formulation.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior 1E	1	For suppression only. Do not use on brussels sprouts, kale, collards, chard, or mustard.
	0.32–1.0 lb malathion	Malathion EC, WP, D	3–7 ^a	See label for rate.
	1.0 lb naled	1.0 pt Dibrom 8E	1	Not for use on kale, collards, chard, or mustard.
	0.375–0.75 lb oxydemeton-methyl	1.5–2.0 pt *Metasystox-R, EC	7–10 ^a	See label for rate. Do not exceed 3 applications per season. Not for use on kale, collards, chard, or mustard.

*Restricted-use pesticide.

(continued)

Insect control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cabbage aphid (cont.)	thiamethoxam	5.0–11.0 Platinum 2SC 1.5–3.0 oz Actara 25WDG	30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct seeded crops in-furrow at the seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11.0 oz/a Platinum per season. Actara is applied as a foliar spray.
	zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use a minimum of 15 gal/a of finished spray. Do not exceed 24 oz/a Mustang Max per season.
Cabbage maggot	azinphos-methyl	1.5 lb Guthion solupak	7	For use in brussels sprouts only. One application per crop per season.
	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR	—	Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not apply more than 0.1 lb/a Capture LFR per season as an at-plant application.
	chlorpyrifos ^b	1.6–3.3 oz/1,000 ft row Lorsban 4E	30	For direct-seeded crops, apply dosage in minimum of 20 gal/a as banded spray over row. Apply ahead of press wheel or planter shoe. For transplants, direct spray at plant base immediately after setting.
		4.6–9.2 oz/1,000 ft row Lorsban 15G		Apply as a 2- to 4-inch band over seed row ahead of planter shoe or in front of press wheel. Not for use on greens.
	0.125–0.25 lb diazinon	several formulations		Apply in transplant water. See label for rate.
	2–3 lb diazinon	several formulations		See label for rate. Broadcast and incorporate 3–4 inches deep before planting.
Caterpillar pests	<i>Apply insecticides only when thresholds are exceeded (see treatment threshold table above).</i>			
(Imported cabbage-worm, cabbage looper, diamondback moth larvae)	0.5–1.0 lb acephate	0.66–1.33 lb Orthene 75S, 0.5–1.0 lb Orthene 97S	14	Cauliflower and brussels sprouts only. Do not exceed 2 lb ai/a per season.
	<i>Bacillus thuringiensis</i> subsp. <i>aizawai</i>	1.0–2.0 lb Agree, 0.5–1.5 lb Xentari	0	Use lower rate for light infestations and small larvae; use higher rate for heavy infestations and larger larvae.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Bactospeine, Biobit, Cutlass, Dipel, Javelin, MVP, Thuricide, and others	0	Rates vary with formulation, check the label. Most effective against young larvae; use other insecticides if larvae are large. Does not kill beneficial insects.
		1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz Brigade 2EC	7	Do not exceed 0.5 lb ai/a or five applications per season. Wait at least 7 days between applications.
	0.05–0.1 cypermethrin	2.5–5.0 fl oz *Ammo 2.5EC 1–2 bags *Ammo WSB	1	Cabbage only.
	0.0075–0.015 lb emamectin benzoate	2.4–4.8 oz *Proclaim	7	Use higher rate for loopers or larger larvae. Apply when larvae first appear and repeat as necessary for control. Do not exceed 28.8 oz/season. Highly toxic to bees.
	0.75–1.0 lb endosulfan	1.5–2.0 lb Thiodan WP, 1.0–1.33 qt Phaser EC	7–21 ^a	Do not exceed 2 applications per season.
		1.0–1.33 qt Thiodan EC	7–21 ^a	Limit of 4 applications or 3 lb ai/a per season.

*Restricted-use pesticide.

(continued)

^a Ranges are given for days to harvest. Check product label for specific number of days between insecticide application on a particular crop and harvest.^b See label for per acre rate limits.

Insect control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Caterpillar pests (<i>cont.</i>)	0.015–0.03 lb esfenvalerate	2.9–5.8 fl oz *Asana XL	3	Imported cabbage worm. Do not exceed 0.4 lb ai/a per season.
	0.2–0.3 lb fenpropathrin	10.66–16.0 fl oz Danitol 2.4EC	7	Do not exceed 2.66 pt/a (42.7 oz/a) per season. Apply in spray volume of 25 to 50 gal/a. Adding nonionic surfactant may improve control.
	0.0075–0.015 lb gamma cyhalothrin	1.92–3.84 oz Proaxis	1	Apply every 5 days as needed. Use the high rate for diamondback moth. Do not exceed 1.92 pt/a (0.12 lb ai/a) per season.
	0.045–0.065 lb indoxacarb	2.5–3.5 oz Avaunt	3	Treat when populations reach threshold levels. For diamondback moth control, use higher rate. May repeat every 3 days as needed. Do not exceed 14 oz/a per crop.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior 1E	1	Apply every 5 days as needed. Use 0.02–0.03 lb ai/a for diamondback moth larvae.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV, 0.25–1.0 lb *Lannate SP	1–10 ^a	Do not exceed 10 applications per season.
	0.06–0.16 lb methoxyfenozide	early season: 4.0–8.0 fl oz Intrepid 2F	1	Will not control diamondback moth. Do not exceed 64 fl oz/a per season. Use the higher rates with higher populations or when spray coverage is difficult. See label for use restrictions in some Wisconsin counties.
		mid- to late season: 8.0–16.0 fl oz Intrepid 2F	1	
	0.039–0.078 lb novaluron	6.0–12.0 fl oz Rimon 0.83EC	7	Apply when the majority of the population has hatched up to the second instar larvae stage. Use higher rates and volumes when larvae are large, when populations are at least double the threshold amount, and when the foliage canopy is dense. Do not apply more than three times per crop per season or more than 24 oz/a per season.
	0.05–0.2 lb permethrin	*Ambush, *Pounce	1	See label for rate. Do not exceed 0.8 lb ai/a per season. Do not graze or feed treated foliage.
	0.039–0.078 lb spinetoram	5.0–10.0 oz Radiant SC	1	Do not apply more than 34 oz/a Radiant (0.266 lb ai) per crop and do not exceed six applications per year.
	0.023–0.094 lb spinosad	1.5–6.0 fl oz SpinTor 2SC 0.5–3.0 fl oz Entrust	1	See product label for specific rates. Use higher rates for larger larvae. Apply in adequate spray to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent.
			1	
	0.09–0.12 lb tebufenozide	6.0–8.0 fl oz Confirm	7	Apply per label directions every 10–14 days as needed. Do not exceed 56 oz/season or 8 oz/application. There is a 1–12 month plantback restriction depending on the crop.
	0.4–1.0 lb thiodicarb	16.0–40.0 fl oz Larvin 3.2	7	Do not exceed 4.0 lb ai/a per season for broccoli, cabbage, and cauliflower only. There is a 30-day plantback restriction.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Use higher rates for cabbage loopers. Apply every 7 days as needed. Use a minimum of 15 gal/a of finished spray. Do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

(continued)

^a Ranges are given for days to harvest. Check product label for specific number of days between insecticide application on a particular crop and harvest.^b See label for per acre rate limits.

Insect control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Flea beetles	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz Brigade 2EC	7	Do not exceed 0.5 lb ai/a or five applications per season. Wait at least 7 days between applications.
	0.5–2.0 lb carbaryl	Sevin WP	—	Can only be applied within 30 days of crop emergence. See label for rate. Do not use on kale or collards.
	0.045–0.268 lb dinotefuran	foliar rate: 1.0–4.0 oz Venom 70SG	1	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not exceed 12 oz/a per season using soil applications. See product label for application directions.
		soil rate: 5.0–6.0 oz Venom 70SG	21	
	1.0 lb disulfoton	1.1–7.4 fl oz/1000 ft row *Di-Syston 8–15%	14–42 ^a	Apply in furrow at planting. Not for use on kale, collards, chard, or mustard.
	0.75–1.0 lb endosulfan	1.0–1.33 qt Thiodan WP, 1.5–2.0 lb Phaser EC	7–21 ^a	Do not exceed 2 applications per season. Only 1 application for kale, collards, chard, mustard.
		1.0–1.33 qt Thiodan EC	7–21 ^a	Do not exceed 4 applications or 3.0 lb ai/a per season. Only 1 application for kale, collards, chard, and mustard.
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	3–7 ^a	Do not exceed 0.4 lb ai/a per season (0.2 lb ai/a for greens).
	0.0075–0.015 lb gamma cyhalothrin	1.92–3.84 oz Proaxis	1	Apply every 5 days as needed. Do not exceed 1.92 pt/a (0.12 lb ai/a) per season.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior 1E	1	Apply every 5 days as needed. Do not exceed 1.92 pt/a per season.
	0.05–0.2 lb permethrin	*Pounce	1	See label for rate. Apply as needed for flea beetle control on cabbage and Chinese cabbage. Do not exceed 1.0 lb ai/a per season.
	thiamethoxam	5.0–11.0 Platinum 2SC 1.5–3.0 oz Actara 25WDG	30	Do not follow applications of Platinum with foliar applications any other neonicotinoid insecticide. Platinum may be applied to direct-seeded crops in-furrow at seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11.0 oz/a per season. Actara is applied as a foliar spray.
Onion thrips	0.4–0.8 lb thiodicarb	16.0–32.0 fl oz Larvin F	7–14 ^a	Do not exceed 4.0 lb ai/a per season for broccoli, cabbage, and cauliflower only. Do not exceed 1.5 lb ai/a per season for greens.
	0.14–0.250 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use a minimum of 15 gal/a of finished spray. Do not exceed 24 oz/a Mustang Max per season.
	<i>Thrips attack only cabbage and brussels sprouts. Plant resistant cabbage varieties to avoid the problem.</i>			
	0.05–0.1 cypermethrin	2.5–5.0 fl oz *Ammo 2.5EC	1	Apply when thrips enter cabbage head. There is a 30-day plantback restriction.
	1.0 lb disulfoton	1.1–7.4 fl oz/1000 ft row *Di-Syston 8–15%	30	No more than 2 applications per season.
	0.0075–0.015 lb gamma cyhalothrin	1.92–3.84 oz Proaxis	1	For suppression only. Apply every 5 days as needed beginning when thrips enter cabbage head. Do not exceed 1.92 pt/a (0.12 lb ai/a) per season.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	1	For suppression only. Apply when thrips enter cabbage head.

*Restricted-use pesticide.

(continued)

Insect control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Onion thrips (<i>cont.</i>)	0.039–0.078 lb novaluron	6.0–12.0 fl oz Rimon 0.83EC	7	For suppression only. Apply when thrips first appear and when they begin to enter the cabbage head. Reapply at 7- to 14-day intervals to protect new growth. Do not apply more than three times per crop per season or more than 24 oz/a per season.
	0.004–0.05 lb pyrethrin	1.0–12.0 fl oz Pyrenone	0	Apply as needed.
	0.4 lb rotenone	Rotacide EC	0	Apply as late in day as possible.
	0.063–0.15 lb spinosad	1.25–3.0 fl oz Entrust	1	Apply when thrips first appear. Do not make more than 3 applications to a single generation or within a 30-day period.
	thiamethoxam	5.0–11.0 Platinum 2SC 3.0–5.5 oz Actara 25WDG	30	Do not follow applications of Platinum with foliar applications any other neonicotinoid insecticide. Platinum may be applied to direct-seeded crops in-furrow at seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11.0 oz/a per season. Actara is applied as a foliar spray.
	0.2–0.25 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply when thrips enter cabbage head. Treat every 7 days as needed. Use a minimum of 15 gal/a of finished spray. Do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

^a Ranges are given for days to harvest. Check product label for specific number of days between insecticide application on a particular crop and harvest.

Weed control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.25–0.50 lb clomazone	direct seeded: 0.67 pt Command 3ME transplant: 0.67–1.3 pt Command 3ME	45	Cabbage only. For suppression and control of annual grasses and broadleaves. Make a single application before seeding or transplanting or after seeding but before crop emergence. Place seed or roots of transplants below the chemical barrier when planting. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read the vegetable disclaimer section of the label—the end user assumes all liability for failure to perform and crop injury.
	1.0 lb napropamide	2.0 lb Devrinol 50-DF		Apply and shallowly incorporate before planting or apply after seeding or transplanting and sprinkler irrigate within 24 hours. Use lower rate on light soil. Do not use on soil with more than 10% organic matter.
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or equivalent		Apply before transplanting. Treflan is also registered at lower rates for direct-seeded cole crops. Controls annual grasses and some broadleaves, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting. Incorporate 1–2 inches deep to avoid loss due to volatilization. Use on mineral soils only.

(continued)

Weed control in cole crops—broccoli, brussels sprouts, cabbage, and cauliflower (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual broadleaves	0.25–0.5 lb oxyfluorfen	1.0–2.0 pt Goal 2XL		For use on transplanted broccoli, cabbage, and cauliflower only. Apply after final tillage but before transplanting. Do not use on direct-seeded cole crops. Use low rate on coarse-textured soils with less than 1% organic matter. If plants contact treated soil, some foliar burn may occur but plants generally outgrow symptoms rapidly. For wider-spectrum weed control, use Goal following preplant-incorporated Treflan.
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Make preemergence applications to weed-free soil at seeding or immediately after transplanting. Can be preplant-incorporated. Use only on soils with 5% or less organic matter.
	0.07–0.375 lb sulfentrazone	2.25–12.0 fl oz Spartan 4F		For processing cabbage only. May be surface-applied in spring up to 30 days before planting or transplanting. It may also be preplant incorporated or applied as a pre-emergent treatment. When used as a pre-emergence treatment, Spartan should be applied before transplanting or within 24 hours of seeding. Banded application to row middles may be made within 72 hours of transplanting or seeding. Rate is based on soil texture and organic matter. May be tank-mixed with other labeled herbicides. Do not apply to emerged cabbage or if sprouts are near the soil surface. Do not apply more than 12 oz per year.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, wait until they have resumed active growth and reached the recommended stage on the label. Allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Band or broadcast apply before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seed and transplant with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label. A directed or shielded application at 1.0–1.5 pt/a may be made to cabbage, but only if no pretreatment of Boa was applied.
Emerged broadleaves	0.09375–0.187 lb clopyralid	0.25–0.5 pt Stinger	30	Controls many broadleaf weeds including common ragweed, nightshade species, and galinsoga. Suppresses Canada thistle and annual sowthistle. Do not exceed 0.5 pt/a per year. Refer to supplemental label for Brassica (Cole) Leafy Vegetables for weeds controlled and use specifics. Note rotational crop interval restrictions from main label before use.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	30	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	30	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	30	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rates. Do not apply more than 3 pt/a Poast in one crop season. Always add 2 pt/a of oil concentrate. Check the label for additional precautions and restrictions.

*Restricted-use pesticide.

Cucumber

Planting

Pickling cucumbers

Hand-harvested plantings: Rows—36–60 inches; plants in row —12–24 inches apart (narrower row spacings), 9–15 inches apart (wider row spacings). The resulting plant population will be 7,000–25,000 plants/a depending on variety.

Machine-harvested plantings: Rows—18–28 inches; seed —4–6 inches. The resulting plant population will be 50,000–90,000 plants/a.

Slicing cucumbers

Rows —48–72 inches; **plants in row** —12–24 inches apart.

Plant seed 0.75–1.5 inches deep, depending on soil type and moisture. Reduce planting depth on heavier soils or when soils are cool and moist at planting.

If hand harvesting, plant seeds with corn or bean planter and use appropriate cucumber plates. For machine harvesting, use precision planting to eliminate thinning.

Cucumbers will grow on a wide variety of soils if they are well drained and have a high fertility level. To use machine harvesting, the fields must be level and stone-free. Avoid excessive tillage, which can cause moisture loss, soil compaction, and crusting.

Cucumbers are a warm season crop and require growing temperatures of 60–75°F. They will not tolerate frost, so avoid fields that have frost pockets. Temperatures above 90°F or below 60°F slow growth. Good seed germination requires soil temperatures of 55–95°F. Because of these requirements, do not plant seed in northern Wisconsin before June 1.

Irrigation

Cucumbers require a constant supply of moisture, especially during blossom and fruit development. Silt and clay soils have a relatively high moisture-holding capacity, so normal rainfall is usually adequate for cucumber production on these soils. Sandy soils do not hold much moisture and irrigation is essential for profitable cucumber production. If the WISP scheduling program is used, the AD value for sands is 1.0 inches. The AD value for silt loams is 2.5 inches.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 5.8 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in table below. Take credits for previous legume crops and manure.

Application: For hand-harvested plantings, apply fertilizer in a band 2 inches below the seed at planting. For destructive, machine-harvested plantings, fertilizer can be planter applied or broadcast and worked in before planting.

Nitrogen: Split nitrogen recommendation into two or more applications during the season. Make the first application when plants have two to three true leaves. Make a second application when vines begin to fill the rows. For hand harvest, apply 15–20 lb N/a at 10–14 day intervals after harvest has begun. These applications can be made through the irrigation system.

Annual nitrogen, phosphate, and potash recommendations for cucumber

Nitrogen		Phosphate and potash	
		Yield goal	Amount to apply ^a
Organic matter	Amount to apply		P_2O_5 K_2O
— % —	— lb/a —	— bu/a —	— — — lb/a — — —
<2	100	300–400	10 25
2.0–9.9	80		
10–20	60		
>20	30		

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Pollinating

Hand-harvested acreage: Typically, the natural bee population provides adequate pollination.

Machine-harvested acreage: Supplement the natural bee population by adding one colony (40,000–60,000 bees)/a in the field at blossoming time. (Note: many beekeepers provide pollinating services.)

Disease control

Many cucumber cultivars are resistant to several important diseases including angular leaf spot, anthracnose, cucumber mosaic virus, downy mildew, powdery mildew, and scab. Use resistant varieties and disease-free seed. Practice a 3- to 4-year rotation. Planting cultivars with multiple disease resistance minimizes the need for fungicide and bactericides on this crop.

Disease control in cucumber

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria leaf blight	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl oz Quadris Flowable	1 1	Amistar, Quadris, Cabrio, and Reason belong to the Group 11 (strobilurin) fungicide category. Quadris Opti contains a combination of Group 11 and M5 fungicides. Tanos contains a combination of Group 11 and Group 27 fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per crop per year. Do not exceed 1.25 lb/a Amistar, 1.92 qt/a Quadris, 2 gal/a Quadris Opti, 32 oz/a Tanos, 22 fl oz/a Reason, or 64 oz/a Cabrio per season. Tanos must be tank-mixed with a contact fungicide such as mancozeb, chlorothalonil, or a copper-containing fungicide. Following the last application of Reason 500 SC, do not rotate to wheat for 30 days; for all other crops, wait 1 year before rotating.
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	
	famoxadone + cymoxanil	8.0 oz Tanos	3	
	fenamidone	5.5 fl oz Reason 500 SC	14	
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or any other Group 7 or 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	chlorothalonil	1.5–2.0 pt Bravo Weather Stik, Equus 720	0	If necessary, apply selected fungicide according to label directions. Do not apply more than 15.75 lb ai/a of chlorothalonil products per year.
		1.8–2.7 lb Bravo Ultrex 82.5WDG, Equus DF	0	
		2.25–2.75 pt Bravo Zn, Echo Zn, Equus 500 Zn	7	
	maneb	1.5–2.0 lb Maneb 80WP	7	Consult label for product limits.
		1.2–1.6 qt Maneb plus Zinc F4	7	
		1.2–1.6 qt Manex F4	7	
	mancozeb	1.6–2.4 qt Dithane F-45	5	Consult label for product limits.
		2.0–3.0 lb Dithane 75DF Rainshield NT	5	
		2.0–3.0 lb Manzate 200 75DF	5	
		2.0–3.0 lb Penncozeb 80WP, 75DF	5	
Angular leaf spot (<i>Pseudomonas</i>)	fixed copper	1.0–1.3 pt Champion Formula 2 4.6F	0	Use disease-free seed and rotate crops. Many cultivars are resistant to this disease. If needed, begin applications before fruit appear. Copper sprays are most effective when applied immediately after a rain or wind storm has damaged foliage.
		1.5–2.0 lb Champion 77WP	0	
		1.5–2.0 lb Kocide 101 77WP, DF	0	
		2.0–2.3 pt Kocide LF 2.4F	0	
		1.3 pt Kocide 4.5 LF	0	
		1.5 lb Kocide 2000 DF	0	

(continued)

Disease control in cucumber (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Anthracnose	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl oz Quadris Flowable	1 1	See remarks for these products in the alternaria leaf blight listing.
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	
	cymoxanil + famoxadone	8.0 oz Tanos	3	Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed two sequential applications of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or of any other Group 7 or 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	boscalid + pyraclostrobin	18.5 oz Pristine WDG	0	
	chlorothalonil	1.5–2.0 pt Bravo Weather Stik, Echo 720, Equus 720 1.4–1.8 lb Bravo Ultrex 82.5WDG, Equus DF 1.3–1.6 lb Echo 90DF	0 0 0	
	maneb	1.5–2.0 lb Maneb 80WP 1.2–1.6 qt Maneb plus Zinc F4 1.2–1.6 qt Manex F4	7 7 7	
	mancozeb	1.6–2.4 qt Dithane F-45 2.0–3.0 lb Dithane 75DF Rainshield NT 2.0–3.0 lb Manzate 200 75DF 2.0–3.0 lb Penncozeb 80WP, 75DF	5 5 5 5	
	thiophanate methyl	0.25–0.5 lb Topsin M 70W, Topsin M WSB	0	Apply when disease first appears and repeat if needed every 7–14 days.
Bacterial wilt (<i>Erwinia</i>)	<i>Eliminate the cucumber beetles that carry this pathogen (see Insect Control).</i>			
Belly rot	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl oz Quadris Flowable	1 1	See remarks for Quadris, Amistar, and Cabrio in the alternaria leaf blight listing.
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
Black rot	See fungicide treatments recommended for anthracnose. fixed copper			Use certified disease-free seed. Destroy infected plant refuse.
Downy mildew	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	See remarks for these products in alternaria leaf blight section.
	cymoxanil + famoxadone	8.0 oz Tanos 50DF	3	
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	cyazofamid	2.1–2.75 fl oz Ranman	0	

(continued)

Disease control in cucumber (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Downy mildew (<i>cont.</i>)	dimethomorph	6.0 fl oz Forum	0	Do not exceed 30 fl oz/a or five applications per season. Do not make more than two sequential applications of Forum before alternating to another effective fungicide with a different mode of action for at least one application.
	famoxadone + cymoxanil	8.0 oz Tanos	3	See remarks in Phytophthora blight.
	fixed copper	1.5–2.0 lb Champion 77WP	0	Use disease-free seed and rotate crops. Begin applications before fruit form at less than 7-day intervals. After a rain and wind storm, make two or three applications as soon as possible after the storm at 2- to 3-day intervals.
		1.0–1.3 pt Champ Formula 2 4.5F	0	
		1.5–2.0 lb Kocide 101 77WP	0	
		1.5–2.0 lb Kocide DF	0	
		2.6 pt Kocide LF 2.4F	0	
		1.3 pt Kocide 4.5 LF	0	
		1.5 lb Kocide 2000 DF	0	
	fosetyl-al	2.0–5.0 lb Aliette WDG	12 hr	Begin applications when conditions favor disease development (high moisture and moderate temperatures). Repeat at 7- to 14-day intervals. Do not exceed seven applications per season.
	propamocarb hydrochloride	1.2 fl oz Previcur Flex or 0.6 fl oz Previcur Flex plus chlorothalonil	2	Do not apply more than 6 pt/a Previcur Flex per season.
Fusarium wilt	<i>The only practical control is to grow wilt-resistant varieties. Rotate with crops other than melons.</i>			
Mosaic	<i>Plant resistant varieties. When possible, control by isolation from the following plants: burdock, catnip, china aster, chrysanthemum, wild cucumber, geranium, gladiolus, wild ground cherry, horse nettle, hyacinth, jimsonweed, larkspur, lily, marigold, milkweed, morning glory, nasturtium, petunia, phlox, pokeweed, salvia, snapdragon, flowering spurge, tulip, white cockle, and zinnia. Control aphids that spread the disease (see Insect Control).</i>			
Phytophthora blight or crown rot (<i>Phytophthora capsici</i>)	cyazofamid	2.75 fl oz Ranman 400SC	0	Do not apply more than six sprays or 16.5 fl oz/a per year. Alternate Ranman (Group 21) sprays with a fungicide having a different mode of action. Crops not listed on the label should not be planted within 30 days after the last application.
	dimethomorph	6.0 fl oz Forum	0	Do not exceed 30 fl oz/a or five applications per season. Do not make more than two sequential applications of Forum before alternating to another effective fungicide with a different mode of action for at least one application.
	famoxadone + cymoxanil	8.0–10.0 oz Tanos	3	Do not make more than one application of Tanos before alternating with a fungicide having a different mode of action. Do not make more than four applications of Tanos or other Group 11 fungicides per season and do not alternate Tanos with other Group 11 fungicides. Do not exceed 32 oz/a Tanos per crop per season. Tanos is helpful for suppressing Phytophthora blight, but it must be tank-mixed with a contact fungicide such as mancozeb, chlorothalonil, or a copper-containing fungicide.
	fosetyl-al	2.0–5.0 lb Aliette WDG	12 hr	Begin applications when conditions favor disease development (high moisture and moderate temperatures). Repeat at 7- to 14-day intervals. Do not exceed seven applications per season.
	zoxamide + mancozeb	1.5–2.0 lb Gavel 75DF	5	Do not exceed eight applications or 16 lb/a product per season.

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Disease control in cucumber (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Powdery mildew	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl oz Quadris Flowable	1 1	Amistar, Quadris, Flint, and Cabrio belong to the strobilurin group of fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per crop per acre per year. Do not exceed 1.25 lb/a Amistar, 1.92 qt/a Quadris, 8 oz/a Flint, or 64 oz/a Cabrio per crop per season. Do not tank-mix Amistar, Quadris, Flint, or Cabrio with additives or adjuvants. See labels for listing of products that should not be tank-mixed with these materials.
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	trifloxystrobin	1.5–2.0 oz Flint	0	
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	
	myclobutanil	2.5–5.0 oz Nova 40W	0	
	triflumizole	4.0–8.0 oz Procure 50WS	0	
Seed rot and damping off	thiophanate methyl	0.25–0.5 lb Topsin M 70W, Topsin M WSB 10 fl oz Topsin 4.5 FL	0 0	Apply when disease first appears and repeat if needed every 7–14 days.
	seed treatment: captan	0.5–1.0 teaspoon Captan 50% WP/lb of dry seed		
	thiram	0.75 teaspoon Thiram 50% WP/lb seed		
	soil treatment: mefenoxam	1.0–2.0 pt Ridomil Gold EC 1.0–2.0 lb Ridomil Gold WSP		
				Use disease-free soil. Water plants in morning. Chemicals listed are seed treatments. Do not use treated seed for feed or food. Preplant incorporated application or surface application after planting.

Scouting calendar for cucumber insect pests

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
Wireworm					
	Striped and spotted cucumber beetles				
	Seed maggot				
	Aphids		Aphids		
			Mites		

Insect control in cucumber

(Note: heavy applications and certain formulations may be phytotoxic to cucumbers.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cucumber beetles (striped, spotted)	<i>Treat when there are more than 4–5 adults per 50 plants. Cucumber beetles are vectors of bacterial wilt. High beetle populations (more than 20 per plant) may overwhelm the ability of the insecticide to control beetles quickly enough to stop the transmission of the wilt-causing bacterium.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than two applications after bloom. Do not exceed 0.3 lb ai/a per season.
	0.5–1.0 lb carbaryl	2.0 lb Sevin 50WP 1.25 lb Sevin 80S 1.0 qt Sevin XLR Plus	1	See label for rate. Do not apply during maximum flowering or fruit set, or when pollinating bees are in the field. Spray during the evening.
	0.019–0.022 lb cyfluthrin	2.4–2.8 fl oz Baythroid XL	0	Apply every 7 days as needed. Do not exceed 11.2 fl oz/a.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	3	Apply every 3 days as needed. Do not exceed 14.4 fl oz/a per season.
	0.132–0.179 lb dinotefuran	3.0–4.0 oz Venom 70SG	1	Do not exceed 6 oz/a Venom per season.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC 1.0–2.0 lb Thiodan WP	2	Do not exceed 3 lb ai/a or six applications per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per season.
	0.2–0.3 lb fenpropathrin	10.66–16.0 oz Danitol 2.4EC	7	Do not exceed 2.66 pt/a per season.
	0.25–0.375 lb imidacloprid	7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on plant row within 14 days before planting or as an in-furrow treatment during planting. Do not exceed 0.38 lb ai/a per year.
	0.9–1.75 lb malathion	several formulations	1	
	0.5–1.0 lb methomyl	1.5–3.0 pt *Lannate LV 0.5–1.0 lb *Lannate SP	1–3	See label for days to harvest.
	0.5–1.0 lb oxamyl	2.0–4.0 pt Vydate L	1	Make first application 2–4 weeks after planting. Repeat 2–3 weeks later.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	See label for rate. Do not apply more than 1.6 lb ai/a per season.
	10.0 lb rotenone	Rotenone D, WP	1	
	thiamethoxam	5.0–11.0 Platinum 2SC 3.0–5.5 oz Actara 25WDG	30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct-seeded crops in-furrow at seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11.0 oz/a per season. Actara is applied as a foliar spray.
	0.018–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Cutworm	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than two applications after bloom. Do not exceed 0.3 lb ai/a per season.
	1.0 lb carbaryl	Sevin Bait	1	See label for rate. Broadcast when cutworms are present in damaging numbers.
	0.0065–0.0125 lb cyfluthrin	0.8–1.6 fl oz Baythroid XL	0	Apply every 7 days as needed. Do not exceed 11.2 fl oz/a.

*Restricted-use pesticide.

(continued)

Insect control in cucumber (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cutworm (<i>cont.</i>)	0.012–0.028 lb deltamethrin	1.0–2.4 fl oz *Delta Gold	3	Apply every 3 days as needed. Do not exceed 14.4 fl oz/a per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per season.
	0.1–0.2 lb permethrin	*Ambush EC, WP	0	See label for rate. Do not apply more than 1.6 lb ai/a per season.
	0.008–0.025 lb zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Melon aphid	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than two applications after bloom. Do not exceed 0.3 lb ai/a per season.
	0.25–0.75 lb diazinon	several formulations	3	Apply as soon as aphids are noticed. Apply no more than five applications per season.
	0.045–0.268 lb dinotefuran	foliar: 1.0–4.0 oz Venom 70SG	1	Do not follow soil applications with foliar applications of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 12 oz/a per season using soil applications. See product label for application directions.
		soil: 5.0–6.0 oz Venom 70SG	21	
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC, 1.0–2.0 lb Thiodan WP	2	Do not exceed 3 lb ai/a per year.
	0.25–0.38 lb imidacloprid	7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on plant row within 14 days before planting or as an in-furrow treatment during planting. Do not exceed 0.38 lb ai/a per year.
	1.0–2.0 lb malathion	several formulations	1	Do not apply before vining or to wet plants.
	0.45–0.9 lb methomyl	1.5–3.0 pt *Lannate LV 0.5–1.0 lb *Lannate SP		See label for days to harvest. Do not exceed 5.4 lb ai/a per season.
	0.375–0.5 lb oxydemeton-methyl	1.5–2.0 pt *Metasystox-R	3	Do not apply more than two applications per season.
	0.86 lb pymetrozine	2.75 oz Fulfill	14	Controls melon and green peach aphids. Treat when aphids first appear. May repeat in 7 days. Do not exceed 5.5 oz/a per season or more than two applications per crop.
	thiamethoxam	1.5–3.0 oz Actara 25WDG 5.0–11.0 fl oz Platinum 2SC	30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct-seeded crops in-furrow at the seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11.0 oz/a Platinum per season. Actara is applied as a foliar spray.
	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season
Seed corn maggot	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR		Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not apply more than 0.1 lb/a Capture LFR per season as an at-plant application.
Spider mite	0.938–1.88 lb abamectin	8.0–16.0 fl oz *Agri-Mek 0.15EC	7	May repeat after 7 days, but do not make more than two sequential treatments or exceed 5.64 lb ai/a per year.
	0.375–0.5 lb bifenazate	0.75–1.0 lb Acramite 50WS	3	Do not exceed one application per season.

*Restricted-use pesticide.

(continued)

Insect control in cucumber (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Spider mite (cont.)	0.08–0.10 lb bifenthrin	5.12–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than two applications after bloom. Do not exceed 0.3 lb ai/a per season.
	0.625 lb dicofol	20.0 oz Dicofol 4E	2	Do not make more than one application per season. Do not use in mixtures with other materials.
	0.2 lb fenpropathrin	10.0–66.0 fl oz Danitol 2.4EC	7	Treat when mites first appear and repeat every 7 days as needed. Do not exceed 0.8 lb ai/a per season.
	1.5–2.0 lb malathion	several formulations	1	Do not apply before vining or to wet plants.
	0.11–0.13 lb spiromesifen	7.0–8.5 fl oz Oberon 2SC	7	Apply every 7 days as needed. Do not exceed 25.5 fl oz/a per season.
Squash bug	<i>Check undersides of leaves for squash bug eggs laid in neat rows. Eggs hatch within 1–2 weeks. Treat when squash bugs are young; they are difficult to control as older nymphs or adults. Destroy crop residue in fall to reduce overwinter survival of this pest.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than two applications after bloom. Do not exceed 0.3 lb ai/a per season.
	0.5–1.0 lb carbaryl	Sevin WP	3	See label for rate.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC, 1.0–2.0 lb Thiodan WP	2	Do not exceed 3 lb ai/a per year.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per season.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Will kill adult squash bugs. See label for rate.
	0.018–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season
Squash vine borer	<i>Treat when adults are observed (900 DD₅₀ or when chicory is in bloom), especially when runners are less than 2 feet long. Larvae boring in the main stem can kill the entire plant, while loss of a runner or two when the plant is larger will not cause economic damage. Look for sawdust-like excrement coming from holes in the stems, and open the stems to confirm the presence of squash vine borer larvae. Repeat applications at 5- to 7-day intervals throughout the 3-week egg-laying period.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than 2 applications after bloom. Do not exceed 0.3 lb ai/a per season.
	0.5–1.0 lb carbaryl	Sevin (several formulations)	3	Do not apply during maximum flowering or fruit set, or when pollinating bees are in the field. Spray during the evening.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC, 1.0–2.0 lb Thiodan WP	2	Apply weekly to flower buds, stems, and vines beginning when moths first appear.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per season
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. Do not apply more than 1.6 lb ai/a per season.
	0.4 lb rotenone	Rotacide EC	0	Apply as late in day as possible.
	0.018–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season

*Restricted-use pesticide.

Weed control in cucumber

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.15–0.38 lb clomazone	0.4–1.0 pt Command 3ME	45	For suppression and control of annual grasses and broadleaves, make a single preemergent soil application before seeding or transplanting. Place seed or roots of transplants below the chemical barrier when planting. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read and understand the vegetable disclaimer section of the label—the end user assumes all liability for failure to perform and crop injury resulting from its use.
	1.1–1.7 lb ethalfluralin	3.0–4.5 pt Curbit 3EC		Make a single broadcast application within 2 days of seeding. Rate varies with soil texture and organic matter. A shallow cultivation or ½ inch of water is needed to activate the herbicide. Heavy rain following application or shallow seeding may result in crop injury. Do not incorporate or use under plastic mulch, broadcast over transplants, or apply through irrigation. Do not use on soils with more than 10% organic matter.
	0.4–1.2 lb ethalfluralin + 0.125–0.375 lb clomazone	2.0–6.0 pt Strategy	45	Use only as a postplant surface-applied herbicide. Make one application before crop and weeds emerge or apply as a banded spray between rows following crop emergence or transplanting. Strategy requires rainfall, irrigation, or a shallow cultivation within 2–5 days after application for activation. Because of the potential for offsite movement and severe crop injury, strictly follow all precautions and restrictions on the label.
	2.0–4.0 lb naptalam + 4.0–6.0 lb bensulide	4.0–8.0 qt Alanap-L + 4.0–6.0 qt Prefar 4E		This tank mix controls both grassy and broadleaf weeds better than either material alone. Apply just before planting and shallowly incorporate. If you irrigate immediately after application, incorporation isn't necessary.
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or equivalent	30	Direct-spray between rows when plants have reached the 3- to 4-leaf stage. Set incorporation equipment to move treated soil around the base of plants. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		This treatment should be preplant incorporated (1–2 inches deep) to avoid losses from volatilization. Use on mineral soils only.
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Apply to weed-free soil. Treat only if plants have 4–5 true leaves and are well established, and growing conditions are favorable or severe crop injury may result. Use only on soils with 5% or less organic matter.

(continued)

Weed control in cucumber (cont.)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual broadleaves	2.0–4.0 lb naptalam	4.0–8.0 qt Alanap-L		Apply Alanap to weed-free soil. Light irrigation after application enhances herbicide activity. Apply preemergence treatment immediately after seeding. Do not apply when growing conditions are poor (cool, wet spring weather) as stunting may result. Do not apply post-emergence when temperatures exceed 100° F. Check label for application rate for your soil type. A second application can be made about 1 month after seeding just before the crop starts to vine and before weeds have emerged.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea	30	Sandea controls several broadleaf weeds and nutsedge. It will not control grasses. Sandea has both pre- and postemergence activity and can be used under plastic mulch. Do not exceed two applications per crop cycle or 2 oz per 12-month period. Do not apply foliar organophosphate insecticides within 21 days before or 7 days after any Sandea application. Consult label for rate, application timing and other important usage information and precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Some formulations require a wait of 3 days between application and seeding. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding should be performed with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	14	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	14	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	14	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rates. Do not apply more than 3 pt/a Poast in one crop season. Always add 2 pt/a oil concentrate. Check the label for additional precautions and restrictions.

*Restricted-use pesticide.

Eggplant

Planting

Choose well-drained, moderately fertile, sandy loam soils. Seeds germinate best at soil temperatures of 75–90°F. Set medium-sized, vigorous 6- to 8-week-old plants outside about June 1, or after danger of frost and chilling. Before transplanting, harden the plants by holding them at 60–65°F for a few days or place them in covered beds outside the greenhouse. To lessen the shock from transplanting, use a starter solution high in phosphorus.

Rows—24–48 inches;

plants in row—18–30 inches apart. Use 2 oz seed/a. (1 oz produces 2,500 plants.)

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.6–6.9.

Fertilizer rates: Apply 60–100 lb N/a, 60 lb P₂O₅/a, and 60 lb K₂O/a. Take credits for previous legume crops and manure.

Application: Broadcast and work in before planting.

Nitrogen: On sandy soils, use the higher nitrogen rate and split the recommendation into two or more applications during the season, preferably at 2–3 week intervals.

Disease control in eggplant

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria blight, Anthracnose, and Phomopsis fruit rot	fixed copper	2.0 lb Champion 77WP	0	Rotate with crops other than eggplant, tomato, or pepper; use disease-free seed; and grow resistant varieties. 'Florida Market' and 'Florida Beauty' are resistant to Phomopsis fruit rot, though they are very late for Wisconsin.
		2.6 pt Champion Flowable 4.5F	0	
		2.0 lb Kocide 101 77WP, DF	0	
		2.3 pt Kocide LF 2.4F	0	
		1.3 pt Kocide 4.5 LF	0	
		1.5 lb Kocide 2000 DF	0	
Anthracnose	azoxystrobin	2.0–5.0 oz Amistar 80 WDG	0	Amistar, Quadris, and Cabrio belong to the Group 11 (strobilurin) category of fungicides. Do not exceed one application of a strobilurin product before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per crop per acre per year. Do not exceed 1.25 lb/a Amistar, 1.92 qt/a Quadris, or 96 oz/a Cabrio per season.
		6.2–15.4 fl oz Quadris Flowable	0	
	pyraclostrobin	8.0–12.0 oz Cabrio EG	0	
Phytophthora blight, ripe rot	dimethomorph	6.4 oz Acrobat 50WP	0	Disease suppression only. Tank-mix with another fungicide active against Phytophthora blight and having a different mode of activity. Do not make more than 2 sequential applications of Acrobat 50WP before alternating to another effective fungicide. Do not make more than 5 applications per season or apply more than 32 oz/a per season.
Seed rot and damping-off	mefenoxam	1.0 pt Ridomil Gold EC 1.0 lb Ridomil Gold WSP		Use disease-free or sterilized soil. Soil treatment at time of planting.
Verticillium wilt	metam-sodium	Vapam HL, Metam, Sectagon 42		Use long rotations with non-susceptible crops and eradicate weeds. Plant in well-drained soils. Steam sterilization can also be used.

Insect control in eggplant

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphid	acetamiprid	0.8–1.2 oz Assail 70WP 2.0–4.0 oz Assail 30SG	7 7	Begin treatment when thresholds are reached. Apply every 7 days as needed. Do not exceed 0.375 lb ai/a per season.
	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, Phaser WSB 0.66–1.33 qt Thiodan EC, Phaser EC	1	Do not exceed 0.5 lb ai/year.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a Decis.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	For suppression of aphids only. Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.25–0.38 lb imidacloprid	7.0–10.5 fl oz Admire Pro	21	Systemic at planting.
		3.75 fl oz Provado 1.6	0	Foliar spray. Do not exceed 18.75 fl oz/a Provado per season.
	0.63–1.0 lb malathion	several formulations	3	
	0.225–0.90 lb methomyl	0.25–1.0 lb *Lannate SP, 0.75–3.0 pt *Lannate LV	5	Do not exceed 4.5 lb ai/a per season.
	0.5 lb oxydemeton-methyl	2.0 pt *Metasystox-R	7	Do not apply more than three times per season.
	pymetrozine	2.75 oz Fulfill WDG	14	Treat when aphids first appear. Controls potato and green peach aphids. May repeat application in 7 days. Do not exceed 5.5 oz/a per season or 2 applications per crop.
	thiamethoxam	2.0–3.0 oz Actara	0	Apply before pests reach damaging levels. Repeat as needed every 5 days. Do not exceed 8 oz/a of product per season.
		5.0–11.0 fl oz Platinum	30	Apply as an in-furrow spray at planting or as a post-seeding transplant or hill drench. Irrigate sufficiently to move the chemical into the root zone. Use the higher rate for long residual control. Do not apply less than 5 fl oz/a or more than 11 fl oz/a of Platinum per season.
	zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.
Colorado potato beetle	<i>When plants are smaller than 6 inches, treat if you find 2 small larvae or 1 large larvae or adult per plant. For plants taller than 6 inches, treat if you find 4 small larvae or 2 large larvae or adults per plant.</i>			
	0.009–0.019 lb abamectin	8.0–16.0 fl oz Agri-Mek 0.15EC	7	Begin treatments at thresholds. Use high rates for resistance management.
	acetamiprid	0.16–1.1 oz Assail 70WP 1.5–2.5 oz Assail 30SG	7 7	Begin treatment when thresholds are reached. Apply every 7 days as needed. Do not exceed 0.375 lb ai/a per season.
	<i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i>	1.0–3.0 qt Novador	0	Make initial spray when small larvae are first observed.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC	7	Apply every 7 days as needed. Do not exceed 0.2 lb ai/a per season.
	0.5–2.0 lb carbaryl	Sevin	3	Several formulations; see label for rate.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a.
	0.045–0.268 lb dinotefuran	foliar: 1.0–4.0 oz Venom 70SG	1	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 12 oz/a per season using soil applications. See product label for application directions.
		soil: 5.0–6.0 oz Venom 70SG	21	

*Restricted-use pesticide.

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Insect control in eggplant (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Colorado potato beetle (cont.)	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, Phaser WSB 0.66–1.33 qt Thiodan EC, Phaser EC	1	Do not exceed 1 lb ai/a per year.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.25–0.38 lb imidacloprid	7.0–10.5 fl oz Admire Pro	21	Systemic at planting.
		3.75 fl oz Provado 1.6	0	Foliar spray.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	3	Apply no more than 2 lb ai/a per season.
	0.039–0.078 lb spinetoram	5.0–10.0 oz Radiant SC	1	Do not apply more than 34 oz/a Radiant (0.266 lb ai/a) per crop and do not exceed six applications per year.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	1 1	Use higher rate for larger insects. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent. Spray thoroughly for control.
		thiamethoxam	2.0–3.0 oz Actara	0
			5.0–11.0 fl oz Platinum	30
	zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.
European corn borer	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.065–0.11 lb indoxacarb	3.5–6.0 oz Avaunt	7	Do not exceed 0.26 lb ai/a per season.
	0.063–0.25 lb methoxyfenozide	4.0–16.0 fl oz Intrepid 2F	1	Will not control Colorado potato beetle. Do not exceed 64 fl oz/a per season. Use higher rate with higher populations or when spray coverage is difficult. See label for use restrictions in some Wisconsin counties.
	0.039–0.078 lb spinetoram	5.0–10.0 oz Radiant SC	1	Do not apply more than 34 oz/a Radiant (0.266 lb ai/a) per crop and do not exceed six applications per year.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust	1	Use higher rate for larger insects. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent. Spray thoroughly for control.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

(continued)

Insect control in eggplant (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Flea beetles (striped, spotted)	<i>When eggplants are less than 3 inches tall, treat if you find 2 beetles per plant. At a plant height of 3–6 inches, treat if there are 4 beetles per plant. For plants taller than 6 inches, treat if you find 8 or more beetles per plant.</i>			
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC	7	Apply every 7 days as needed. Do not exceed 0.2 lb ai/a per season.
	0.5–1.0 lb carbaryl	2.0 lb Sevin 50WP 1.25 lb Sevin 80S 1 qt Sevin XLR Plus	3	See label for rate.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a.
	0.045–0.268 lb dinotefuran	<i>foliar:</i> 1.0–4.0 oz Venom 70SG <i>soil:</i> 5.0–6.0 oz Venom 70SG	1 21	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 12 oz/a per season using soil applications. See product label for application directions.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Systemic at planting.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	3	Apply no more than 2 lb ai/a per season.
	thiamethoxam	2.0–3.0 oz Actara	0	Apply before pests reach damaging levels. Repeat as needed every 5 days. Do not exceed 8 oz/a of product per season.
		5.0–11.0 fl oz Platinum	30	Apply as an in-furrow spray at planting or as a post-seeding transplant or hill drench. Irrigate sufficiently to move the chemical into the root zone. Use the higher rate for long residual control. Do not apply less than 5 fl oz/a or more than 11 fl oz/a of Platinum per season.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

Weed control in eggplant

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	1.0–2.0 lb napropamide (transplants only)	2.0–4.0 lb Devrinol 50-DF		Apply to weed-free soil before transplanting. Incorporate 1–2 inches. Use the lower rate on coarse, sandy soils. Carry-over the following year may affect sensitive crops, especially small grains.
	0.5–0.75 lb trifluralin	1.0–1.5 pt Treflan HFP or equivalent		Apply before transplanting or as a directed spray to the soil between rows after transplanting. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Incorporate within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting and incorporate 1–2 inches deep to avoid loss due to volatilization. Use on mineral soils only.

*Restricted-use pesticide.

(continued)

Weed control in eggplant (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Make preemergence applications to weed-free soil 4–6 weeks after transplanting or to seedlings that are 4–6 inches tall. Use only on soils with 5% or less organic matter.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea	30	Sandea controls several broadleaf weeds and nutsedge. It will not control grasses. Sandea may be applied between rows of direct-seeded or transplanted eggplant as a directed or shielded spray. Avoid contact of the spray with the crop. If plastic was used on the planted row, adjust equipment to keep application off the plastic. Do not apply more than 2 oz/a per crop cycle or 12-month period. Soil or foliar applications of organophosphate insecticides to Sandea-treated crops may increase potential for and severity of crop injury. Consult label for additional usage information and other precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Some formulations require a wait of 3 days between application and seeding. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding and transplanting should be performed with minimal soil disturbance. Up to three directed/shielded treatments may be made per season using precision equipment to prevent spray contact with the crop. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	20	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	20	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	20	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for early and rescue treatment rates as well as additional precautions and restrictions. Do not exceed 4.5 pt/a Poast per season. Always add 2 pt/a oil concentrate.

*Restricted-use pesticide.

Horseradish

Horseradish is usually grown commercially as an annual in Wisconsin. One-year-old secondary roots are selected and detached from primary roots at harvest for planting the following year. When grown as a perennial, the main roots are harvested and secondary roots broken off during harvest will provide root material for the next year's crop.

In Wisconsin, horseradish is grown on sands, sandy loams and organic soils. Such soils should be well drained and stone free. Irrigation is recommended for profitable horseradish production on very sandy soils.

Planting **Rows**—30–36 inches; **plants in row**— 12–18 inches apart.

Use set roots that are 1/4–1/2 inch thick and 12–14 inch long. Lay roots flat in shallow furrows with the crown end resting slightly higher than the basal end. Cover the sets with 2–4 inches of soil, then firm the soil using a roller.

After the plant is established, lift the crown end slightly to break off the new secondary roots from the upper portion. The remaining secondary roots at the basal end will nourish the set and young plant. Removing the secondary crown roots allows enlargement of the set root, yielding high quality primary roots.

Lime and fertilizer **Lime:** Use dolomitic lime to maintain a pH of 6.8.

Fertilizer rates: On sands/sandy loams with a pH of 6.5 or higher, the soil test value for phosphorous should be in the range of 60 ppm. The potassium soil test should be in the range of 140 ppm. Use annual nitrogen, P₂O₅, and K₂O recommendations listed in the table below.

Application: Broadcast lime and fertilizer and work in before planting. Sidedress annual applications at planting.

Nitrogen: On irrigated sands, apply 25% of the nitrogen at planting. Apply the remainder in at least two applications after crop emergence. Split applications reduce the potential for nitrate leaching.

Micronutrients: Irrigated sands may require additional sulfur and boron.

Annual nitrogen, phosphate, and potash recommendations for horseradish

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P ₂ O ₅	K ₂ O
— % —	— lb/a —	— t/a —	— — — lb/a — — —	
<2	160	6	50	160
2.0–9.9	120			
10–20	100			
>20	75			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in horseradish

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria leaf spot and white rust	azoxystrobin	2.0–6.5 oz Amistar 80 WDG	0	Amistar, Quadris, and Cabrio belong to the Group 11 (strobilurin) category of fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed 3 applications of strobilurin fungicides per year. Do not exceed 2.5 lb/a Amistar, 2.88 qt/a Quadris or 48 oz/a Cabrio per season.
		6.2–15.4 fl oz Quadris Flowable	0	
	pyraclostrobin	8.0–16.0 oz Cabrio EG	0	
Pythium and Phytophthora root rot	mefenoxam	1.0–2.0 pt Ridomil Gold EC 1.0–2.0 lb Ridomil Gold WSP		Preplant incorporated application or surface application after planting.
Verticillium wilt root rot pathogens	metam-sodium	50 gal Vapam HL, Metam, Sectagon 42		Knife into plow layer of soil at a rate of 50 gal/a or on sandy soils only apply through the irrigation system in 0.6–1.0 inches of water in the fall. An approved backflow prevention valve must be used when applying fumigant through irrigation system. Do not apply if significant rainfall is forecast in the next 24 hours. Fields must be monitored during and after application. Soil temperature must be below 75°F. Fumigant cannot be applied through an irrigation system within 1/4 mile of an institution such as a hospital, school, or prison.

Insect control in horseradish^a

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	imidacloprid	0.31–0.74 fl oz Admire Pro/1000 ft of row	21	Admire may only be applied once per season.
		4.4–10.5 fl oz Admire Pro	21	Apply Provado every 5 days as needed. Do not exceed 3 applications per season.
		3.5 fl oz Provado	7	Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
	0.45 lb methomyl	1.5 pt *Lannate LV 0.5 lb *Lannate SP	65	Do not exceed 1.8 lb ai/a per season.
	0.94–1.25 lb malathion	several formulations	7	
	0.4 lb rotenone	Rotacide	0	
	thiamethoxam	1.5–3.0 fl oz Actara	7	Apply before pests reach damaging levels. Use higher rate for heavy infestations. Do not exceed 8 oz/a per season.
Beet leafhopper	imidacloprid	5.0–12.0 fl oz Platinum	0–30	Apply as an in-furrow spray or as a surface band at seeding. For surface-banded applications, irrigate within 24 hours to seeding depth using trickle or drip watering.
	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season
	imidacloprid	0.31–0.74 fl oz Admire Pro/1000 ft of row	21	Admire may only be applied once per season.
		4.4–10.5 fl oz Admire Pro	21	Apply Provado every 5 days as needed. Do not exceed 3 applications per season.
		3.5 fl oz Provado	7	Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
Beet leafhopper	0.45 lb methomyl	1.5 pt *Lannate LV 0.5 lb *Lannate SP	65	Treat when migrating beet leafhoppers are collected (usually July–August) or when brittle root disease is detected in fields.
	0.1 lb permethrin	*Ambush, *Pounce	22	Several formulations; see label for rate. Do not exceed three foliar applications per season.

*Restricted-use pesticide.

^aAdapted from Illinois pest control recommendations.

(continued)

Insect control in horseradish^a (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Beet leafhopper (cont.)	thiamethoxam	1.5–3.0 fl oz Actara	7	Apply before pests reach damaging levels. Use higher rate for heavy infestations. Do not exceed 8 oz/a per season.
		5.0–12.0 fl oz Platinum	0–30	Apply as an in-furrow spray or as a surface band at seeding. For surface-banded applications, irrigate within 24 hours to seeding depth using trickle or drip watering.
	0.011–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season
Diamondback moth (DBM)	imidacloprid	0.31–0.74 fl oz Admire Pro/1000 ft of row	21	Admire may only be applied once per season.
		4.4–10.5 fl oz Admire Pro	21	Apply Provado every 5 days as needed. Do not exceed 3 applications per season.
		3.5 fl oz Provado	7	Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Cutlass, Dipel, Javelin, and others	0	Rates vary with formulation, check the label. Must be eaten by caterpillars to be effective. Thorough coverage is necessary; some labels recommend wetting agents.
		1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.5–1.5 lb <i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i>	Xentari		Treat early instar larvae before noticeable feeding damage occurs. Must be eaten to be effective. Thorough coverage is necessary. Repeat as needed.
	0.1 lb permethrin	*Ambush, *Pounce	22	Treat when larvae are small. Several formulations; see label for rate. Do not exceed 3 foliar applications per season. In some areas DBM has become resistant to permethrin and other compounds; resistance levels vary within the state and locally. Use <i>Bt</i> products where resistance to these compounds has developed or to slow development of resistance.
Flea beetles	<i>Treat only if you find large populations early in the season.</i>			
	0.5–2.0 lb carbaryl	Sevin	3	Several formulations; see label for rate.
	imidacloprid	0.31–0.74 fl oz Admire Pro/1000 ft of row	21	Admire may only be applied once per season.
		4.4–10.5 fl oz Admire Pro	21	Apply Provado every 5 days as needed. Do not exceed 3 applications per season.
		3.5 fl oz Provado	7	Maximum imidacloprid use per season is 0.5 lb ai/a from any formulation.
	0.4 lb rotenone	Rotacide	0	Apply as late in the day as possible.
	0.046–0.063 lb spinetoram	6.0–8.0 oz Radiant SC	3	For suppression only. Do not apply more than 28 oz/a Radiant (0.219 lb ai) per crop and do not exceed three applications per year.
	thiamethoxam	1.5–3.0 oz Actara 25WDG	0–30	Apply as an in-furrow spray or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 12.0 o/a per season. Actara is applied as a foliar spray.
		5.0–12.0 Platinum 2SC		
	0.011–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season
Imported crucifer weevil	<i>Crop rotation, destroying volunteers, use of insecticide dips for sets, and foliar insecticide sprays will help reduce weevil populations.</i>			
	0.1% solution permethrin	*Ambush (several formulations)	30	At planting. Soak sets 30 minutes and air dry before planting to kill eggs and larvae.
	0.2 lb permethrin	*Ambush, *Pounce	30	Apply if needed when adults are present on foliage (usually August). Several formulations; see label for rate. Do not exceed three foliar applications per season.
	0.011–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season

*Restricted-use pesticide.

^aAdapted from Illinois pest control recommendations.

Weed control in horseradish

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.56–0.98 lb dimethenamid-P	12.0–21.0 fl oz Outlook 6.0	40	Apply only when horseradish is between the 2-leaf and 8-leaf stage. Outlook will not control emerged weeds. Injury may occur when cool weather follows application.
Annual broadleaves	0.5 lb oxyfluorfen	2.0 pt Goal 2XL		Controls common lambsquarters, redroot pigweed, common purslane, shepherd's purse, and Pennsylvania smartweed. Apply after planting but before annual weed emergence. Use flat fan nozzles in a minimum of 20 gal/a of water and 20–40 psi. For maximum activity, soil surface should be smooth and free of weed and crop residue. Avoid disturbing the soil surface after application for as long as weed control is desired. Cultural practices that redistribute or disturb the soil surface will decrease herbicidal activity. Rainfall or irrigation of 1/4 inch after application is necessary for herbicide activation. Do not apply through irrigation. Do not use when horseradish plantings are weak or stressed.
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Make preemergence applications to weed-free soil immediately after planting. Use only on soils with 5% or less organic matter.
	0.07–0.25 lb sulfentrazone	2.25–8.0 oz Spartan 4F		Broadcast applications can be made in the fall, in the spring before planting, or after planting up to 5 days before crop emergence. Banded applications to row middles are permitted following crop emergence. Use rate is based on soil texture and organic matter. Do not exceed maximum annual use rate. See label for weeds controlled and other precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. May be applied any time before the crop emerges. Do not treat mowed or tilled weeds until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow at least 7 days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified. Roundup WeatherMax also has a 24c label for wiper application (expires 12/31/09).
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	30	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals. Do not cultivate grasses within 7 days before or after application. Always include crop oil concentrate at 1% v/v in the final spray mix. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	30	
	0.094–0.47 lb sethoxydim	0.5–2.5 pt Poast	60	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rate and for information on quackgrass control. Do not exceed 2.5 pt per application or 5 pt/a per season. Always add 2 pt/a of crop oil concentrate. Do not cultivate within 5 days before or 7 days after application.
Volunteer horseradish	4.0 lb acid equivalent glyphosate	4.0 qt Roundup Ultra		For control of volunteer horseradish, apply in mid-September. Disc field 4–6 weeks prior to application. Use spray only. Do not wick apply.

Leafy greens

lettuce, chicory, endive, escarole, and others

Planting

Make successive plantings from April to mid-July. Irrigate after seeding in dry weather. Choose deep, fertile soils with an abundance of available moisture during the growing season. Rotate leafy greens with other vegetable crops. Break up fresh leafy greens residue and allow it to dry for several days before plowing or working the residue into the soil. Crisphead-lettuce types are difficult to grow in Wisconsin. Some varieties will not germinate in warm soils (above 40–50°F)

Rows—12–36 inches;

plants in row—2–12 inches. Use 0.5–1.0 lb seed/a (use only mosaic-free seed).

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 5.6 or higher in organic soils and at least 5.8 in other soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in table below. Take credits for previous legume crops and manure.

Application: Broadcast and work in before planting. For most efficient use of nitrogen, split the recommendation into two or more applications during the season.

Micronutrients: Leafy greens need relatively high amounts of manganese, molybdenum, and copper. Use soil and plant analyses to check for deficiencies of these nutrients.

Annual nitrogen, phosphate, and potash recommendations for leafy greens

Nitrogen		Phosphate and potash	
		Amount to apply ^a	
Organic matter	Amount to apply	Yield goal	P_2O_5 K_2O
— % —	— lb/a —	— t/a —	— — — lb/a — — —
<2	120	15–20	40 160
2.0–9.9	100		
10–20	80		
>20	40		

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in leafy greens

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aster yellows	Control aster leafhopper (see insect control table); also see “Aster Yellows Index” at the beginning of the book .			
Bottom rot (Rhizoctonia) and drop (Sclerotinia)	Use long rotations with resistant crops such as corn, grasses, or small grains. Good weed control is important because these disease pathogens attack a wide range of plants. Maintain good soil fertility—healthy plants will be more resistant to disease. Also improve soil aeration at the base of plants by pairing the rows on raised beds and thinning plants to allow optimum growth. Chop debris with Rotobeater or flail-type machine. This will encourage rapid breakdown of plant materials and reduce potential of pathogens overwintering.			
	iprodione	1.5–2.0 pt Rovral 4FL	14	Lettuce only. Spray at the three-leaf stage and again 10 days later. Use a tractor-mounted boom with hollow cone or flat fan nozzles. Direct spray to the base of plants.
Damping-off (Pythium)	Avoid growing lettuce on wet, poorly drained soil.			
	mefenoxam	1.0–2.0 pt Ridomil Gold EC 1.0–2.0 lb Ridomil Gold WSP		Lettuce and endive only. Preplant incorporated application or surface application after planting.
Downy mildew	fixed copper	1.0–2.0 lb Champion 77WP	0	Lettuce, endive, and escarole only.
		0.6–1.3 pt Champ Formula 2 4.6F	0	
Lettuce mosaic	Use seed certified mosaic-free.			
Root rot	Thoroughly work old plant refuse into the soil. Only grow one lettuce crop per season on a field.			

Scouting calendar for insect pests of leafy greens

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
	Flea beetles				
	Leafminers				Leafminers
		Aster leafhopper			
		Aphids			
			Loopers		

Insect control in leafy greens

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	<i>Treat seedlings if 1 or more aphids per plant; treat established plants if 10 or more aphids per plant.</i>			
	0.5–1.0 lb acephate	0.5–1.0 lb Orthene 97	14	Head lettuce only. Do not exceed 2.66 lb ai/a per season.
	acetamiprid	0.8–1.2 oz Assail 70W	7	Begin treatment when thresholds are reached. Apply every 7 days as needed. Do not exceed five applications or 0.375 lb ai/a per season.
		2.0–4.0 oz Assail 30SG	7	
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC	7	Apply to head lettuce every 7 days as needed. Do not exceed 0.5 lb ai/a per season.
	0.25–0.5 lb diazinon	several formulations	14	
	0.25 lb dimethoate	0.5 pt Dimethoate EC	7 (head) 14 (leaf)	
	imidacloprid	4.4–10.5 fl oz Admire Pro	21	Systemic at planting. Do not exceed 24 fl oz/a Admire per season.
		3.75 fl oz Provado F	7	Foliar spray. Apply before populations become damaging. Do not exceed 18.75 fl oz/a Provado per season.
	0.02–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	1	Do not apply more than 2.4 pt/a per season.
	1.25–1.9 lb malathion	several formulations	7–14	Apply twice a week. Check label for crop.
	0.375–0.5 lb oxydemeton-methyl	1.5–2.0 pt *Metasystox-R	21	Head lettuce only. Maximum of 3 applications per season.
	0.1–0.2 lb permethrin	*Pounce (several formulations)	1	Apply every 3–5 days as needed. Do not exceed 2 lb ai/a per season; for spinach do not apply more than 1 lb ai/a per season.
	0.086 lb pymetrozine	2.75 oz Fulfill 50WDG	0	Apply before aphids reach damaging levels. Do not exceed 5.5 oz/a per season.

thiamethoxam	1.5–3.0 oz Actara 25WDG 5.0–11.0 Platinum 2SC	0–30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct seeded crops in-furrow at the seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11 oz/a per season. Actara is applied as a foliar spray.
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0.014–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
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*Restricted-use pesticide.

(continued)

Insect control in leafy greens (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aster leafhopper and tarnished plant bug	0.5–1.0 lb acephate	0.5–1.0 lb Orthene 97	21	Head lettuce only. See label for feeding restrictions. Do not exceed 2.66 lb ai/a per season.
	0.033–0.10 lb bifenthrin (leafhopper)	2.1–6.4 fl oz * Brigade 2EC	7	Apply to head lettuce every 7 days as needed.
	0.08–0.10 lb bifenthrin (tarnished plant bug)	5.12–6.4 fl oz *Brigade 2EC	7	Do not exceed 0.5 lb ai/a per season.
	1.0–2.0 lb carbaryl	Sevin (several formulations)	3	Apply at 5- to 7-day intervals.
	0.25 lb dimethoate	0.5 pt Dimethoate EC	7 (head) 14 (leaf)	Apply weekly as needed.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	1	Do not exceed 2.4 pt/a per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV 0.25–1.0 lb *Lannate SP	10 (lettuce) 80 (chicory)	Refer to label for application limits.
	0.1–0.2 lb permethrin	*Ambush (several formulations)	1	See label for specific restrictions.
	zeta-cypermethrin	2.24–4.0 fl oz *Mustang Max	1	Apply every 7 days as needed. Do not exceed 24 oz/a Mustang Max per season.
Leafhoppers only	0.05–0.1 lb cypermethrin	2.5–5.0 fl oz *Ammo EC	5	Apply no more than 0.6 lb ai/a per season.
	0.045–0.268 lb dinotefuran	foliar: 1.0–4.0 oz Venom 70SG soil: 5.0–6.0 oz Venom 70SG	1 21	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 12 oz/a per season using soil applications. See product label for application directions.
	imidacloprid	4.4–10.5 fl oz Admire Pro	21	Systemic at planting. Do not exceed 24 fl oz/a Admire per season.
	0.25–0.5 lb malathion	several formulations	7–14	Apply twice a week.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Do not exceed 2 lb ai/a per season.
	thiamethoxam	3.0–5.5 oz Actara 25WDG 5.0–11.0 Platinum 2SC	30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct seeded crops in-furrow at the seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11 oz/a per season. Actara is applied as a foliar spray.
Loopers	<i>For damage-free produce in mass-harvested crops, treat when 5% of the plants are infested. If selectively harvesting only healthy plants, more damage can be tolerated; treat when 15% of plants are infested.</i>			
	0.5–1.0 lb acephate	0.5–1.0 lb Orthene SP, 97	21	Head lettuce only. Do not exceed 2.66 lb ai/a per season.
	<i>Bacillus thuringiensis</i>	Bactospeine FC, WP; Biobit FL, WP; Cutlass; Dipel 2DF; Javelin; MVP	0	Rates vary with formulation, check the label.
	1.0–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC	7	Apply to head lettuce every 7 days as needed. Do not exceed 0.5 lb ai/a per season.
	0.025–0.1 lb cypermethrin	*Ammo WSB, EC; *Cymbush EC	5 5	Do not exceed 0.6 lb ai/a per season.

*Restricted-use pesticide.

(continued)

Insect control in leafy greens (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Loopers (<i>cont.</i>)	0.0075–0.015 lb emamectin benzoate	3.2–4.8 oz *Proclaim	7	Apply when larvae first appear. Use higher rate for larger larvae or severe outbreaks. Do not exceed 28.8 oz ai/a per season. Highly toxic to bees.
	0.75–1.0 lb endosulfan	1.0–1.33 qt Thiodan, Phaser EC 1.5–2.0 lb Thiodan WP	14	Do not feed crop waste to livestock. Limit of three applications after thinning. Remove wrapper leaves at harvest.
	0.045–0.065 lb indoxacarb	2.5–3.5 oz Avaunt	3	For use on head and leaf lettuces only. Apply when insect populations reach threshold levels. Do not exceed 0.25 lb ai/a per crop.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	1	Do not exceed 2.4 pt/a per season.
	1.25–1.9 lb malathion	several formulations	7–14	
	0.45–0.9 lb methomyl	1.5–3.0 pt *Lannate LV 0.5–1.0 lb *Lannate SP		See label for days to harvest.
	0.06–0.16 lb methoxyfenozide	early season: 4.0–8.0 fl oz Intrepid 2F mid- to late season: 8.0–16.0 fl oz Intrepid 2F	1 1	Do not exceed 64 fl oz/a per season. Use the higher rates with higher populations or when spray coverage is difficult. See label for use restrictions in some Wisconsin counties.
	0.1–0.2 lb permethrin	*Ambush, *Pounce (several formulations)	1	Do not exceed 1 lb ai/a for spinach and 2 lb ai/a for all other leafy greens per season.
	0.039–0.078 lb spinetoram	5.0–10.0 oz Radiant SC	1	Do not apply more than 34 oz/a Radiant (0.266 lb ai/a) per crop and do not exceed six applications per year.
	0.047–0.125 lb spinosad	3.0–8.0 fl oz SpinTor 2SC 1.0–2.5 fl oz Entrust	1 1	Use higher rate for larger larvae. Apply in adequate spray volume to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not apply to seedlings grown for transplant.
	0.09–0.12 lb tebufenozide	6.0–8.0 fl oz Confirm 2F	7	Apply per label directions every 10–14 days as needed. Do not exceed 56 oz/season or 8 oz/application. There is a 1–12 month plantback restriction depending on the crop.
	zeta-cypermethrin	2.24–4.0 fl oz *Mustang Max	1	Apply every 7 days as needed. Do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

Weed control in leafy greens (see label for specific crop species)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	1.0–2.0 lb pronamide	2.0–4.0 lb Kerb 50W	55	Rate depends on soil texture and method of irrigation. Not recommended for high organic (muck) soils. Application can be made before or after planting, but prior to emergence of weeds. Do not apply postemergence to leaf lettuce. Do not use more than 3 lb Kerb 50W on certain varieties of crisp lettuce or on endive or escarole or make more than one application per season. Kerb should be incorporated mechanically or with rainfall or irrigation within 2–3 days of application.

(continued)

Weed control in leafy greens (cont.)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds (cont.)	trifluralin	Treflan HFP or other registered trifluralin formulation		See label for allowable leafy greens and rates. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting. Incorporate 1–2 inches deep to avoid loss due to volatilization. Use on mineral soils only.
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75		Make preemergence applications to weed-free soil at seeding. Can be preplant incorporated. Use only on soils with 5% or less organic matter.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding and transplanting should be performed with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	14	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	(leaf lettuce) 30 (chicory)	
	0.124–0.188 lb fluazifop-P-butyl	8.0–12.0 oz Fusilade DX	28	Only labeled for endive. Make postemergence application to actively growing grasses. Read label for size range and treatment rate. Always add either crop oil concentrate or nonionic surfactant to final spray mix. Do not apply more than 48 oz/a per season.
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	30 (head lettuce) 15 (leaf lettuce, endive, escarole)	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for early and rescue treatment rates. Do not apply more than 3 pt Poast/a in one crop season. Always add 2 pt/a of crop oil concentrate. Do not use on chicory.

*Restricted-use pesticide.

Melon

muskmelon (cantaloupe), watermelon

Planting

Melons need a long growing season of relatively high temperatures (averaging 70–80°F) for optimal growth. Vine crops are susceptible to frost, and seeds will not germinate in soils colder than 60°F. Planting generally begins around May 10 in southern Wisconsin and June 1 in northern Wisconsin.

Use tillage practices that create a level, firm seedbed with adequate moisture for germination. Melons grown on sandy soil will need irrigation.

Muskmelon

Rows—60–84 inches; **plants in row**—8–12 inches apart.

Watermelon

Rows—60–96 inches; **plants in row**—36–96 inches apart.

Transplants can and often should be used to start plantings. Vine crops are sensitive to transplanting and should be seeded in individual containers about 3–4 weeks before putting in the field. Move plants to the field starting around May 20 in southern Wisconsin and June 1 in northern counties. Vine crops do well when grown on black plastic mulch or under floating row covers in spring and early summer.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 5.8 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in the table below. Take credits for previous legume crops and manure.

Application: Broadcast lime and fertilizer and work into the soil before planting. Apply fertilizer at planting time in a band 2 inches to the side and 2 inches below seed level.

Nitrogen: Split nitrogen recommendation into two or more applications during the season. Make the first application when plants have two or more true leaves. Make a second application when vines begin to fill the rows. Subsequent applications (15–20 lb N/a each) can be made at 10- to 14-day intervals after harvest has started.

Annual nitrogen, phosphate, and potash recommendations for melon

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P_2O_5	K_2O
— % —	— lb/a —	— t/a —	— — — lb/a — — —	— — —
<2	100	8–10	40	145
2.0–9.9	80			
10–20	60			
>20	30			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease management

Try to grow crop under ideal conditions for fertility, soil texture, soil moisture, and pH. Use disease-free seed. Avoid fruit injury. Rotate crops with non-cucurbits and eradicate cucurbit weeds. Follow a 7-day fungicide spray schedule, starting before the disease occurs. Apply the selected fungicide in at least 50 gal water/a when using ground equipment or in 5–10 gal water/a with aerial application.

Disease control in melon— muskmelon, watermelon

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alternaria leaf blight	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl. oz. Quadris Flowable	1 1	Amistar, Quadris, Cabrio, and Reason belong to the Group 11 (strobilurin) fungicide category. Quadris Opti contains Groups 11 and M5 fungicides. Tanos contains Groups 11 and 27 fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per crop per year. Do not exceed 1.25 lb/a Amistar, 1.92 qt/a Quadris, 64 oz/a Cabrio, 22 fl oz/a Reason or 2 gal/a Quadris Opti per season. For Reason 500 SC, wait 30 days before rotating to wheat and 1 year following the last application before rotating to all other crops.
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	
	cymoxanil + famoxadone	8.0 oz Tanos 50DF	3	
	fenamidone	5.5 fl oz Reason 500 SC	14	
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action and not belonging to Groups 7 or 11. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	chlorothalonil	1.5–2.0 pt Bravo Weather Stik, Equus 720 1.8–2.7 lb Bravo Ultrex 82.5WDG, Equus DF	0 0	
	maneb	1.5–2.0 lb Maneb 80WP 1.2–1.6 qt Maneb plus Zinc F4 1.2–1.6 qt Manex F4	7 7 7	Consult label for product limits.
	mancozeb	1.6–2.4 qt Dithane F-45 2.0–3.0 lb Dithane 75DF Rainshield NT 2.0–3.0 lb Manzate 200 75DF 2.0–3.0 lb Penncozeb 80WP, 75DF	5 5 5 5	
Anthracnose	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl. oz. Quadris Flowable	1 1	See remarks for Amistar, Quadris, Tanos, and Cabrio in alternaria leaf blight section.
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	
	cymoxanil + famoxadone	8.0 oz Tanos 50DF	3	
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	boscalid + pyraclostrobin	18.5 oz Pristine WDG	0	
				Pristine belongs to Group 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	chlorothalonil	1.5–2.0 pt Bravo Weather Stik, Echo 720 1.4–1.8 lb Bravo Ultrex 82.5WDG 1.3–1.6 lb Echo 90DF	0 0 0	
	maneb	1.5–2.0 lb Maneb 80WP 1.2–1.6 qt Maneb plus Zinc F4 1.2–1.6 qt Manex F4	7 7 7	
				Consult label for product limits.

(continued)

Disease control in melon—muskmelon, watermelon (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Anthracnose (cont.)	mancozeb	1.6–2.4 qt Dithane F-45 2.0–3.0 lb Dithane 75DF Rainshield NT 2.0–3.0 lb Manzate 200 75DF 2.0–3.0 lb Penncozeb 80WP, 75DF	5 5 5 5	Consult label for product limits.
	thiophanate methyl	0.25–0.5 lb Topsin M 70W, Topsin M WSB	0	Apply when disease first appears and repeat if needed every 7–14 days.
Bacterial wilt (<i>Erwinia</i>)	<i>Eliminate the cucumber beetles that carry this pathogen (see Insect Control).</i>			
Black rot	See fungicide treatments recommended for anthracnose. fixed copper			Use certified disease-free seed. Destroy infected plant refuse.
Downy mildew	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	See remarks for these products in alternaria leaf blight section.
	cymoxanil + famoxadone	8.0 oz Tanos 50DF	3	
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	cyazofamid	2.1–2.75 fl oz Ranman	0	Ranman belongs to Group 21 fungicide category. Do not apply more than six sprays of Ranman per crop. Alternate Ranman sprays with a fungicide having a different mode of action. Do not apply more than 16.5 fl oz/a per year.
	dimethomorph	6.0 fl oz Forum	0	See remarks in Phytophthora blight.
	famoxadone + cymoxanil	8.0 oz Tanos	3	See remarks in Phytophthora blight.
	fixed copper	1.5–2.0 lb Champion 77WP	0	Use disease-free seed and rotate crops. Begin applications before fruit form at less than 7-day intervals. After a rain and wind storm, make two or three applications as soon as possible after the storm at 2- to 3-day intervals.
		1.0–1.3 pt Champ Formula 2 4.5F	0	
		1.5–2.0 lb Kocide 101 77WP	0	
		1.5–2.0 lb Kocide DF	0	
		2.6 pt Kocide LF 2.4F	0	
		1.3 pt Kocide 4.5 LF	0	
		1.5 lb Kocide 2000 DF	0	
	fosetyl-al	2.0–5.0 lb Aliette WDG	12 hr	Begin applications when conditions favor disease development (high moisture and moderate temperatures). Repeat at 7- to 14-day intervals. Do not exceed seven applications per season.
	propamocarb hydrochloride	1.2 fl oz Previcur Flex or 0.6 fl oz Previcur Flex plus chlorothalonil	2	Use as a foliar spray in a preventive program. Begin applications when conditions are favorable for disease, but before infection. Continue at 7- to 14-day intervals until the threat of disease is over. When applying at intervals longer than 7 days, alternate with an application of a contact fungicide midway between applications. Do not apply more than 6 pt/a Previcur Flex per season.
Fusarium wilt	<i>The only practical control is to grow wilt-resistant varieties. A lone crop rotation with crops other than melons can be beneficial.</i>			
Mosaic	<i>Plant resistant varieties. When possible, control by isolation from the following plants: burdock, catnip, china aster, chrysanthemum, wild cucumber, geranium, gladiolus, wild ground cherry, horse nettle, hyacinth, jimsonweed, larkspur, lily, marigold, milkweed, morning glory, nasturtium, petunia, phlox, pokeweed, salvia, snapdragon, flowering spurge, tulip, white cockle, and zinnia. Control aphids that spread the disease (see Insect Control).</i>			

(continued)

Disease control in melon—muskmelon, watermelon (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Phytophthora blight or crown rot (<i>Phytophthora capsici</i>)	dimethomorph	6.0 fl oz Forum	0	Do not exceed 30 fl oz/a per growing season. Do not make more than five applications per season. Do not make more than two sequential applications of Forum before alternating to another effective fungicide with a different mode of action for at least one application.
	zoxamide + mancozeb	1.5–2.0 lb Gavel 75DF	5	Do not exceed eight applications or 16 lb/a of Gavel per season.
	cyazofamid	2.75 fl oz Ranman 400SC	0	Do not apply more than six sprays or 16.5 fl oz/a of Ranman per year. Alternate Ranman (Group 21) sprays with a fungicide having a different mode of action. Crops not listed on the label should not be planted within 30 days after the last application.
	famoxadone + cymoxanil	8.0 oz Tanos	3	Do not make more than one application of Tanos before alternating with a fungicide having a different mode of action. Do not make more than four applications of Tanos or other Group 11 fungicides per season. Do not exceed 32 oz/a Tanos per crop per season. Tanos is helpful for suppressing Phytophthora blight. Tanos must be tank-mixed with a contact fungicide such as mancozeb, chlorothalonil, or copper-containing fungicide.
	fosetyl-al	2.0–5.0 lb Aliette WDG	12 hr	Begin applications when conditions favor disease development (high moisture and moderate temperatures). Repeat at 7- to 14-day intervals. Do not exceed seven applications per season.
Powdery mildew	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl oz Quadris Flowable	1 1	Amistar, Quadris, Cabrio, and Flint belong to the Group 11 (strobilurin) fungicide category. Quadris Opti contains a combination of Group 11 and Group M fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per crop per year. Do not exceed 1.25 lb/a Amistar, 1.92 qt/a Quadris, 64 oz/a Cabrio, 8 oz/a Flint or 2 gal/a Quadris Opti per season. Do not tank-mix Amistar, Quadris, Cabrio, Flint, or Quadris Opti with additives or adjuvants.
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	trifloxystrobin	1.5–2.0 oz Flint	0	
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Group 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	myclobutanil	2.5–5.0 oz Nova 40W	0	Do not exceed 1.5 lb/a product (0.6 lb ai/a) per year. Observe a 30-day plantback interval between last application and planting new crops.
	thiophanate methyl	0.25–0.5 lb Topsin M 70W, Topsin-M WSB 10.0 fl oz Topsin 4.5 FL	0	Apply when disease first appears and repeat if needed every 7–14 days.
	triflumizole	4.0–8.0 oz Procure 50WS	0	Do not apply more than 40 oz of Procure per season. See product label for plantback restrictions for leafy vegetables (30 days), root vegetables (60 days) and all other crops (1 yr).

(continued)

Disease control in melon—muskmelon, watermelon (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Seed rot and damping off	seed treatment:			
	captan	0.5–1.0 teaspoon Captan 50% WP/lb of dry seed		Use disease-free soil. Water plants in morning. Chemicals listed are seed treatments. Do not use treated seed for feed or food.
	thiram	0.75 teaspoon Thiram 50% WP/lb seed		
	soil treatment:			
	mefenoxam	1.0–2.0 pt Ridomil Gold EC 1.0–2.0 lb Ridomil Gold WSP		Preplant incorporated application or surface application after planting.

Scouting calendar for insect pests of melons

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
Wireworm					
	Aphids		Aphids		
	Striped and spotted cucumber beetles				
	Seed maggot				
			Mites		

Insect control in melon—muskmelon, watermelon

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cucumber beetles (striped, spotted)	<i>Treat when there are more than 4–5 adults per 50 plants.</i>			
	0.04–0.10 lb bifethrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.5–1.0 lb carbaryl	Sevin (several formulations)	0	Do not apply during maximum flowering or fruit set, or when pollinating bees are in the field. Spray during the evening.
	0.019–0.022 lb cyfluthrin	2.4–2.8 fl oz Baythroid XL	0	Apply every 7 days as needed. Do not exceed 11.2 fl oz/a.
	0.018–0.024 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	3	Apply every 3 days as needed. Do not exceed 14.4 fl oz/a per season.
	0.132–0.179 lb dinotefuran	3.0–4.0 oz Venom 70SG	1	Do not apply more than 62 oz/a per season.
	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, 0.66–1.33 qt Phaser EC	2	Do not exceed 3 lb ai/a per year.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per year.
	0.2–0.3 lb fenpropathrin	10.66–16.0 oz Danitol 2.4EC	7	Do not exceed 2.66 pt/a per season.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on plant row within 14 days before planting or as an in-furrow treatment during planting. Do not exceed 0.38 lb ai/a per year.
	0.94–1.9 lb malathion	several formulations	1	Do not apply before vining or to wet plants.
	0.45–0.9 lb methomyl	1.5–3.0 pt *Lannate LV, 0.5–1.0 lb *Lannate SP	1–3	See label for days to harvest.

*Restricted-use pesticide.

(continued)

Insect control in melon (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cucumber beetles (<i>cont.</i>)	0.5–1.0 lb oxamyl	2.0–4.0 pt Vydate L	1	Make first application 2–4 weeks after planting. Repeat 2–3 weeks later.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per year.
	10.0 lb rotenone	Rotenone D, WP	1	
	thiamethoxam	3.0–5.5 oz Actara 25WDG 5.0–11.0 Platinum 2SC	30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct seeded crops in-furrow at the seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11 oz/a per season. Actara is applied as a foliar spray.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Cutworm	0.04–0.10 lb bifethrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	1.0 lb carbaryl	Sevin Bait (several formulations)	1	Broadcast when cutworms are present in damaging numbers.
	0.0065–0.0125 lb cyfluthrin	0.8–1.6 fl oz Baythroid XL	0	Apply every 7 days as needed. Do not exceed 11.2 fl oz/a.
	0.012–0.028 lb deltamethrin	1.0–2.4 fl oz *Delta Gold	3	Apply every 3 days as needed. Do not exceed 14.4 fl oz/a per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Use as a rescue treatment when worms are present.
	0.1–0.2 lb permethrin	*Ambush	0	See label for rate. Do not exceed 1.6 lb ai/a per year.
	spiromesifen	7.0–8.5 fl oz Oberon 2SC	7	Apply every 7 days as needed. Do not exceed 25.5 fl oz/a per season.
	0.01–0.025 lb zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Melon aphid	0.04–0.10 lb bifethrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.25–0.75 lb diazinon	several formulations	3	Apply as soon as aphids are noticed.
	0.5 lb dimethoate	1.0 pt Dimethoate EC	3	
	0.045–0.268 lb dinotefuran	<i>foliar</i> : 1.0–4.0 oz Venom 70SG <i>soil</i> : 5.0–6.0 oz Venom 70SG	1 21	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 12 oz/a per season using soil applications. See product label for application directions.
	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, 0.66–1.33 qt Phaser EC	2	Do not exceed 3 lb ai/a per season.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on plant row within 14 days before planting or as an in-furrow treatment during planting. Do not exceed 0.38 lb ai/a per year.
	1.0–2.0 lb malathion	several formulations	1	Do not apply before vining or to wet plants.
	0.45–0.9 lb methomyl	1.5–3.0 pt Lannate LV 0.5–1.0 lb Lannate SP	1–3	Do not exceed 5.4 lb ai/a per season.

*Restricted-use pesticide.

(continued)

Insect control in melon (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Melon aphid (<i>cont.</i>)	0.375–0.5 lb oxydemeton-methyl	1.5–2.0 pt *Metasystox-R	14 (muskmelon) 7 (watermelon)	Apply no more than three times per season to muskmelon and no more than twice per season to watermelon.
	pymetrozine	2.75 oz Fulfill 50WDG	14	Controls melon and green peach aphids. Treat when aphids first appear. May repeat in 7 days. Do not exceed 5.5 oz/a per season or more than two applications per crop.
	thiamethoxam	2.0–3.0 oz Actara	0	Apply before pests reach damaging levels. Repeat as needed every 5 days. Do not exceed 8 oz/a of product per season.
		5.0–11.0 fl oz Platinum	30	Apply as an in-furrow spray at planting or as a post-seeding transplant or hill drench. Irrigate sufficiently to move the chemical into the root zone. Use the higher rate for long residual control. Do not apply less than 5 fl oz/a or more than 11 fl oz/a of Platinum per season.
	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Seed corn maggot	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR		Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not exceed 0.1 lb/a per season as an at-plant application.
	0.01–0.025 lb zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Spider mite	0.938–1.88 lb abamectin	8.0–16.0 fl oz *Agri-Mek 0.15EC	7	May repeat after 7 days, but do not make more than two sequential treatments or exceed 5.64 lb ai/a per year.
	bifenazate	0.75–1.0 lb Acramite 50WS	3	Do not exceed one application per season.
	0.08–0.10 lb bifenthrin	5.12–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat applications after 7 days, but do not make more than two applications after bloom. Do not exceed 0.3 lb ai/a per season.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	3	
	0.2 lb fenpropathrin	10.66 fl oz Danitol 2.4EC	7	Treat when mites first appear and repeat every 7 days as needed. Do not exceed 0.8 lb ai/a per season.
	spiromesifen	7.0–8.5 fl oz Oberon 2SC	7	Apply every 7 days as needed. Do not exceed 25.5 fl oz/a per season.
Squash bug	<i>Check undersides of leaves for squash bug eggs laid in neat rows. Eggs hatch within 1–2 weeks. Treat when squash bugs are young; they are difficult to control as older nymphs or adults. Destroy crop residue in fall to reduce overwinter survival of this pest.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.5–1.0 lb carbaryl	Sevin (several formulations)	0	Do not apply during maximum flowering or fruit set, or when pollinating bees are in the field. Spray during the evening.
	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, 0.66–1.33 qt Phaser EC	2	Do not exceed 3 lb ai/a per year.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per year.
	0.132–0.179 lb dinotefuran	3.0–4.0 oz Venom 70SG	1	Do not apply more than 6 oz/a per season.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Will kill adult squash bugs. Several formulations; see label for rate.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

(continued)

Insect control in melon (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Squash vine borer	<i>Treat when adults are observed (900 DD₅₀ or when chicory is in bloom), especially when runners are less than 2 feet long. Larvae boring in the main stem can kill the entire plant, while loss of a runner or two when the plant is larger will not cause economic damage. Look for sawdust-like excrement coming from holes in the stems, and open the stems to confirm the presence of squash vine borer larvae. Repeat applications at 5- to 7-day intervals throughout the 3-week egg-laying period.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Apply every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, 0.66–1.33 qt Phaser EC	2	Apply weekly to flower buds, stems, and vines beginning when moths first appear. Do not exceed 3 applications per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per season
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. Do not apply more than 1.6 lb ai/a per season.
	0.4 lb rotenone	Rotacide EC	0	Apply as late in day as possible.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

Weed control in melon— muskmelon, watermelon

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.15–0.25 lb clomazone	0.4–0.67 pt Command 3ME		For suppression and control of annual grasses and broadleaves, make a single preemergent soil application before seeding or transplanting. Place seed or roots of transplants below the chemical barrier when planting. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read and understand the vegetable disclaimer section of the label—the end user assumes all liability for failure to perform and crop injury resulting from its use.
	1.1–1.7 lb ethalfluralin	3.0–4.5 pt Curbit 3EC		Make a single broadcast application within 2 days after seeding. Rate varies with soil texture and organic matter. A shallow cultivation or 1/2-inch of water is needed to activate the herbicide. Heavy rain following application or shallow seeding may result in crop injury. Do not incorporate or use under plastic mulch, broadcast over transplants, or apply through irrigation. Do not use on soils with more than 10% organic matter.
	0.4–1.2 lb ethalfluralin + 0.125–0.375 lb clomazone	2.0–6.0 pt Strategy	45	Use only as a postplant surface-applied herbicide. Make one application before crop and weeds emerge or apply as a banded spray between rows following crop emergence or transplanting. Do not make broadcast applications to transplants or use under plastic mulch. Strategy requires rainfall, irrigation, or a shallow cultivation within 2–5 days after application for activation. Because of the potential for offsite movement and severe crop injury, strictly follow all precautions and restrictions on the label.

*Restricted-use pesticide.

(continued)

Weed control in melon—muskmelon, watermelon (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds (<i>cont.</i>)	2.0–4.0 lb naptalam + 4.0–6.0 lb bensulide	4.0–8.0 qt Alanap-L + 4.0–6.0 qt Prefar 4E		This combination controls broadleaf and grassy weeds better than either herbicide alone. Apply just before planting and shallowly incorporate. If you irrigate immediately after application, you do not need to incorporate.
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or registered equivalent	60 (water- melon) 30 (all other cucurbits)	Direct spray between rows when plants have reached the 3- to 4-leaf stage. Set incorporation equipment to move treated soil around the base of plants. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See label for plant-back restrictions. Ineffective on peat and muck soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting. Incorporate 1–2 inches deep to avoid loss due to volatilization. Use on mineral soils only.
Annual broadleaves	2.0–4.0 lb naptalam (cantaloupe, muskmelon, watermelon)	4.0–8.0 qt Alanap-L		Apply Alanap to weed-free soil. Light irrigation after application enhances herbicide activity. Apply preemergence immediately after seeding. Do not apply when growing conditions are poor (cool, wet spring weather) as stunting may result. A second application can be made about 1 month after seeding, just before the crop is starting to vine and before weeds have emerged. Do not apply postemergence when temperatures exceed 100°F. Check label to match application rate to soil type.
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Apply to weed-free soil. Treat only if plants have 4–5 true leaves and are well established, and growing conditions are favorable or severe crop injury may result. Use only on soils with 5% or less organic matter.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea (Rate varies by melon type, application type, and timing. See label for appropriate rate.)	57	Sandea controls several broadleaf weeds and nutsedge. It will not control grasses. Sandea has both pre- and postemergence activity and can be used under plastic mulch. Broadcast application to watermelon should not exceed 0.75 oz/a Sandea. Do not exceed two applications or apply more than 2 oz per 12-month period. Soil or foliar applications of organophosphate insecticides to Sandea-treated crops may cause severe crop injury. Consult label for application timing, maximum Sandea use per crop cycle, and other important usage information and precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Some formulations require a wait of 3 days between application and seeding. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.

*Restricted-use pesticide.

(continued)

Weed control in melon—muskmelon, watermelon (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged weeds (<i>cont.</i>)	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding and transplanting should be performed with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	14	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	14	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	14	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rates. Do not apply more than 3 pt/a Poast in one crop season. Always add 2 pt/a of oil concentrate. Check the label for additional precautions and restrictions.

*Restricted-use pesticide.

Mint

Wisconsin mint is grown on high organic or muck soils with high water tables or on fine-textured soils. Since mint is a shallow-rooted crop, irrigation is desirable.

Planting

Mint is grown as a vegetatively propagated perennial. New fields are planted in the spring with stolons dug from an existing planting known to be free of pathogens and perennial weeds with a digger similar to a potato digger. First-year plantings are known as “row mint” as the stolons are planted in rows with special planters. One acre of well-established mint will usually yield enough stolons to plant 10–15 acres. Given good growing conditions, the stolons quickly spread covering the entire field with plants. This solid stand, called “meadow mint,” contributes to the spread of disease and some perennial weed problems but is important in helping control soil erosion and annual weeds. Weeds, insects, and diseases can reduce quality and yield.

Mint is usually plowed shallow after the first killing frost to protect the crop from winterkill and to help control pests that might otherwise overwinter on the mint stubble. To maintain profitable production, short rotations of 3 years of mint should be followed by 3 years of another crop.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 5.6 or higher on organic soils and 5.8 on mineral soils.

Fertilizer rates: Apply 50 lb/a phosphate and 200 lb/a potash when soil tests P and K are in the optimum range. Optimum nitrogen rates may vary between soils, organic nutrients, and locations. Apply 100–150 lb N/a on mineral soils or 50–80 lb N/a on organic soils depending on muck depth, quality, and length of time the field has been farmed. At least some of the nitrogen should be applied prior to the rapid growth phase in May.

Application: Broadcast applications are commonly used.

Micronutrients: Mint has relatively low micronutrient requirements. It is unlikely that this crop will respond to micronutrient additions.

Annual nitrogen, phosphate, and potash recommendations for mint

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P ₂ O ₅	K ₂ O
— % —	— lb/a —		— — — lb/a — — —	
<2	120	35–55 lb (oil)	50	200
2.0–9.9	100			
10–20	80			
>20	50			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Harvest

Mint harvest in Wisconsin generally begins about mid-July. Mint fields are usually cut before the plants reach 10% of full bloom. Harvesting at a later growth stage can result in lower quality oil and lower yields. The cut hay is left in windrows for 24–36 hours, until mint leaves begin to dry. If the hay gets too dry, the leaves will shatter during pickup, reducing yield. If too green when collected, the hay will require more time and energy to distill. Rain while the cut hay is still in the field can result in significant yield loss due to leaf loss and oil washed from the plants. The mint is chopped directly into custom-built distilling tubs. A typical mint tub holds hay from 0.75 to 1.25 acres of land. The hay is carried from the field in the distillation tubs to the mint still. There, steam is applied to the mint through a series of tubes located in the bottom of the tub. Boiler size, for supplying the steam, depends on the number of tubs that will be distilled at one time. As a general rule, 100 horsepower is required for each tub. The vaporized oil passes through a condenser where the oil and water condense for collection in the receiver. The temperature of the condensate leaving the condenser should be maintained at 110°F. The lighter oil floats on top of the water in the receiver and is periodically drained off into clean barrels. The distillation process takes about 1 hour per tub, depending on tub size, condition of the hay, and steam pressure. Improper distillation can result in yield loss, lower oil quality, and increased energy costs.

Disease control in mint

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Rust, powdery mildew	azoxystrobin	2.0–5.0 oz Amistar 80 WDG	7	Amistar, Quadris Flowable, and Headline belong to the Group 11 (strobilurin) fungicide category. Do not apply more than one foliar spray of any strobilurin product before alternating with a fungicide having a different mode of action. Do not exceed three applications of strobilurin fungicides per year. Do not exceed 0.93 lb/a Amistar, 1.44 qt/a Quadris, or 48 fl oz/a Headline per season.
		6.2–15.4 fl oz Quadris Flowable	7	
	pyraclostrobin	9.0–12.0 fl oz Headline	14	
	chlorothalonil	1.25 lb Bravo Ultrex 82.5WDG, Equus DF	80	
		1.38 pt Bravo Weather Stik, Echo 720, Equus 720	80	
		1.2 lb Echo 90DF	80	
	myclobutanil	4.0–5.0 oz Nova 40W	30	Treat in early spring when plants break dormancy and continue applications on a 14- to 21-day schedule. Do not apply more than 15 oz/a product (0.375 lb ai/a) per season.
Verticillium wilt	<i>Ideally, mint plantings should be kept in production for no longer than 4–6 years. Rotate to nonsusceptible crops for as long as possible between mint crops. The following cultivars are listed in order of increasing susceptibility: Native Spearmint, Scotch Spearmint, Murray Mitcham and Todd Mitcham Peppermint, and Black Mitcham Peppermint.</i>			
Mint stolon decay	<i>Early spring tillage hastens soil warming, which creates unfavorable conditions for disease development. Clipping the regrowth before plowdown in the fall reduces later losses to stolon decay. Application of fungicides for control is not feasible at this time.</i>			

Insect control in mint

Insect	Rate/a of active ingredient	Commercial product	Days to harvest	Remarks and suggestions
Armyworms, cutworms, and loopers	<i>Many species of armyworms, cutworms, and loopers may occur together in the field. Small larvae may be collected in sweep net samples. Estimate larger instars by inspecting the soil surface (one square foot) after vigorously shaking the foliage in the area. Use the total number of all foliage-feeding worms to determine if treatment is necessary. Thresholds vary from 1.5 to 3.0 larvae/sq ft.</i>			
	1.0–1.33 lb acephate	Orthene 75S, 97	14	Do not apply more than 2.66 lb/a.
	0.5–2.0 lb <i>Bacillus thuringiensis aizawai</i>	XenTari	0	Treat when larvae are young. Use another type of product to control older larvae.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Biobit WP, Dipel DF, Gut Buster BT, Javelin WG	0	See label for rate. Treat when larvae are young.
	1.0–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	1.0–2.0 lb chlorpyrifos	Lorsban 4E	90	Use the lower rate when larvae are less than 3/4 inch long, and the higher rate when larger. The long interval to harvest for this product limits its use to very early season applications.
	0.065 lb indoxcarb	3.5 oz Avaunt 30DG	7	The minimum interval between applications is 5 days. Do not apply more than 24 oz/a Avaunt (0.44 lb ai/a) per crop.
	0.031–0.093 lb spinetoram	4.0–12.0 oz Radiant SC	7	Do not apply more than 60.5 oz/a Radiant (0.48 lb ai/a) per crop and do not make more than four applications per crop. Must wait at least 4 days before repeating applications.
	0.675–0.9 lb methomyl	*Lannate LV, SP	14	Do not apply more than 1.8 lb ai/a.

*Restricted-use pesticide.

(continued)

Insect control in mint (*cont.*)

Insect	Rate/a of active ingredient	Commercial product	Days to harvest	Remarks and suggestions
Armyworms, cutworms, and loopers (<i>cont.</i>)	pyrethrin	1.0–2.0 pt Pyrenone E.C.	0	
	spinosad	0.06–0.10 lb Entrust	4	Apply when small larvae appear. Treat larger larvae at higher rate or retreat. Do not exceed 9 oz/a or three applications per year.
Floridotarsonemus mite	<i>Determine mite populations from bud samples. Examine at least 20 buds per field at several sites throughout the field. Open each bud and examine a single leaf surface with a 10–15X hand lens. Count the number of adult (brown) mites. Treatment is recommended if there is an average of more than one mite per bud.</i>			
	0.05–0.1 lb fenpyroximate	1.0–2.0 pt Fujimite 5EC	1	Apply Fujimite in 25–50 gallons of water to ensure uniform coverage and canopy penetration. Do not exceed 2 pt/a per year.
	2.25 lb propargite	Omite 6E, Comite	14	Apply in large volume of water and high pressure for good penetration. Apply up to two applications at 7- to 10-day intervals.
Mint aphid	<i>No treatment thresholds have been established, but relative populations can be estimated from sweep net samples taken when sampling for other pests. Damage occurs only when aphids are so numerous that leaves are coated with honeydew.</i>			
	1.0 lb acephate	Orthene 75S, 97	14	Do not apply more than 2.66 lb/a.
	0.7–1.0 lb malathion	Malathion	7	
	pyrellin	1.0–2.0 pt Pyrenone E.C.	0	May be combined with other insecticides
	thiamethoxam	1.5–3.0 oz Actara	7	Apply every 14 days as needed. Do not exceed 8 oz/a per season.
Mint flea beetle	<i>Direct control measures at adults since no materials are registered for larval control. Adults emerge in late July (1100 DD, soil temperature at 6-inch depth, 40°F base) and begin laying eggs 2 weeks later. Treat before egg laying when adults are present if the following thresholds are exceeded: (1) larval damage—stunting, purpling in June—is visible; (2) no larval damage is visible, but more than 25 adults/100 sweeps are collected in standing mint; or (3) fewer than 25 adults/100 sweeps are present in standing mint, but more than 25/100 sweeps are collected from stubble after harvest.</i>			
	0.7–1.0 lb malathion	Malathion	7	
	0.675–0.9 lb methomyl	*Lannate LV, SP	14	Do not apply more than 1.8 lb ai/a.
	thiamethoxam	1.5–3.0 oz Actara	7	Apply every 14 days as needed. Do not exceed 8 oz/a per season.
Twospotted spider mite	<i>Determine mite populations from leaf samples. Examine a total of 45 leaves (15 leaves each from the bottom, middle, and top of the canopy) at several locations throughout the field. For each 30 acres, monitor 15 individual field sites. Classify the leaves as “infested” (5 or more mites) or “uninfested” (fewer than 5 mites). Treat if 18 or more of the leaves in the 45-leaf sample at each site are “infested.”</i>			
	0.009–0.014 lb abamectin	8.0–12.0 oz Agri-Mek 0.15EC	28	Treat when mites first appear and have exceeded thresholds.
	0.375–0.75 lb bifentazate	0.75–1.5 lb Acramite 50WS	7	Apply Acramite in at least 50 gallons of water to ensure uniform coverage and canopy penetration. Do not apply more than once per year.
	0.438–0.625 lb dicofol	1.75–2.5 pt Dicofol 4E	30	Do not make more than one application of Dicofol per crop per year.
	0.05–0.1 lb fenpyroximate	1.0–2.0 pt Fujimite 5EC	1	Apply Fujimite in 25–50 gallons of water to ensure uniform coverage and canopy penetration. Do not exceed 2 pt/a per year.
	0.75 lb oxydemeton-methyl	*Metasystox-R	14	Primarily an aphicide, but also suppresses mites.
	1.5–2.25 lb propargite	Omite 6E, Comite	14	Do not apply more than twice per year. Most effective when temperatures are above 70°F.

*Restricted-use pesticide

Weed control in mint

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.5 lb clomazone	1.3 pt Command 3ME	84	For suppression and control of annual grasses and broadleaves, make a single broadcast application to the soil before weeds emerge and before mint plants begin any new growth. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read and understand the vegetable disclaimer section of the label—the end user assumes all liability for failure to perform and crop injury resulting from use of this product.
	0.125 lb flumioxazin	4.0 oz Chateau Herbicide WDG	80	Chateau may be applied to dormant mint for preemergent control of weeds as well as to assist in the postemergent control of emerged weeds. If emerged weeds are present, tank-mix with paraquat and a nonionic surfactant. Do not apply more than 4 oz/a per application or more than 8 oz/a per season. Allow 60 days between applications. See label for weeds controlled and for additional instructions and precautions.
	0.71–1.9 lb pendimethalin	1.5–4.0 pt Prowl H ₂ O (based on soil texture—see label)	90	Make a single application to dormant established mint before weed emergence. Do not apply to mint during the first year of establishment or to mint that has broken dormancy. Do not use on peat or muck soils.
	0.14–0.375 lb sulfentrazone	4.5–12.0 oz Spartan 4F		Apply Spartan to dormant mint following cultivation and before mint emergence. Rate is based on soil texture and organic matter. Split applications may be used for preemergent sequential control of winter and summer annuals. Spartan may be tank-mixed with other labeled mint products. May be applied before crop emergence to newly planted mint, but application should be reduced 25%. Do not apply more than 12 oz/a per 12-month period. Rainfall or irrigation after application is required for herbicide activation. See label for weeds controlled and other precautions.
	Labeled rates: 0.25–0.8 lb terbacil Recommended rates (see note in Remarks): 0.125–0.25 lb terbacil	Labeled rates: 0.3–1.0 lb Sinbar 80W Recommended rates (see note in Remarks): 0.16–0.3 lb Sinbar 80W	60	For preemergence applications, treat before weeds and mint emerge, after last cultivation. For postemergence applications, treat before broadleaves are 2 inches tall and before grasses are 1 inch tall. Do not exceed 2 lb/a per season. Do not plant to crops other than mint within 2 years after last application. Note: Wisconsin recommends using less than 0.5 lb/a of Sinbar per year due to its long residual activity. Low rates may give inadequate weed control.
	0.5–0.75 lb trifluralin	1.0–1.5 pt Treflan HFP or other registered trifluralin formulations		Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies depending on soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See the label for plantback restrictions. Ineffective on peat and muck soils.

*Restricted-use pesticide.

(continued)

Weed control in mint (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Germinating annuals	0.5 lb oxyfluorfen	2.0 pt Goal 2XL		Apply Goal <i>only</i> to mint grown on muck soils with at least 20% organic matter. Make one preemergence application in the spring after the last tillage operation before new mint growth emerges. May cause temporary stunting of mint. Applications to first-year mint should be made within 4 days of planting.
Emerged weeds	glyphosate	several manufacturers and formulations	7	See manufacturer's label to assure that the formulation is labeled for spot treatment in mint. Use handheld equipment to direct the spray solution. The spray will kill all plants it contacts. Do not treat more than 1/10 of any acre at any time. Treatment may be repeated at 30-day intervals.
	*paraquat (rate varies by label)	several manufacturers and formulations		Apply to dormant mint before emergence. May be mixed with Sinbar. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on the label.
Emerged grasses	0.094–0.25 lb clethodim	6.0–16.0 oz Select 2EC	21	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.24 lb clethodim	9.0–32.0 oz Select Max	21	
	0.094–0.47 lb sethoxydim	0.5–2.5 pt Poast	20	Apply postemergence to actively growing grasses. Include 1 pt/a Dash HC or 1 qt/a crop oil concentrate. Do not apply more than 5 pt/a Poast or make more than 2 applications per season. Do not apply if rain is expected within 1 hour.
	0.034–0.08 lb quizalofop	5.0–12.0 oz Assure II or Targa	30	Apply postemergence to actively growing grasses. Add COC or NIS to spray mixture. Do not make more than two applications per season. Wait a minimum of 24 hours following application before applying a post broadleaf herbicide. Do not apply Assure II or Targa following a post broadleaf herbicide until grass plants begin to develop new leaves. See label for maximum annual use rate.
Emerged annual broadleaves, some perennials	1.0–2.0 lb bentazon	2.0–4.0 pt Basagran		Apply early postemergence when weeds are small and actively growing. Add 1 qt/a oil concentrate. Do not apply more than 4 pt/a per year. May cause leaf burn under some conditions, but the mint will generally outgrow this condition within 10 days.
	0.125–0.38 lb acid equivalent clopyralid	0.33–1.0 pt Stinger	45	Controls specific annual and perennial weeds. Apply early postemergence to actively growing annuals before they send up a flower stalk. For Canada thistle, apply when most basal leaves are formed but before bud stage. May cause temporary injury, but should not reduce oil yields. Read label carefully for follow crop restrictions. Do not make aerial applications.

*Restricted-use pesticide.

(continued)

Weed control in mint (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged annual broadleaves	0.25–0.38 lb bromoxynil	1.0–1.5 pt Buctril <i>2.0–4.0 oz Buctril</i> (see note in Remarks)	70	<p>Apply postemergence to actively growing weed seedlings before weeds have more than 4 leaves, are 2 inches in height, or are 1 inch in diameter, whichever comes first. See label for list of susceptible weeds. Do not apply in spring or to newly planted mint. Buctril can cause temporary stunting and discoloration of the mint, but should not reduce yield. Buctril may cause unacceptable injury if temperatures exceed 70°F following application, if mint is under stress, or if mint has been treated with Sinbar. Do not apply more than 6 pt/a per season or by aerial application.</p> <p><i>Under Wisconsin conditions, using the label rate may result in unacceptable mint injury. We recommend 2–4 oz/a.</i></p>

Onion

dry bulb onion on high organic soils

Planting Plant seeds, transplants, or “sets” in April to early May. Choose deep, fertile soils and provide adequate drainage. Rotate onions with other vegetable crops. Onions work well in rotation with potatoes or carrots.

In the field **Rows**—direct-seeded onions are usually planted in paired rows, 16–24 inches apart. **Plants in row**—6–12/ft (120,000–160,000 seeds/a). For transplants, set 4–6 inches apart (60,000–100,000 plants/a).

In beds **Rows**—6–9 inches with 6–8 rows/bed; **plants in row**—6–12/ft.

Lime and fertilizer **Lime:** Use dolomitic limestone to maintain a pH of 5.4 or higher in organic soils and at least 5.6 in other soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in table below. Take credits for previous legume crops and manure.

Application: Broadcast and work in before planting. For most efficient use of nitrogen, split recommended rate into two or more applications during the season.

Micronutrients: Onions need relatively high amounts of manganese, copper, zinc, and molybdenum. Use soil and plant analyses to check for deficiencies of these nutrients. Specific recommendations vary with fertilizer sources, soil, and method of application.

Annual nitrogen, phosphate, and potash recommendations for onion

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P_2O_5	K_2O
— % —	— lb/a —	— cwt/a —	— — — lb/a — — —	
<2	150	400–600	60	130
2.0–9.9	140			
10–20	130			
>20	120			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in onion

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Downy mildew	azoxystrobin	9.2–15.4 fl oz Quadris Flowable	0	Amistar, Quadris, and Cabrio belong to the Group 11 (strobilurin) fungicide category. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per year. Do not exceed 1.88 lb/a Amistar, 2.88 qt/a Quadris, or 72 oz/a Cabrio per season.
		3.0–5.0 oz Amistar 80 WDG	0	
	pyraclostrobin	12.0 oz Cabrio EG	7	
	boscalid + pyraclostrobin	18.5 oz Pristine WDG	7	Disease suppression only. Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 11 fungicide per season. Do not exceed 111 oz/a Pristine per season.

(continued)

Disease control in onion (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Downy mildew (cont.)	dimethomorph	6.0 oz Forum	0	Tank-mix Forum with another fungicide active against downy mildew and having a different mode of action. Do not make more than two sequential applications of Forum before alternating to another effective fungicide. Do not make more than five applications per season or use more than 30 oz/a per season.
	mefenoxam	2.5 lb Ridomil Gold MZ	7 (dry bulb)	Spray at 14-day intervals when conditions are favorable for disease alternating sprays with other protective fungicides. Use up to four applications on dry bulb onions.
		2.0 lb Ridomil Gold Bravo	7 (dry bulb) 21 (green)	Spray at 14-day intervals when conditions are favorable for disease alternating sprays with other protective fungicides. Limit of four applications on dry bulb onions and three applications on green onions.
	phosetyl-aluminum	2.0–3.0 lb Aliette WDG	7	Begin applications when conditions favor disease development (high moisture and moderate temperatures). Repeat at 7- to 14-day intervals. If disease is already present, treat at 3.0 lb/a and repeat at 7-day intervals. Do not exceed seven sprays per year.
Fusarium basal rot	<i>Plant resistant varieties such as 'Fusario 24', 'Nugget', 'Hickory', and 'Nutmeg'. 'Harvestmore' has some tolerance to basal rot.</i>			
Leaf blight (Botrytis) + purple blotch (Alternaria)	boscalid	6.8 oz Endura WDG in combination with broad spectrum fungicide	7	Endura belongs to the Group 7 (anilide) fungicide category. Do not exceed two sequential applications of Endura before alternating to a labeled fungicide with a different mode of action. Do not exceed six applications per season. Do not exceed 41 oz/a Endura per season. Note comments on Pristine below.
	boscalid + pyraclostrobin	10.5–18.5 oz Pristine WDG	7	Pristine belongs to Groups 7 and 11 fungicide categories. Do not exceed two sequential applications of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 11 fungicide per season. Do not exceed 111 oz/a Pristine per season.
	chlorothalonil	1.0–2.0 pt Bravo Weather Stik, Echo 720, Equus 720	7	Do not exceed 6.7 lb ai/a chlorothalonil per season. Spray every 7–10 days during the growing season (more frequently during periods favoring the disease). You can alternate chlorothalonil with mancozeb. Do not use on 'Sweet Spanish' onions. Excessive use can reduce yields.
		0.9–1.8 lb Bravo Ultrex 82.5WDG, Equus DF	7	
		1.2–1.7 lb Echo 90DF	7	
		1.5–3.0 pt Bravo Zn, Echo Zn	7	
		1.4–2.8 pt Equus 500 Zn	7	
	cyprodinil + fludioxonil	11.0–14.0 oz Switch 62.5WG	7	Do not exceed 56 oz product per year per acre. Do not plant rotational crops other than strawberries or onions for 12 months following the last application of Switch 62.5WG.
	iprodione	1.5 pt Rovral 4F	7	Spray every 7 days during the growing season (more often during periods favoring the disease).
	maneb	1.6–2.4 qt Maneb plus Zinc F4	7	Consult labels for product limits. Do not apply to exposed bulbs. Spray every 7–10 days depending on weather conditions. Maneb will also control downy mildew.
		2.0–3.0 lb Maneb 80WP	7	
		1.6–2.4 qt Manex F4	7	

(continued)

Disease control in onion (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Leaf blight (<i>Botrytis</i>) + purple blotch (<i>Alternaria</i>) (cont.)	mancozeb	1.6–2.4 qt Dithane F-45 4F	7	Consult labels for product limits. Do not apply to exposed bulbs. Spray every 7–10 days depending on weather conditions. Mancozeb will also control downy mildew.
		2.0–3.0 lb Dithane 75DF	7	
		Rainshield NT	7	
		2.0–3.0 lb Manzate 200DF	7	
	pyraclostrobin	2.0–3.0 lb Penncozeb 80WP, 75DF	7	Cabrio belongs to the Group 11 (strobilurin) fungicide category. Do not exceed one application of Group 11 products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per year. Do not exceed 72 oz/a Cabrio per season.
		8.0–12.0 oz Cabrio EG	7	
	pyrimethanil	9.0 fl oz Scala SC in combination with broad-spectrum fungicide	7	Scala belongs to the Group 9 fungicide category. Use the 9 fl oz rate of Scala in a tank mix with a broad-spectrum fungicide. Alternating the tank mix combination with a broad-spectrum fungicide is a resistance management strategy.
Neck rot	<i>Plant varieties that mature properly so neck tissues dry before storage; undercut and windrow onions until inside neck tissues are dry before topping and storing. Forced heated air at 93–95°F for 5 days at the beginning of the storage period may help.</i>			
Ozone injury	<i>No treatment.</i>			
Pink root	<i>Long rotation with unrelated crops and use good crop management to promote healthy plant growth.</i>			
Purple blotch	azoxystrobin	6.2–12.3 fl oz Quadris	0	Amistar, Quadris, and Cabrio belong to the strobilurin group of fungicides. Do not exceed one application of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per year. Do not exceed 1.88 lb/a Amistar, 2.88 qt/a Quadris, or 72 oz/a Cabrio per season.
		Flowable	0	
	pyraclostrobin	2.0–4.0 oz Amistar 80 WDG	0	
Purple blotch + downy mildew	fenamidone	8.0–12.0 oz Cabrio EG	7	Reason belongs to the Group 11 (strobilurin) fungicide category. Do not exceed one application of any strobilurin products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per year. Do not exceed 22 fl oz/a Reason per season. Allow 30 days after the last application before rotating to wheat, and 1 year for all other crops.
		5.5 fl oz Reason 500 SC	7	
		1.3 pt Champ Formula 2 4.6F	0	
		2.0 lb Kocide 101 77WP, DF	0	
	copper hydroxide	2.6 pt Kocide LF 2.4F	0	May be useful to reduce losses to bacterial infections during periods of wet weather.
		1.3 pt Kocide 4.5 LF	0	
Smut	carboxin/thiram	Pro-Gro seed treatment		While there is no Wisconsin label for treating seed, it is legal to purchase and plant pretreated seed.
	mancozeb	2.4 qt Dithane F-45 3.0 lb Dithane 75DF Rainshield NT 3.0 lb Penncozeb 80WP, 75DF		Apply as a furrow drench when planting seeds. Use 75–125 gal/a water.
Tipburn	<i>This is not a disease but a condition that can result from high concentrations of ozone in the air—often associated with thunderstorms.</i>			

Scouting calendar for insect pests of onion

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
			Onion maggots						Onion maggots						Onion maggots		
									Onion thrips								

Insect control in onion

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Maggot	<i>A preventive treatment at planting is usually necessary; foliar treatments to suppress adults are usually not successful. Continuous planting of onions on the same ground increases onion maggot problems. Rotate with other crops to reduce populations. Destroy cull piles and crop debris to prevent onion maggot buildup.</i>			
Maggot—furrow treatments	chlorpyrifos	Lorsban 4E, 15G		Apply Lorsban 4E in furrow. Use minimum of 40 gal drench/a. Direct seeded; bulb onions only. Do not exceed one application of Lorsban 15G per year.
	cyromazine	6.6 lb Trigard OMC, 75%OMC/100 lb seed	60	Section 18 registration. Seed treatment in California only. Trigard has limited activity against seed corn maggot.
	2.0–4.0 lb diazinon ^a	several formulations		Apply diazinon in furrow. Use minimum of 40 gal drench/a. Direct seeded; bulb onions only.
Maggot—foliar treatments	0.5 lb diazinon ^a	several formulations	10	
	0.0075–0.0125 lb gamma cyhalothrin	1.92–3.84 oz Proaxis	14	Apply every 5 days as needed. Do not apply more than 1.92 pt/a (0.12 lb ai/a) per season.
	0.015–0.025 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	14	Do not apply more than 0.24 lb ai/a per season.
	0.1–0.3 lb permethrin	*Ambush	1	Several formulations; see label for rate. Do not exceed 2.4 lb ai/a per season.
	spinosad	1.0–2.0 oz Entrust	3	Apply to small larvae. Do not exceed 7 oz/a Entrust or four applications per year.
	zeta-cypermethrin	2.24–4.0 oz *Mustang Max	7	Apply every 7 days as needed. Use higher rates as populations escalate to avoid rescue treatments. Do not exceed 20 oz/a Mustang Max per year.
Thrips	<i>Treat when there are 7 or more thrips per plant. Tolerant varieties such as El Charo, Snow White, Vega, White Keeper, and Zapotec can handle more than 45 thrips per plant. Direct the spray down the center of the plants. Thrips populations in other states have shown resistance to several organophosphate insecticides; spray only when necessary and alternate two or more materials each season to minimize potential for resistance.</i>			
	0.04–0.10 lb cypermethrin	2.0–5.0 fl oz *Ammo EC	7	
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 9.6 fl oz/a per season.
	0.5 lb diazinon ^a	several formulations	14	Do not exceed three applications per season.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	14	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.02–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	14	Do not apply more than 0.24 lb ai/a per season.
	1.0–1.6 lb malathion	several formulations	3–7	
	0.45–0.9 lb methomyl	1.5–3.0 pt *Lannate LV 0.5–1.0 lb *Lannate SP	7	
	0.25–0.5 lb methyl parathion	1.0–2.0 pt *PennCap-M, F 0.5–1.0 pt *Methyl Parathion, EC	15	Do not apply when onions bloom.

* Restricted-use pesticide.

(continued)

^a Some onion maggots in other midwestern states have shown resistance to diazinon. Use a different insecticide if satisfactory control has not been obtained in recent years.

Insect control in onion (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Thrips (<i>cont.</i>)	0.25–0.5 lb oxamyl	1.0–2.0 pt Vydate L	14	Vydate L has a 24c label for thrips and suppression of aster leafhopper as a foliar spray. Higher rates may be applied at planting for stubby root nematode control.
	0.15–0.3 lb permethrin	*Ambush	1	Several formulations; see label for rate. Do not apply more than 2.0 lb ai/a per season.
	0.047–0.078 lb spinetoram	6.0–10.0 oz Radiant SC	1	Do not apply more than 30 oz/a Radiant (0.234 lb ai/a) per crop and do not make more than five applications per crop.
	0.06–0.12 lb spinosad	1.25–2.5 oz Entrust 4.0–8.0 oz SpinTor 2SC	1 1	Treat every 4 days as needed.
	zeta-cypermethrin	2.88–4.0 oz *Mustang Max	7	Apply every 7 days as needed. Use higher rates as populations escalate to avoid rescue treatments. Do not exceed 20 oz/a Mustang Max per year.

*Restricted-use pesticide.

Weed control in onion

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.56–0.98 lb dimethenamid-P	<i>coarse soils:</i> 12.0–18.0 fl oz Outlook 6.0 <i>medium- and fine-textured soils:</i> 18.0–21.0 fl oz Outlook 6.0	30	For use in direct seeded and transplanted dry bulb onions. Apply only after onion has reached the 2 true leaf stage. Applications to transplants should be delayed several days until soil has settled around the plants. Do not exceed 21 fl oz/a in a growing season and allow at least 14 days between applications.
	0.016–0.064 lb flumioxazin	0.5–2.0 oz Chateau WDG	45	Chateau may be applied to transplanted dry bulb onions between the 2- and 6-leaf stage, and on direct-seed dry bulb onions between the 3- and 6-leaf stage. Apply before weeds emerge. See label for weeds controlled. Wait at least 14 days between applications. Do not exceed 1 oz/a Chateau per season on soils that contain greater than 90% sand and gravel; on all other soils, do not exceed 3 oz/a per year. Application with an adjuvant or as part of a tank-mix may result in unacceptable crop injury.
	0.375–0.625 lb trifluralin	0.75–1.25 pt Treflan HFP or other registered trifluralin formulations	60	Spray and incorporate between onion rows. Avoid covering onions with treated soil during incorporation as injury may occur. Do not apply as a preplant or preemergence treatment. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting and incorporate 1–2 inches deep to avoid losses due to volatilization. Use on mineral soils only.

*Restricted-use pesticide.

(continued)

Weed control in onion (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Make preemergence applications to weed-free soil at seeding or transplanting and/or at layby. On sandy soil, do not apply more than 10 lb/a Dacthal W-75. Ineffective on muck soils.
	0.5–2.0 lb pendimethalin	1.2–4.8 pt Prowl 3.3 EC or Pendimax	45	For use in direct-seeded and transplanted dry bulb onions. Do not apply to green (bunching) onions. Rate varies depending on soil classification, texture, organic matter and herbicide formulation. May be applied sequentially on muck soils. See label for additional instructions and restrictions.
	0.71–1.9 lb pendimethalin	1.5–4.0 pt Prowl H ₂ O	45	
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat (rate varies by label)	several manufacturers and formulations	60	Treat when a maximum number of grasses and broadleaves have emerged, but before the crop has emerged. Always add crop oil concentrate or nonionic surfactant to the spray mixture. Follow precautions on the label.
Emerged grasses	0.094–0.25 lb clethodim	6.0–16.0 fl oz Select 2EC	45	Make postemergence applications when actively growing grasses are in the size ranges specified on the label. Do not apply more than 0.5 lb ai/a clethodim in one crop season. Include appropriate surfactant as required by product label. Requires a 1-hour rainfree period.
	0.068–0.24 lb clethodim	9.0–32.0 oz Select Max	45	
	0.13–0.19 lb fluazifop-P-butyl	0.5–0.75 pt Fusilade DX	45	Make postemergence applications when actively growing grasses are in the size ranges specified on the label. Always add to the finished spray volume 1% crop oil concentrate or 0.25% nonionic surfactant. Multiple applications may be made to control late germinating grasses, but do not exceed 3 pt/a Fusilade DX per crop season.
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	30	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet or rescue treatment rates. Do not apply more than 4.5 pt/a Poast per crop season. Always add 2 pt/a of oil concentrate.
Emerged annual broadleaves	0.12 lb oxyfluorfen (dry bulb onions only)	0.5 pt Goal 2XL	45	For seeded onions, apply postemergence when onions have at least two true leaves and weeds are in the two- to four-leaf stage. Do not exceed 2.0 pt/a Goal 2XL per season. Do not apply when onion plants are stressed. Do not mix with pesticides, oils, surfactants, or fertilizers. Check the label for application to transplanted onions.
	0.25–0.375 lb bromoxynil	1.0–1.5 pt Buctril 2E		Apply when onions are in the two to five true leaf stage and weeds are less than 2 inches tall— younger or older onions may be injured. Apply in at least 50 gal water/a to avoid crop injury; do not add surfactant. Apply when soil and onion leaves are dry. Do not treat onions damaged by insects or blowing sand.

Pea

Peas grow best in cool, moist early spring weather. To avoid all peas maturing at once, planting dates and varieties are chosen on the basis of degree days (DD). The base temperature used in computing degree days is 40°F. The number of degree days needed for a variety to reach the processing stage is fairly constant. Within a variety, temperature records are commonly used to predict the maturation or harvest date. Because of the large difference in spring and summer temperatures, several days separation at planting time may be required to separate harvests by only 1 or 2 days. Planting dates are determined using growing degree day requirements for maturation and on historical weather records.

Select fields with uniform fertility, soil type, slope, and drainage. Silt loams, sandy loams, or clay loams are best. High organic matter improves tilth and makes soil less droughty. Peas grown on sands and mucks require careful irrigation management.

Peas need adequate soil moisture but too much or too little reduces yield. Inadequate drainage starves the root zone of oxygen so that normal root respiration cannot occur, nitrogen-fixing bacteria cannot function efficiently, and root rot organisms become more destructive.

Peas typically follow corn in a rotation. Other crops such as small grains and hay also work well. The usual sequence is corn, peas, small grain, hay. Rotations with potatoes do not work well unless soil pH is above 6.6. Peas are sometimes grown in a double crop system. Snap beans, soybeans, or silage corn may be planted after the peas are harvested. Double cropping can increase risks from diseases and insects.

Frequent pea culture increases disease and insect problems, especially common root rot. To avoid buildup of these problems, peas should not be grown on the same field more than once every 4 or 5 years.

Peas do not compete well with weeds. The best time to control weeds is before planting. Canada thistles are particularly troublesome because their buds are hard to remove from shelled peas and greatly reduce the pea grade. Choose fields without major weed problems. Check that previous herbicides will not damage peas, since some chemicals persist in the soil.

Planting

The best yields can be expected from the earliest planted peas. Till seedbed 4–5 inches deep, but do not work the soil too fine, or crusting will cause problems in emergence. Grain drills are generally used to plant peas. Seeding rates vary depending on cultivar. Plant seeds 2 inches deep in firm moist soil to promote fast, uniform germination and seedling emergence. Plant shallower if soil is heavy or very moist. Plant deeper (but no more than 3 inches) on light soils or if soil is dry or cloddy.

Good yields require adequate stands. Full stands of strong vigorous plants provide needed competition against weeds and make full use of soil moisture and nutrients. The problem is more apt to be one of too few plants rather than too many.

Early and light-vined varieties, such as Alsweet, should have at least 672,000 plants/a (nine plants/ft in 7 inch rows). Later varieties need a minimum population of 500,000 plants/a (six plants/ft in 7 inch rows). There are indications that populations higher than these minimums may be profitable. Base seeding rates on the final plant population desired. Large seeds require heavier rates than small seeds. Poor germinating seeds or unfavorable conditions at planting require heavier rates.

Seed treatment

Most pea seeds for commercial production are treated with a fungicide and dyed to make them stand out. The fungicide coating helps protect seed and seedling from soil fungi until emergence. Treated seeds are poisonous and must not be used for food or feed.

Seed inoculation

Peas in association with the proper nitrogen-fixing bacteria can fix their own nitrogen from the air, therefore it may be beneficial to inoculate the seeds before planting. This is especially important if peas have not been grown in that field for more than 5 years.

Lime and fertilizer

Determine fertilizer and lime needs with a soil test.

Lime: Adjust pH to 6.0 or higher on mineral soils and 5.6 on organic soils for maximum yields.

Fertilizer rates: Apply annual nitrogen, P_2O_5 , and K_2O rates shown in the table below. Take credits for previous legume crops and manure.

Application: Broadcast and work in lime and fertilizer before planting. Small amounts of fertilizer (up to 200 lb/a) can be applied with the drill at planting time. Additional required fertilizer should be broadcast and incorporated before planting. Drill-applied fertilizer should be placed

2 inches to the side and slightly below the seed. Starter fertilizer is especially important for early peas on cool, wet soils because nitrogen-fixing bacteria are less active.

Annual nitrogen, phosphate, and potash recommendations for peas

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P ₂ O ₅	K ₂ O
— % —	— lb/a —	— — — — —	— lb/a — — — — —	— — — — —
<2	40	1,000–2,500	10	15
2.0–9.9	30	2,501–4,000	15	30
10–20	20	4,001–6,000	25	45
>20	0			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in pea

Disease	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Ascochyta blight	<i>Use clean, disease-free seed and a 3-year rotation.</i>			
	azoxystrobin	2.0–5.0 oz Amistar 80 WDG	0	Amistar, Quadris, and Headline belong to the strobilurin group of fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed two applications of strobilurin fungicides per crop per year. Do not exceed 1.88 lb/a Amistar, 2.88 qt/a Quadris, or 18 fl oz/a Headline per crop per season.
		6.4–15.4 fl oz Quadris Flowable	0	
	pyraclostrobin	6.0–9.0 fl oz Headline	7	
Bacterial blight (“syringae” blight)	<i>Use clean, disease-free seed. Avoid planting after snap and lima beans. Don’t over-irrigate.</i>			
Common root rot (Aphanomyces)	<i>There are no disease resistant cultivars. Rotations with non-legumes slow the buildup of disease problems. A test from the UW-Madison Dept. of Plant Pathology predicts the potential for root rot. Trifluralin herbicide gives some protection against Aphanomyces root rot.</i>			
Fusarium near wilt	<i>Cultivars resistant to near wilt are the only effective control.</i>			
Fusarium root rot	<i>Avoid close cropping of peas. Plant peas in a 4-year rotation with other crops.</i>			
Fusarium wilt	<i>Use resistant varieties.</i>			
Powdery mildew	8.0–10.0 lb wettable sulfur in 100 gal water or dust on 325 mesh dusting sulfur			Use mildew-resistant varieties. Begin applications at first sign of mildew. Do not apply when plants are wet or when temperatures are above 85°F.
Rhizoctonia root rot	azoxystrobin	0.125–0.25 oz Amistar 80WDG/1000 row ft	0	Use at planting. Follow manufacturer’s directions.
Seed rot and damping-off	captan or thiram			Seed treatment. Follow manufacturer’s instructions. Combination fungicides-insecticides are available. If using inoculum, apply it just before planting. Plant disease-free seed.
Virus diseases	<i>Virus diseases such as enation virus, mosaic seed-borne virus, mosaic pea streak virus, and pea stunt are spread by aphids. Good aphid control is the most effective control measure.</i>			

Scouting calendar for insect pests of peas

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
	Aphids				
	Caterpillar contaminants				

Insect control in pea^a

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Alfalfa caterpillar	<i>Treat if you find one caterpillar per 25 sweeps.</i>			
	0.033–0.1 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC, *Discipline 2EC	3	Do not exceed 12.8 oz/a (0.2 lb ai/a) per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Foliar treatment. Do not exceed 0.1 lb ai/a per season. Do not feed treated forage to livestock.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 fl oz *Proaxis	7	Apply every 5 days as needed. Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	7	Apply every 5 days as needed. Do not exceed 0.12 lb ai/a (0.96 pt/a Warrior) per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	1 ^b	Foliar treatment.
	0.017–0.025 lb zeta-cypermethrin	2.72–4.0 oz *Mustang Max	1	Wait at least 5 days between applications. Do not exceed 24 oz/a (0.15 lb ai/a) per season.
Aphids	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not apply more than 0.266 lb ai/a per season. Wait at least 5 days between applications.
	<i>Treatment is recommended if you find one aphid per small pod or 10 per sweep.</i>			
	0.033–0.1 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC, *Discipline 2EC	3	Do not exceed 12.8 oz/a (0.2 lb ai/a) per season.
	dimethoate	0.33–1.0 pt Dimethoate EC	3	Foliar treatment. Do not feed or graze forage within 21 days of last application. Make only one application per season. Do not apply if bees are visiting the areas to be treated when crops or weeds are in bloom.
	0.015–0.03 lb esfenvalerate	2.9–5.8 fl oz *Asana XL	3	Foliar treatment. Do not exceed 0.1 lb ai/a per season. Do not feed treated forage to livestock.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 fl oz *Proaxis	7	For suppression of aphids only. Apply every 5 days as needed. Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season. See resistance statement under “General Use Precautions and Restrictions” on label.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Soil application in furrow, seed line. See label for various application methods and timing.
		3.5 fl oz Provado 1.6F	7	Foliar application. Wait at least 7 days between applications. Do not exceed 10.5 fl oz/a Provado per season and do not exceed 0.5 lb ai/a imidacloprid per season (any formulation).
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	7	Apply every 5 days as needed. Do not exceed 0.12 lb ai/a (0.96 pt/a Warrior) per season. See resistance statement under “General Directions for Use” on label.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	1 ^b	Foliar treatment.
	thiamethoxam	1.28 fl oz Cruiser 5FS /100 lb seed	30	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.017–0.025 lb zeta-cypermethrin	2.72–4.0 oz *Mustang Max	1	Wait at least 5 days between applications. Do not exceed 24 oz/a (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not apply more than 0.266 lb ai/a per season. Wait at least 5 days between applications.

* Restricted-use pesticide.

(continued)

^a EPA-approved insecticides for pea insects. Usually honey bees do not work pea blossoms, but weed blossoms in the field or in the fencerow might attract bees. Avoid using Sevin sprays if bee yards are located within 2–2½ miles of pea fields. Apply insecticides in the evening to avoid excessive kill of foraging bees.

^b Harvest time is 5 days for forage and 14 days for hay.

Insect control in pea^a (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Armyworm	0.5–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Dipel DF, Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.033–0.1 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC, *Discipline 2EC	3	Do not exceed 12.8 oz/a (0.2 lb ai/a) per season.
	carbaryl	1.0–1.5 qt Sevin XLR Plus	3	Do not exceed 6 qt/a per crop. Do not apply within 14 days of grazing or harvest of forage or within 3 days of harvest of fresh peas or within 21 days of harvest of dried peas.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Foliar treatment. Do not exceed 0.1 lb ai/a per season. Do not feed treated forage to livestock.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 fl oz *Proaxis	7	For control of first and second instars only. Apply every 5 days as needed. Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	7	Use higher rates for large larvae. Apply every 5 days as needed. Do not exceed 0.12 lb ai/a (0.96 pt/a Warrior) per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	1 ^b	Foliar treatment.
	0.031–0.063 lb spinetoram	4.0–8.0 fl oz Radiant	3	Do not make more than six applications per crop. Do not exceed 0.219 lb ai/a per season. Wait at least 4 days between applications.
	0.06–0.09 lb spinosad	1.25–2.0 fl oz Entrust 4.0–6.0 fl oz SpinTor 2SC	3	Foliar treatment. Do not apply more than 0.45 lb ai/a per season.
	0.017–0.025 lb zeta-cypermethrin	2.72–4.0 oz *Mustang Max	1	Wait at least 5 days between applications. Do not exceed 24 oz/a (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not apply more than 0.266 lb ai/a per season. Wait at least 5 days between applications.
Cutworms	0.033–0.1 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC, *Discipline 2EC	3	Do not exceed 12.8 oz/a (0.2 lb ai/a) per season.
	1.5 lb carbaryl	30 lb Sevin bait	3	Broadcast treatment.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Foliar treatment. Do not exceed 0.1 lb ai/a per season. Do not feed treated forage to livestock.
	0.0075–0.0125 lb gamma-cyhalothrin	1.92–3.20 fl oz *Proaxis	7	Do not apply more than 0.96 pt/a (0.06 lb ai/a) per season.
	0.015–0.025 lb lambda-cyhalothrin	1.92–3.20 fl oz *Warrior	7	Do not exceed 0.96 pt/a Warrior (0.12 lb ai/a) per season.
	0.008–0.025 lb zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Wait at least 5 days between applications. Do not exceed 24 oz/a (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not apply more than 0.266 lb ai/a per season. Wait at least 5 days between applications.
Loopers	<i>Treat if you find one looper per 25 sweeps.</i>			
	0.5–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Dipel DF, Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC, *Discipline 2EC	3	Do not exceed 12.8 fl oz/a (0.2 ai/a) per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Foliar treatment. Do not exceed 0.1 lb ai/a per season. Do not feed treated forage to livestock.

* Restricted-use pesticide.

(continued)

^a EPA-approved insecticides for pea insects. Usually honey bees do not work pea blossoms, but weed blossoms in the field or in the fencerow might attract bees. Avoid using Sevin sprays if bee yards are located within 2–2½ miles of pea fields. Apply insecticides in the evening to avoid excessive kill of foraging bees.

^b Harvest time is 5 days for forage and 14 days for hay.

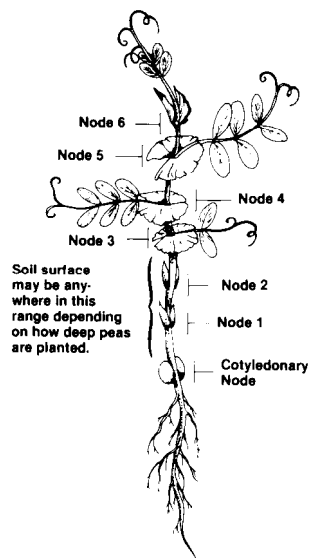
Insect control in pea (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Loopers (<i>cont.</i>)	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 fl oz *Proaxis	7	Wait at least 5 days between applications. Do not exceed 0.96 pt/a (0.06 lb ai/a) per season.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	7	Wait at least 5 days between applications. Do not exceed 0.12 lb ai/a (0.96 pt/a Warrior) per season.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	1 ^b	Foliar treatment.
	0.031–0.063 lb spinetoram	4.0–8.0 fl oz Radiant	3	Do not make more than six applications per crop. Do not exceed 0.219 lb ai/a per season. Wait at least 4 days between applications.
	0.06–0.09 lb spinosad	1.25–2.0 fl oz Entrust 4.0–6.0 fl oz SpinTor 2SC	3	Foliar treatment. Do not apply more than 0.45 lb ai/a per season.
	0.017–0.025 lb zeta-cypermethrin	2.72–4.0 oz *Mustang Max	1	Wait at least 5 days between applications. Do not exceed 24 oz/a (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not apply more than 0.266 lb ai/a per season. Wait at least 5 days between applications.
Seed maggot	thiamethoxam	1.28 fl oz Cruiser 5FS /100 lb seed	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.

* Restricted-use pesticide.

^a EPA approved insecticides for pea insects. Usually honey bees do not work pea blossoms, but weed blossoms in the field or in the fencerow might attract bees. Avoid using Sevin sprays if bee yards are located within 2–2½ miles of pea fields. Apply insecticides in the evening to avoid excessive kill of foraging bees.

^b Harvest time is 5 days for forage and 14 days for hay.



Weed control

Postemergence herbicides need to be applied at the correct stage of growth to avoid injury and prevent yield losses. Correctly counting leaves or nodes on pea plants is critical in timing herbicide applications.

To count nodes, refer to the drawing of the pea plant. The point where the cotyledons (seed) are attached to the plant is the cotyledonary node. The root forms below this node and the stem above. The two nodes above this point produce incomplete or stipular leaves. These leaves can be above or below the soil surface and can be difficult to detect.

Count the first two nodes above the cotyledonary node as one and two. The third node has normal stipules and usually a leaf with two leaflets. The rest of the nodes produce normal stipules and a leaf with four leaflets. The uppermost node from which a leaf extends is the last developed node to be counted. Within the folded stipules of this node are the growing point of the pea plant and stipules and leaves of still more nodes.

Weed control in pea

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annuals	0.5 lb clomazone	1.3 pt Command 3ME		Command provides fair control of annual grasses and several broadleaf weeds, but is weak on pigweed and black nightshade. Command is ineffective on peat and muck soils. The 3ME formulation is labeled for preemergence applications, but shallow incorporation is permitted, which should prevent volatility. Off-site movement through drift or vapors can cause bleaching of sensitive plants and must be avoided. Application is prohibited within 1,200 feet of housing, greenhouses, and nurseries and within 300 feet of desirable sensitive plants. Do not apply if wind exceeds 10 mph. Cabbage, soybeans, and tobacco can be replanted anytime after application. Beans, field and sweet corn, cucurbits, potatoes, and transplant tomatoes can be planted 9 months after application. Wheat can be planted 12 months after application, but small-seeded legumes and other small grains should not be planted for 16 months. Treated pea vines cannot be fed to livestock.
	0.047 lb imazethapyr	3.0 fl oz Pursuit or 1.08 oz Pursuit DG	30	<p>Apply as a preplant treatment within 7 days of planting and incorporate 1–2 inches deep or as a preemergence treatment within 3 days after planting. Ineffective on peat or muck soils.</p> <p>Or apply postemergence when weeds are less than 2 inches tall and after peas are at least 3 inches tall but prior to five nodes before flowering. Include 2 pt/100 gal of nonionic surfactant in the final spray mixture. Do not use crop oil as an adjuvant. Tank-mixing Pursuit with postemergence grass herbicides may reduce grass control. Apply Pursuit at least 7 days before or 3 days after a postemergence grass herbicide.</p> <p>Pursuit controls several annual broadleaf weeds, including black nightshade, and some annual grasses. It can stunt peas if cool and/or wet weather follows treatment. Pursuit at 2 fl oz/a can be applied postemergence after a trifluralin treatment to suppress nightshade, but the risk of injury increases.</p> <p>The following crop rotation restrictions apply to fields treated with 3 oz/a Pursuit. Soybeans, lima beans, peas, and Clearfield corn may be planted anytime after application. Wait 3 months before planting snap beans or wheat; 4 months before planting alfalfa, barley, edible beans, or rye; 8.5 months before planting conventional field corn or seed corn; 9.5 months before planting tobacco; 18 months before planting oats, sorghum, or sweet corn; 26 months before planting potatoes; and 40 months for all other crops. Treated pea vines cannot be fed to livestock.</p>

(continued)

Weed control in pea (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annuals (<i>cont.</i>)	0.047 lb imazethapyr + 0.63 lb pendimethalin	30 fl oz Pursuit Plus	30	<p>Apply as a preplant incorporated treatment within 7 days of planting. Incorporate to a depth of 1–2 inches. Do not make more than one application per year or apply after June 30. Pursuit Plus may reduce crop growth and delay maturity if cold and wet conditions occur soon after planting.</p> <p>Pursuit Plus controls several annual broadleaf weeds, including black nightshade, and some annual grasses. Add 0.25–0.5 pt/a of Prowl 3.3EC to control the annual grass weed species listed on the Prowl label.</p> <p>The following crop rotation restrictions apply to fields treated with Pursuit Plus. Soybeans, dry beans, and peas may be planted anytime after application. Wait 2 months before planting snap beans; 4 months before planting barley or wheat; 8.5 months before planting field or seed corn; 9.5 months before planting alfalfa or tobacco; 18 months before planting oats, popcorn, sorghum, or sweet corn; 26 months before planting potatoes; and 40 months for all other crops. Treated pea vines cannot be fed to livestock.</p>
	0.95–1.9 lb s-metolachlor	1.0–2.0 pt Dual II Magnum or Cinch		<p>Apply preemergence for good to excellent control of foxtails and other annual grasses, good control of black nightshade and pigweed, and partial control of nutsedge. Does not control most other broadleaf weeds. Can cause significant pea injury. Residues will not carryover to the fall or next season. Pea vines can be cut for hay 120 days after application. Ineffective on peat or muck soils.</p>
	0.5–1.5 lb pendimethalin	1.2–3.6 pt Prowl or Pendimax 1.5–3.0 pt Prowl H ₂ O		<p>Preplant-incorporated treatment controls annual grasses, lambsquarters, and pigweed but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Incorporate 1–2 inches deep within 7 days after application. Can be tank-mixed with Pursuit. Can delay maturity of early maturing pea cultivars. Pea injury is more severe on wet soils. Ineffective on peat or muck soils. Some suppression of common root rot. Crops that allow preplant-incorporated pendimethalin use can be double cropped after peas. Do not plant winter wheat until 120 days after application; any crop may be planted the following year. Treated pea vines cannot be fed to livestock.</p>
	0.5–0.75 lb trifluralin	1.0–1.5 pt Treflan MTF or comparable trifluralin formulation		<p>Preplant-incorporated treatment controls annual grasses, lambsquarters, and pigweed but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Incorporate 2–3 inches deep within 24 hours of application. Can delay maturity of early maturing pea cultivars. Pea injury is more severe on wet soils. May carryover in soil. Ineffective on peat or muck soils. Some suppression of common root rot.</p>

(continued)

Weed control in pea (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged annual broadleaves	0.75–1.0 lb bentazon	1.5–2.0 pt Basagran	10	Excellent control of velvetleaf and wild mustard. Partial control of black nightshade, common lambsquarters, and redroot pigweed when applied to very small seedlings. Some burndown of yellow nutsedge and Canada thistle. Does not control grasses. Apply when broadleaf weeds are small and actively growing, but only after three pairs of pea leaves (usually four nodes) are present. Do not include spray oil in the spray mixture. Spray to thoroughly cover weeds. Use minimum of 20 gal/a of water and 40 psi pressure and apply through flat fan or hollow cone nozzles no more than 20 inches apart. Do not apply if peas are stressed. Do not tank-mix with other pesticides. Rain within 4 hours reduces effectiveness.
	0.023 lb imazamox	3.0 fl oz Raptor		Controls eastern black and hairy nightshade, wild mustard, field pennycress, shepherd's purse, and pigweed. Apply before weeds exceed 3 inches in height. Peas must be at least 3 inches tall, but 5 nodes before flowering. Add 0.25% nonionic surfactant to the spray mixture. Weed control can be improved by adding 2.5% of liquid nitrogen fertilizer (28%) or 12–15 lb of ammonium sulfate per 100 gal of mix. Suppression of annual grasses will be increased if 1% crop oil concentrate is used instead of surfactant. When using crop oil concentrate or nitrogen fertilizer as an adjuvant, always add 6–16 oz/a of Basagran to reduce crop injury. Rain within 1 hour will reduce control. The following crop rotation restrictions apply to fields treated with Raptor. Soybeans and edible legumes can be planted anytime after application. Alfalfa and wheat can be planted after 3 months and barley and rye after 4 months. All types of corn can be planted after 8.5 months, and carrot, onion, oats, and many other crops can be planted after 9 months. Beets can be planted after 18 months if the soil pH is 6.2 or greater.
	0.12–0.37 lb acid equivalent MCPA	0.25–0.75 pt MCPA		Controls most annual broadleaf weeds and inhibits Canada thistle bud formation. Weak on black nightshade and smartweed but does control mustards. Low rate controls young weeds only. Need 0.5–0.75 pt to inhibit thistle bud formation. Apply no later than three nodes before pea flowering. May delay pea maturity 1–4 days. Avoid application if soils are waterlogged, temperatures are above 90°F, or during drought. Treated pea vines cannot be fed to livestock. <i>Most MCPA labels do not allow use on peas in the Midwest. Consult label prior to use.</i>

(continued)

Weed control in pea (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Emerged annual broadleaves (<i>cont.</i>)	0.5–1.0 lb acid equivalent MCPB	2.0–4.0 pt/a Thistrol		Controls many annual broadleaf weeds and inhibits Canada thistle flower bud formation. Weak on smartweed, mustards, and black nightshade. Lower rate controls only young weeds less than 3 inches tall. Apply 3–4 pt for thistle inhibition. Apply no later than three nodes before pea flowering. Usually delays pea maturity 1–4 days. Do not apply when soils are waterlogged or during drought. Do not apply if temperatures are over 90°F. Treated pea vines cannot be fed to livestock.
Emerged annual grasses	0.094–0.188 lb sethoxydim	0.5–1.0 pt Poast plus 2.0 pt of oil concentrate	15	Apply the higher rate when foxtails, fall panicum, barnyardgrass and woolly cupgrass are up to 8 inches tall and actively growing. The same treatment will control shattercane that is up to 18 inches tall and volunteer corn that is up to 20 inches tall. The lower rate will control 10 inch tall wild proso millet. Controls most annual and perennial grasses but does not control broadleaf weeds or sedges. Thoroughly cover weeds. Use 5–20 gal/a of water and 40 psi pressure and apply through flat fan or hollow cone nozzles. Rainfall within 1 hour reduces effectiveness.
	0.034–0.083 lb quizalofop	5.0–12.0 oz Assure II or Targa plus 1% oil concentrate or 0.25% nonionic surfactant	30	Controls most annual and perennial grasses but does not control broadleaves. Apply 5–8 oz/a for wild proso millet, 7–8 oz/a for foxtails, 8–10 oz/a for crabgrass, 9–10 oz/a for woolly cupgrass, and 10–12 oz/a for quackgrass. To avoid antagonizing activity, apply broadleaf herbicides either 7 days before or 24 hours after Assure II or Targa. If tank-mixing with Basagran, increase the Assure II or Targa rate by 2 oz to minimize grass antagonism. Apply in 10–20 gal/a of water with flat fan or hollow cone nozzles. Rainfall within 1 hour reduces effectiveness. Treated pea vines cannot be fed to livestock.
Perennial weeds	0.75–2.25 lb acid equivalent glyphosate	0.7–2.0 qt Roundup WeatherMax or equivalent glyphosate rate		Excellent control of quackgrass, good control of Canada thistle and other perennial weeds. Apply preplow before planting peas. Don't till or mow target weeds for several months before treatment. Don't till fields in fall that you plan to treat in spring. For quackgrass control, treat with 1.5 lb ae/a in fall or spring when quackgrass is 6–8 inches tall and actively growing, or apply 0.75 lb ae/a in 3–10 gal/a of spray using flat fan or hollow cone spray nozzles. For Canada thistle control, treat with 2 lb ae/a when thistles are in the bud to early bloom stage and actively growing. Do not mow or till treated quackgrass or Canada thistle for 3 days. Rain within 2 hours of application can reduce effectiveness.

Pepper

Planting

Transplants **Rows**—18–36 inches;
plants in row—18–24 inches. Use 24 lb/a seed (1 oz produces 215 plants).

Set transplants May 20–June 1 in the southern half of Wisconsin and 7–10 days later in the northern counties after danger of frost is past. Plants stop growing below 55°F. Poor fruit set may occur below 60°F or above 75°F.

Transplants should be 6–8 weeks old, vigorous, slightly hardened (held at 60–65°F several days), stocky, dark green, and without disease or insect injury. Handle transplants carefully. Use a starter solution high in nitrogen and phosphorus as transplants are set out.

Irrigation

Irrigation is essential on sandy soils and may help on heavier soils during prolonged dry periods. Approximately 1–1.5 inches of water is needed every 5–7 days. If maximum daily temperatures exceed 85°F, more frequent irrigation may be necessary.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.0 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in the table below. Take credits for previous legume crops and manure.

Application: Broadcast recommended fertilizer and plow or disk under before setting transplants.

Nitrogen: Apply preplant or sidedress. Split nitrogen into two or three applications, especially on sandy soils.

Annual nitrogen, phosphate, and potash recommendations for peppers

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P_2O_5	K_2O
— % —	— lb/a —	— t/a —	— — — lb/a — — —	— — —
<2	100	8–10	10	50
2.0–9.9	80			
10–20	60			
>20	30			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in pepper

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Bacterial spot	<i>Plant cultivars with resistance to bacterial spot. Several cultivars have field tolerance to races of the pathogen. A hot water seed treatment will help prevent bacterial spot. Place the seed in a mesh bag and dip it into water heated to 122°F; treat for 25 minutes. Immediately transfer the bag to cold water to cool the seed. There will be some reduction in the germination rate of treated seed. You may wish to sow additional seed to compensate.</i>			
	copper ammonium complex	0.33–0.75 gal K-Cop	0	Spray every 7 days.
	copper hydroxide	2.0–3.0 lb Champion 77WP	0	
		1.3–2.0 pt Champ Formula 2 4.6F	0	
		2.0–3.0 lb Kocide 101	0	
		2.0–3.0 lb Kocide DF	0	
		2.6–4.0 pt Kocide LF 2.4F	0	
		1.5–2.0 pt Kocide 4.5 LF	0	
		1.5–2.25 lb Kocide 2000 DF	0	

(continued)

Disease control in pepper (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Bacterial spot (cont.)	copper sulfate	3.0–4.0 lb Tri-Basic Copper		
	streptomycin sulfate	200 ppm solution of 21.2% streptomycin sulfate		Spray every 4–5 days in the plant bed, but do not use after transplanting.
Damping off, crown rot	mefenoxam	1.0 pt Ridomil Gold EC 1.0 lb Ridomil Gold WSP		Soil treatment at the time of planting.
Phytophthora blight, ripe rot	cymoxanil + famoxadone	8.0–10.0 oz Tanos 50DF	3	Disease suppression only. Do not make more than 1 application of Tanos before alternating with a fungicide having a different mode of action. Do not exceed 72 oz/a Tanos per season.
	dimethomorph	6.0 oz Forum	0	Disease suppression only. Tank-mix Forum with another fungicide active against Phytophthora blight and having a different mode of activity. Do not make more than two sequential applications of Forum before alternating to another effective fungicide. Do not exceed five applications per season or 30 oz/a per season.
	maneb	1.2–2.4 qt Maneb plus Zinc F4	7	Consult label for product limits. Begin treatment when disease threatens.
		1.5–3.0 lb Maneb 80WP	7	
		1.2–2.4 qt Manex F4	7	
Virus diseases (alfalfa mosaic, cucumber mosaic, tobacco mosaic, potato viruses X & Y, tobacco etch)	<i>Be sure transplants are free from virus infections. Plant peppers far from potatoes, tomatoes, squash, cucumbers, melons, alfalfa. Eliminate all perennial weed hosts within 150 ft of field. Plant varieties resistant to tobacco mosaic virus.</i>			

Insect control in pepper

Insect	Rate/a of active ingredient	Commercial product	Days to harvest	Remarks and suggestions
European corn borer	<i>Treat when eggs or larvae are observed OR when female European corn borer moths in nearby blacklight traps exceed 4 per night on three consecutive nights when peppers are forming. Repeat applications at 5- to 7-day intervals while moth flights continue or until harvest.</i>			
	0.25–1.0 lb acephate	0.25–1.0 lb Orthene 97	7	Sweet bell peppers only. Do not exceed 2.66 lb ai/a per season.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.033–0.1 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC	7	Apply every 7 days as needed. Do not exceed 12.8 oz/a (0.2 lb ai/a) per season.
	1.0–2.0 lb carbaryl	Sevin	3	Several formulations; see label for rate.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	7	Do not use when peppers are grown for seed. Ground applications only. Do not exceed 16.8 fl oz/a Baythroid 2 per season. Allow 7 days between applications.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana L	7	Do not exceed 0.35 lb ai/season
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.065 lb indoxacarb	3.5 oz Avaunt 30DG	3	Wait at least 5 days between applications. Do not exceed 24 oz/a Avaunt (0.44 lb ai/a) per crop.
	0.02–0.03 lb lambda cyhalothrin	2.56–3.84 fl oz *Warrior	5	Apply every 5 days as needed. Do not exceed 0.36 lb ai/a or 2.88 pt/a Warrior per year.

*Restricted-use pesticide.

(continued)

Insect control in pepper (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
European corn borer (<i>cont.</i>)	0.06–0.16 lb methoxyfenozide	<i>early season:</i> 4.0–8.0 fl oz Intrepid 2F <i>mid- to late season:</i> 8.0–16.0 fl oz Intrepid 2F	1 1	Will not control flea beetles. Do not exceed 64 fl oz/a per season. Use the higher rates with higher populations or when spray coverage is difficult. See label for use restrictions in some Wisconsin counties.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	3	Sweet bell peppers only. See label for rate. Do not exceed 1.6 lb ai/a per season.
	0.039–0.078 lb spinetoram	5.0–10.0 oz Radiant SC	1	Do not apply more than 34 oz/a Radiant (0.266 lb ai/a) per crop and do not exceed four applications per year.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	1 1	Use higher rate for larger insects. Apply adequate spray to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent.
	0.09–0.12 lb tebufenozide	6.0–16.0 fl oz Confirm 2F	7	Apply at first sign of feeding or when populations exceed threshold levels. Do not exceed 64 fl oz per season. There is a 1–12 month plantback restriction depending on the crop.
	zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.
Green peach aphid	0.25–1.0 lb acephate	0.25–1.0 lb Orthene 97	7	Sweet bell peppers only: Do not exceed 2.66 lb ai/a per season. Non-bell peppers: Do not exceed 1.33 lb ai/a per season.
	acetamiprid	0.8–1.2 oz Assail 70WP 2.0–4.0 oz Assail 30SG	7 7	Begin treatment when thresholds are reached. Apply every 7 days as needed. Do not exceed 0.3 lb ai/a per season.
	0.033–0.1 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC	7	Apply every 7 days as needed. Do not exceed 0.2 lb ai/a per season.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a.
	0.25–0.33 lb dimethoate	0.5–0.66 pt Dimethoate EC	0	
	0.045–0.268 lb dinotefuran	<i>foliar:</i> 1.0–4.0 oz Venom 70SG <i>soil:</i> 5.0–6.0 oz Venom 70SG	1 21	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz/a per year using foliar applications, or 12 oz/a per season using soil applications. See product label for application directions.
	0.5–1.0 lb endosulfan	1.0–2.0 lb Thiodan WP, 0.66–1.33 qt Phaser EC	1–4	Do not exceed 2 applications per season.
	imidacloprid	7.0–14.0 fl oz Admire Pro	21	Systemic at planting. Do not exceed 32 fl oz/a Admire per season.
	0.05 lb imidacloprid	3.75 fl oz Provado 1.6	0	Foliar spray. Do not exceed 18.75 fl oz/a Provado per season.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.02–0.03 lb lambda cyhalothrin	2.56–3.84 fl oz *Warrior	5	Apply every 5 days as needed. Do not exceed 0.36 lb ai/a or 2.88 pt/a Warrior per year.
	0.625–1.5 lb malathion	several formulations	3	
	0.225–0.45 lb methomyl	0.75–1.5 pt *Lannate LV, 0.25–0.5 lb *Lannate SP	3	
	0.5–1.0 lb oxamyl	2.0–4.0 pt *Vydate L	7	Sweet bell peppers only. Repeat at 1- to 2-week intervals or as needed.
	0.5 lb oxydemeton-methyl	2.0 pt *Metasystox-R	3	Do not exceed 2 applications per season.

*Restricted-use pesticide.

(continued)

Insect control in pepper (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Green peach aphid (cont.)	pymetrozine	2.75 oz Fulfill 50WDG	14	May be used on bell, chili, cooking, and pimento peppers. Controls melon and green peach aphids. Treat when aphids first appear. May repeat in 7 days. Do not exceed 5.5 oz/a per season or more than 2 applications per crop.
	thiamethoxam	2.0–3.0 oz Actara	0	Apply before pests reach damaging levels. Repeat as needed every 5 days. Do not exceed 8 oz/a of product per season.
		5.0–11.0 fl oz Platinum	30	Apply as an in-furrow spray at planting or as a post-seeding transplant or hill drench. Irrigate sufficiently to move the chemical into the root zone. Use the higher rate for long residual control. Do not apply less than 5 fl oz/a or more than 11 fl oz/a of Platinum per season.
	zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

Weed control in pepper

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
All weeds	<i>Even where you use herbicides, shallow cultivation will help control weeds. Cultivate as needed when weeds are less than 2–3 inches tall.</i>			
Annual weeds	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or registered equivalent		Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
	0.25–1.0 lb clomazone	0.67–2.67 pt Command 3ME		Do not use on banana peppers. For suppression and control of annual grasses and broadleaves, make a single preemergent soil application before seeding or transplanting. Place seed or roots of transplants below the chemical barrier when planting. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read and understand the vegetable disclaimer section of the label—the end user of this product assumes all liability for failure to perform and crop injury resulting from its use.
	1.0–2.0 lb napropamide	2.0–4.0 lb Devrinol 50-DF 2.0–4.0 qt Devrinol 2-E		Apply before planting to weed-free soil surface. Incorporate 1–2 inches deep the same day. Can be applied to direct-seeded or transplanted peppers.
	0.48–1.43 lb pendimethalin	1.0–3.0 pt Prowl H ₂ O	70	Apply as a broadcast preplant-incorporated or as a broadcast surface application before transplanting, or as a post-directed application to transplanted or established direct-seeded peppers. Do not apply postemergence over the top of or to pepper foliage. Rate varies by soil type. Do not exceed 3 pt/a per season or allow treated soil to come in contact with transplants. Do not apply if row will be covered with plastic.

(continued)

Weed control in pepper (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Apply before planting and incorporate 1–2 inches deep to avoid losses due to volatilization. Use on mineral soils only.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea	30	Sandea controls several broadleaf weeds and nutsedge. It will not control grasses. Sandea may be applied between rows of direct-seeded or transplanted peppers as a directed or shielded spray. Avoid contact of the spray with the crop. If plastic was used on the planted row, adjust equipment to keep application off the plastic. Do not apply more than 2 oz/a per crop cycle or 12-month period. Soil or foliar applications of organophosphate insecticides to Sandea-treated crops may cause severe crop injury. Consult label for additional usage information and other precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Some formulations require a wait of 3 days between application and seeding. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding and transplanting should be performed with minimal soil disturbance. Up to three directed/shielded treatments may be made per season using precision equipment to prevent spray contact with the crop. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	20	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	20	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	20	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet and rescue treatment rates. Do not apply more than 4.5 pt/a of Poast in one crop season. Always add 2 pt/a of crop oil concentrate. Do not treat bell peppers during hot, humid weather or unacceptable leaf injury may occur. Check the label for additional precautions and restrictions.

*Restricted-use pesticide.

Potato

Planting

Choose fertile, well-drained sands, sandy loams, or silt loams for best production. Prepare a deep, loose seed bed using minimum tillage. Deep tillage may be beneficial in soils with compacted layers resistant to rooting. Deep tillage should be done at an angle to planting operations to ensure straight rows. Potatoes should be planted from early April through early May on sandy soils, and from mid-April through late May in northern Wisconsin. Potatoes can be planted from late April through early July on muck soils depending on soil moisture conditions and intended market.

Potatoes should be planted when soil temperatures are similar to the pulp temperature of the seed piece (50–55°F). Temperature differences of more than 10°F between soil and seed pieces can lead to condensation on seed piece surfaces, leading to decay. In addition, soils should be near field capacity for moisture at planting. When seed pieces are planted in dry soils and then irrigated or rained upon, they're more vulnerable to decay. Sandy soils dry relatively quickly, especially when tilled and in windy conditions.

Rows—30–36 inches;

seed piece spacing in row—8–16 inches apart, depending on variety and market goals. Seed pieces should be blocky and weigh 1.5–2.0 oz; use 12–24 cwt/a, depending on variety and spacing. Plant 2–6 inches deep.

Seed-piece treatment

Condition seed potatoes prior to planting. Seed potatoes should be warmed slowly to 50–55°F for several days before handling and cutting to minimize bruising. After cutting, store seed at 50–55°F for 3–4 days with good air circulation and high relative humidity to promote wound healing. Treatment of cut and whole seed pieces with a fungicide may help to reduce seed piece decay as well as tuber-borne and soil-borne problems caused by fungi. Fungicides include formulations of captan (5.0–7.5D) and mancozeb (6.0–6.4D), and combination products containing mancozeb + fludioxonil, mancozeb + flutolanil, mancozeb + thiophanate-methyl, and mancozeb + thiophanate-methyl + cymoxanil. For seedlots where a risk of late blight infection exists, the use of the combination product containing cymoxanil should be considered. Treatment of cut seed pieces with fungicide will not, by itself, control seed piece decay caused by bacteria.

Hilling

Potatoes are generally grown in hills that are 15–20 inches across and 6–8 inches tall. Hilling prevents tubers from being exposed to sunlight and greening of tuber ends. Hilling is done at planting and sometimes again shortly after plants emerge. Delaying hilling too long after emergence can prune roots, which stresses plants and could lead to disease infection.

Irrigation

Potatoes require a constant supply of water, especially during tuber formation and growth. With some varieties, such as 'Russet Burbank,' moisture stress not only reduces yields but can significantly lower tuber quality. To ensure good yields and tuber quality most potatoes are irrigated. If the WISP scheduling program is used, the AD for irrigated sands is 0.7 inch. The AD for silt loams is 1.5 inches. These low AD values reflect the shallow rooting system of potatoes. Research and grower experience has shown that frequent irrigation of small amounts is best. See chapter on Irrigation Management for Vegetables.

Lime and fertilizer

Lime: Maintain a pH of 5.2 for scab-susceptible potatoes on organic and mineral soils, 5.6 for scab-resistant varieties on organic soils, and 6.0 for scab-resistant varieties on mineral soils.

Fertilizer rates: Recommended rates are shown in the following tables. Apply amounts recommended by soil test by banding starter fertilizer with the planter (not exceeding 800 lb/a on sands) and broadcasting the remainder before seeding. Recent research on medium-textured, acid soils in northeastern Wisconsin shows response to 120–150 lb/a P₂O₅ even on soils testing more than 100 ppm soil test P. Sandy soils showed few responses when soil test phosphorus was higher than 75 ppm. Potassium should be broadcast in spring on highly leachable sandy and organic soils. Some row-placed starter fertilizer (30-30-30) is recommended even when soils test in the EH range.

Nitrogen: On sandy soils, apply 25–50% of the supplemental N at emergence and the remainder at tuberization or apply it in multiple split applications. During years with high precipitation, multiple split applications improve yield and quality, but during years with normal to low precipitation, splitting nitrogen applications at emergence and at tuberization consistently produces high-yielding, high-quality potatoes. Excessive N splitting may increase the percentage of cull potatoes. Late N can be applied up to 60 days after emergence. Applications after this do not improve yield or quality and may delay crop maturity. On medium to heavily textured soils, there is no advantage to splitting applications. When potatoes follow a legume crop, reduce the nitrogen recommendation by 40–190 lb/a (see table below). Take appropriate credits if manure has been used. For help determining credits, see Extension publication *Credit What You*

Spread—and Reap the Profits (A3580). Broadcasting or applying N with the irrigation water, especially early in the season, results in less efficient N use because most water moves downward in the furrows, therefore the N bypasses the plant roots. Petiole NO_3 levels can help determine the need for late N application. The table below provides optimum petiole NO_3 -N levels for several varieties and stages of growth. If levels are below optimum and the crop has at least 45 days to vine kill, apply 30–50 lb N/a. If you will be monitoring nitrogen levels through petiole NO_3 -N testing, early season supplemental N rates can be reduced by 25–30%. Additional N may be applied when needed through fertigation.

Secondary nutrients and micronutrients: Calcium, magnesium, sulfur, and micronutrients should only be added when the need is clearly indicated by soil test, plant analysis, or confirmed deficiency symptoms. Row magnesium (10 lb Mg/a) is recommended where soil test K exceeds 140 lb/a.

Optimum petiole nitrate-nitrogen levels for several varieties at different growth stages

Stage of growth (days after emergence)	Dry weight basis			Sap basis		
	Norkotah Norland Atlantic Kennebec	Shepody R. Burbank Snowden	Onaway Superior	Norkotah Norland Atlantic Kennebec	Shepody R. Burbank Snowden	Onaway Superior
	— — — — % NO_3 -N — — — —			— — — — ppm NO_3 -N — — — —		
30	2.5–2.8	2.0–2.3	2.3–2.5	1900–2100	1600–1800	1800–1900
40	2.3–2.5	1.7–2.2	2.0–2.3	1800–2000	1600–1700	1600–1800
50	1.8–2.3	1.2–1.6	1.5–1.9	1400–1800	1000–1300	1200–1500
60	1.3–1.9	0.8–1.1	0.9–1.2	1100–1500	700–900	500–1000
70	0.8–1.1	0.5–0.8	0.4–0.6	700–900	500–700	400–600

Annual nitrogen, phosphate, and potash recommendations for potato^a

Yield goal	Nitrogen—amount to apply				Phosphate and potash—amount to apply ^b	
	Organic matter (%)				P_2O_5	K_2O
	<2	2.0–9.9	10–20	>20		
— cwt/a —	— — — — lb/a — — — —				— — — —	— — — —
250–350	145	120	100	60	65	180
351–450	180	155	130	75	80	230
451–550	220	180	150	85	90	280
551–650	250	210	175	95	100	330

^a The nutrient application rates include starter fertilizer and are the total amount of nutrient to apply.

^b Amounts shown are for optimum (O) soil test levels. Apply half the listed rate plus 30 lb/a for soils testing high (H). If soils test excessively high (EH), apply only 30 lb/a. If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Nitrogen replacement credits for previous legume crops

Legume	Credit—sandy soils	Credit—non-sandy soils
Forages^a		
Alfalfa		
poor stands (<1.5 plants/sq. ft.)	80 lb/a	130 lb/a
fair stands (1.5–4.0 plants/sq. ft.)	110 lb/a	160 lb/a
good stands (>4.0 plants/sq. ft.)	140 lb/a	190 lb/a
Red clover or trefoil	Use 80% of alfalfa credit	Use 80% of alfalfa credit
Soybeans	No credit	40 lb/a
Vegetable legumes	No credit	20 lb/a where residue remains on field
Green manure crops		
Sweet clover	30–60 lb/a	80–120 lb/a
Alfalfa	10–50 lb/a	60–100 lb/a
Red clover	0–30 lb/a	50–80 lb/a

^a If harvesting forage crops after September 10, reduce credit by 40 lb/a.

Color enhancement for red potatoes

Properly timed applications of 2,4-D enhance color in red potatoes, aid in storage retention of color, improve skin appearance, increase tuber set, and improve tuber size uniformity. Crop response may vary depending on variety, stress factor, and local conditions. For example, Dark Red Norland has minimal response to 2,4-D while Red Norland turns darker and holds its color. Make first application when potatoes are in the pre-bud stage (about 7–10 inches high) and make a second application about 10–14 days later. Allow 45 days to harvest. **Weedone LV4 EC and AGSCO MXL Herbicide are the only products labeled for this use in Wisconsin.**

Tuber shape

The shape of potato tubers can be improved with the application of maleic hydrazide (Royal MH-30). While maleic hydrazide may reduce total yield, it should increase the marketable yield. Apply at least 2 weeks before vine desiccation. However, typical applications are made around the first week of August, when tubers are 1.5–2.0 inches in diameter. Optimal timing will vary depending on variety. Avoid making applications during hot, dry weather to minimize the potential for phytotoxicity.

Potato vine killing

Apply 3.2 qt/a of Defol 750 (sodium chlorate) mixed with a nonionic surfactant (10–20 gpa for ground application or 5–10 gpa via air) 10 days before harvest. Do not mix with insecticides or other organic materials because of a potential fire and explosion hazard. Do not spray if rain is anticipated within 24 hours. Fully mature vines will die back fastest if clear, calm, sunny days with high temperature and humidity follow application. Crops under stress, incomplete coverage, and cool temperatures can yield slow or erratic results.

Diquat at 0.25 lb/a of active ingredient (1 pt Reglone per acre) with a suggested surfactant kills potato vines adequately. Apply at least 7 days before harvest. Three weeks between vine killing and harvest is recommended. Where vine growth is dense, make a second application at the same rate. Allow a minimum of 5 days between applications. Do not apply Diquat to drought-stressed potatoes. Do not feed vines treated with Diquat to livestock.

Endothall at 0.78–1.04 lb/a of active ingredient (1.5–2.0 gal Des-i-cate per acre) is another option for potato vine killing. Apply Des-i-cate and water spray mixture to potato vines 10 to 14 days prior to harvest. Des-i-cate is corrosive. Carefully check the label for handling precautions, vine growth and rate information, and recommended methods of application.

ET (pyraflufen ethyl) is the latest product labeled for vine desiccation in Wisconsin. When applied to potatoes in the early stages of senescence, it will hasten desiccation of potato vines and foliage as well as burn down late-season broadleaf weeds. Make 1–2 applications of 2.75–5.5 oz/a in 20 to 50 gpa. Vines are typically dried within 14 days after the first treatment. Two applications are allowed, but do not exceed 11 oz/a per crop season.

Selected formulations of paraquat are also registered as vine dessicants for fresh market potatoes only. Directions are generally the same as for diquat, except the preharvest interval is often only 3 days. As with diquat, two split applications made 5 days apart usually give better results than a single treatment. Not all paraquat formulations are registered for this use.

Rely (glufosinate-ammonium) is another nonselective, broad-spectrum herbicide labeled as a potato desiccant. Make a single application of 3 pt/a in 20–100 gallons of water if applying with ground equipment or in 5–10 gallons of water if applying by air. Where the crop canopy is dense, use higher spray volumes for best results. Wait at least 9 days following application before harvesting. Potato varieties with heavy vine growth may require an application of another desiccation product to complete desiccation. Do not use on potatoes grown for seed stock. See label for rotation restrictions.

Aim EW can be used alone or in combination with other herbicides (if allowed by the tank-mix partner label) to desiccate potatoes. Apply Aim EW as a broadcast spray at a rate of 3.2–5.8 oz/a product (0.05–0.09 lb ai/a) with an appropriate spray adjuvant in a spray volume sufficient for complete potato foliage coverage. Thorough coverage is essential. Aim can be applied to potato foliage in the later stages of senescence. If plants are still actively growing, two applications may be required to adequately kill leaves and stems. Wait 7–14 days after the first application before making a second treatment. Allow at least 7 days before harvest. See the Aim EW label for specific application and adjuvant instructions and restrictions.

Harvest

To reduce the chances of tuber infection by early and late blight fungi, do not begin digging until vines are dead either from a vine burner, a chemical vine killer, or frost. Vines should be killed 14–21 days before harvest. (Do not use TPTH fungicides within 21 days of harvest.) This interval allows proper maturity and skin set. Allowing tubers to remain in the soil for several weeks after vines are dead increases the risk of silver scurf, a disease that affects the visual appearance and storability of infected tubers.

Avoid bruising or injuring tubers during harvesting, grading, packaging, and storing. Tuber breakdown organisms generally start where there is a bruise or other mechanical injury.

Proper operation of windrowing and harvesting equipment will minimize tuber damage, especially bruising. Harvester chain and boom drops should be 6 inches or less. Harvester blade angle should cause potatoes to flow onto primary chain. Adjust ground and chain speeds to keep chains as full of potatoes as possible without rollback. All loads of potatoes should be covered during transport from field to grading-storing locations.

Early maturing potatoes should not be harvested in hot, windy conditions because of increased potential for breakdown. For late-maturing varieties, harvest when soil temperatures are 45–65°F. At colder temperatures, tubers are more susceptible to black spot bruising; higher temperatures increase tuber water loss and may promote development of pressure bruising.

Storage

Storage management

Do not store injured, diseased, or immature potatoes. Do not wash potatoes before storage unless they are sound and disease-free. All washed potatoes must be completely dried before storage. When loading bins, allow several feet between the top of the pile and ceiling for adequate air circulation.

Before storage

Remove old refuse and potatoes from storage. Spray inside surfaces of storage with a quaternary ammonium compound or another disinfectant. Except for seed storage, rinse surfaces with clean water after ammonium treatment.

Make sure ventilation system is in proper operation and that insulation and vapor barriers are properly maintained. One week before storage, open doors at night and close them during the day to cool the storage space. Operate air systems and humidifiers in preparation for harvest. The floors can be watered to build up humidity.

Storage operation

Storage operation is divided into three stages: curing, holding, and removal.

1) Curing. Curing promotes suberization (healing of bruises, cuts, and skinned surfaces). Curing takes place over 2–4 weeks immediately after harvest. Cure potatoes at 50–55°F and a relative humidity of 90–95°F. Tubers that are stressed from disease or are excessively wet can be cured at 85% relative humidity, but the lower humidity levels will increase the potential for pressure bruising.

2) Holding. Long-term storage temperatures are based on intended use: 38–40°F for seed and table stocks, 42–47°F for frozen and dehydration stocks and for cultivars used for both table and processing, 50°F for chipping stock and potatoes stored 3 months or less.

Slowly lower storage temperature 1° per 5–7 days, to prevent reducing sugar accumulation. Relative humidity should be 90–95% unless potatoes are damaged by rot, frost, or late blight. Ventilating air flow rates of 0.5–0.8 cfm/cwt should prevent excessive moisture loss and pressure bruising.

Monitor temperatures. Temperatures at the top of the pile should be 1.0–1.5°F higher than the temperature at the bottom of the pile. If temperatures are the same, too much air is moving through the pile.

Monitor relative humidity. At high relative humidities, a drop in outside temperature can cause condensation at the ceiling. This can wet the potatoes and increase the potential for tuber breakdown by soft rot bacteria.

Long-term storage of potatoes will require use of a sprout inhibitor. Sprout inhibitors can be applied either in the field (MH-30 during the growing season) or in storage (such as CPIC) after curing has been completed.

3) Removal. Before removing potatoes, storage should be warmed to 55–65°F for 2–3 weeks. This is essential for reconditioning potatoes for quality chips and french fries. Warming also reduces the possibility of tuber injury. Cold tubers are easily bruised.

Disease control— late blight

Late blight appears periodically in Wisconsin when cool, wet conditions prevail and the disease inoculum is present. Since 1994 late blight caused significant damage to potato foliage and tubers. Historically, metalaxyl (Ridomil MZ58, Ridomil/Bravo 81W, and Ridomil/Copper 70W) was highly effective for late blight control. In 1994 and 1995, many fields were attacked by an especially virulent strain of the late blight fungus (US#8 genotype) that was resistant to metalaxyl fungicide. Since 1996, the US#8 genotype was the only pathogen genotype observed in Wisconsin. Metalaxyl does not control the US#8 genotype and is NOT currently recommended for late blight control in Wisconsin. Protective fungicides (chlorothalonil, maneb,

mancozeb, metiram, fixed coppers, and triphenyltin hydroxide) used before infection, give much better control of late blight and also control early blight. Because several genotypes of the late blight fungus currently exist in the United States, we urge growers observing late blight on seed potatoes or in production fields to submit samples for genotype analysis to the Plant Pathogen Detection Laboratory, Department of Plant Pathology, 283 Russell Laboratory, UW-Madison, Madison, WI 53706, phone 608-262-2863. A nominal fee is charged for processing each sample. Knowing the genotype of the late blight fungus helps with long-term management.

Research has shown that temperature, relative humidity, and rainfall or irrigation play an important role in determining when or if late blight appears, and the timing of influxes in airborne spores of the early blight fungus. A computer program, WISDOM, is available from the UW-Extension to warn growers of the potential development of early and late blight. The programs recommend a schedule of fungicide applications to prevent or control these diseases. Contact W. Stevenson, Plant Pathology Department, University of Wisconsin, Madison, 53706.

Disease control in potato

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Bacterial ring rot	<i>Consult Extension publication A3243, Potato Ring Rot, for information on recognition and control.</i>			
Black dot	azoxystrobin	6.2–15.4 fl oz Quadris Flowable	14	Amistar, Quadris, and Headline belong to the Group 11 (strobilurin) fungicide category. Quadris Opti contains a combination of Group 11 and Group M fungicides. Do not exceed one application of a Group 11 fungicide before alternating with a fungicide having a different mode of action. Do not exceed six applications of Group 11 fungicides per year. Do not exceed 2.5 lb/a Amistar, 2.88 qt/a Quadris, 3.0 gal/a Quadris Opti, or 2.25 qt/a Headline per season.
	azoxystrobin + chlorothalonil	1.6 pt Quadris Opti	14	
	pyraclostrobin	6.0–9.0 fl oz Headline	3	
Black leg	0.5% calcium or sodium hypochlorite	Hilex Clorox 1 gal Lysol 50%/10 gal water		Disinfect machinery, warehouse, planters, and seed cutters.
	formaldehyde	4 cups 40% solution/ 10 gal water		
	phenol	1–3% solution		
Early blight and late blight	azoxystrobin	6.2–15.4 fl oz Quadris Flowable	14	Amistar, Evito, Gem, Headline, Quadris, Reason, and Tanos belong to the Group 11 (strobilurin) fungicide category. Quadris Opti contains a combination of Groups 11 and M5 fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed six applications of strobilurin fungicides per year. Do not exceed 2.5 lb/a Amistar, 22.8 fl oz/a Evito, 48 oz/a Gem, 23 fl oz/a Gem 500 SC, 2.25 qt/a Headline, 2.88 qt/a Quadris, 3.0 gal/a Quadris Opti, 24.6 fl oz/a Reason, or 72 oz/a Tanos per season.
		2.0–5.0 oz Amistar 80 WDG	14	
	azoxystrobin + chlorothalonil	1.6 pt Quadris Opti	14	
	cymoxanil + famoxadone	early blight: 6.0 oz Tanos 50DF	14	
		late blight: 8.0 oz Tanos 50DF	14	
	fenamidone	5.5–8.2 fl oz Reason 500 SC	14	
	fluoxastrobin	3.8 fl oz Evito 480 SC	7	
	pyraclostrobin	early blight: 6.0–9.0 fl oz Headline	3	
		late blight: 6.0–12.0 fl oz Headline	3	
	trifloxystrobin	early blight: 6.0–8.0 oz Gem, 2.9–3.8 fl oz Gem 500 SC	7 7	
		late blight: 8.0 oz Gem or 3.8 fl oz Gem 500 SC, tank-mixed with a registered protectant fungicide		
	boscalid	2.5–4.5 oz Endura WDG	30	For control of early blight only. Endura belongs to the Group 7 fungicide category. Do not exceed two sequential applications of Endura before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications per season. Do not exceed 20.5 oz/a Endura per season.

*Restricted-use pesticide.

(continued)

Disease control in potato (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Early blight and late blight (<i>cont.</i>)	chlorothalonil	1.0–1.5 pt Bravo Weather Stik, Echo 720, Equus 720	7	Note seasonal use limitations on label. Current labeling for annual use of chlorothalonil products in Wisconsin allows 11.2 lb ai/a Equus products and 16 lb ai/a Bravo products (Ultrax, WeatherStik, Zn)—special WI registration expires 12/31/12; and 16 lb ai/a Echo products (720 and Zn)—special WI registration expires 12/31/09.
		0.9–1.4 lb Bravo Ultrax 82.5WDG, Equus DF	7	
		1.5–2.125 pt Bravo Zn, Equus 500 Zn	7	
		0.8–1.2 lb Echo 90DF, Echo Zn	7	
	copper hydroxide	0.66–2.66 pt Champ Formula 2 4.6F	0	Gives fair control of early blight and good control of late blight. Can be tank-mixed with maneb, mancozeb, or chlorothalonil for broad-spectrum disease control. Tank-mixing with insecticides such as Monitor may reduce effectiveness of the insecticide.
		1.0–4.0 lb Champion 77WP	0	
		1.0–4.0 lb Kocide 101, DF	0	
		1.3–5.3 pt Kocide LF	0	
		0.67–2.67 pt Kocide 4.5 LF	0	
		0.75–3.0 lb Kocide 2000 DF	0	
	cymoxanil	3.3 oz Curzate 60DF	14	Do not use Curzate 60DF alone; always mix with another registered protectant fungicide such as mancozeb, chlorothalonil, triphenyltin hydroxide, or metiram. Do not apply more than 7 sprays per season. After 3–4 applications of Curzate 60DF, switch to another fungicide program for one to two sprays before applying additional sprays of Curzate 60DF. Very warm day and night temperatures hastens curative activity to 1 day rather than normal 2–3 days.
	maneb	1.2–1.6 qt Maneb plus Zinc F4	3	Do not exceed a total of 11.2 lb ai/a EBDC per growing season. EBDC materials include maneb, mancozeb, and metiram.
		1.5–2.0 lb Maneb 80WP	3	
		1.2–1.6 qt Manex F4	3	
	mancozeb	1–2 lb Dithane 75DF Rainshield NT	3	Do not exceed a total of 11.2 lb ai/a EBDC per growing season. EBDC materials include maneb, mancozeb, and metiram.
		0.8–1.6 qt Dithane F45 4F	3	
		1.0–2.0 lb Manzate 200 75DF	3	
		1.0–2.0 lb Penncozeb 80WP, 75DF	3	
	pyrimethanil	7 fl oz Scala SC in combination with broad spectrum fungicide	7	Scala belongs to the Group 9 fungicide category and controls only early blight. If used alone, Scala does not control late blight. Use the 7 fl oz rate of Scala only in a tank mix with a broad-spectrum fungicide. Alternating the tank-mix combination with a broad-spectrum fungicide is a resistance management strategy.
	triphenyltin hydroxide (TPTH)	2.5–3.75 oz *Super-Tin 80WP, *Agri-Tin 80WP	7 21	Do not exceed 11.25 oz/a product per season. Combination of TPTH fungicides with MH-30 and some emulsifiable concentrate insecticides can cause serious crop injury. High rates may injure foliage of sensitive varieties such as 'Superior' and 'Norland.' Observe 24-hour field reentry period as specified on label. Note label information regarding mixing, loading, and application.
	triphenyltin hydroxide (TPTH) plus mancozeb or metiram	2.5 oz *Super-Tin 80WP or *Agri-Tin 80WP plus one of the following: 1.5 lb Dithane M45 80WP, 75DF, WSP or 1.2 qt Manex F4 or 1.5 lb Manzate 200 75DF or 1.5 lb Penncozeb 80WP, 75DF or 1.5 lb Polyram 80DF	7 21	Combining TPTH with maneb, mancozeb, or metiram reduces foliage injury while providing improved control of early blight. Do not exceed 11.25 oz /a product per season. See comments on TPTH above. Do not exceed a total of 11.2 lb ai/a EBDC per growing season. EBDC materials include maneb, mancozeb, and metiram.

*Restricted-use pesticide.

(continued)

Disease control in potato (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Early blight and late blight (cont.)	zoxamide/mancozeb	1.5–2.0 lb Gavel 75DF	3	Begin treatment before the onset of late blight. This product contains mancozeb, an active ingredient of EBDC. If using other EBDC-containing fungicides, do not exceed 11.2 lb ai/a EBDC per growing season. Do not make more than six applications per season or exceed 12 lb/a of Gavel 75DF.
Late blight	cyazofamid	1.4–2.75 fl oz Ranman 400SC	7	Do not apply more than 10 sprays or 27.5 fl oz/a per year. Alternate Ranman (Group 21) sprays with a fungicide having a different mode of action. Crops not listed on the label should not be planted within 30 days after the last application.
	dimethomorph	4.0–6.0 oz Forum	4	Begin treatment before the onset of late blight. Forum should be used as a tank-mix with other protectant fungicides, but do not mix with mefenoxam or metalaxyl. Adjust rates and timing according to late blight conditions. Do not exceed 30 oz/a of product per season. Consult the label for rotational crop restrictions. Forum may be used after vine kill for control of late blight tuber infection.
	propamocarb hydrochloride	0.7–1.2 pt Previcur Flex	14	Begin treatment before the onset of late blight. Tank-mix with other fungicides such as chlorothalonil, maneb, or mancozeb. Adjust rates and timing according to late blight conditions. Do not exceed 6 pt/a of Previcur Flex per season.
	fluazinam	5.5 fl oz Omega	14	Application should begin prior to onset of disease. Do not apply more than 3.5 pt/a per season. Tank-mix with other fungicides such as chlorothalonil, maneb, or mancozeb.
Early dying complex	<i>A soil test to determine the presence of Verticillium and/or nematodes is recommended prior to treatment since other agents that are not controlled by soil fumigation may cause early senescence of a potato crop. If Verticillium propagules, root lesion nematodes, or root knot nematodes are present in significant numbers, treatment with a soil fumigant may provide acceptable disease control.</i>			
	metam-sodium	50 gal Vapam HL, Metam, Sectagon 42		Knife into plow layer of soil at a rate of 50 gal/a or on sandy soils only apply through the irrigation system in 0.6–1.0 inch water in the fall. An approved backflow prevention valve must be used when applying fumigant through irrigation system. Do not apply if significant rainfall is forecast in the next 24 hours. Fields must be monitored during and after application. Soil temperature must be below 75°F. Treatment should not be applied immediately following a potato crop. Potato vine debris should be decomposed at the time of fumigant application for best results. A 2- to 3-year rotation between potato crops is recommended. Fumigant cannot be applied through an irrigation system within 1/4 mile of an institution such as a hospital, school, or prison.
Fusarium tuber rot	thiabendazole	0.42 fl oz Mertect 340-F/ 2000 lb of tuber		Mist unwashed tubers entering storage with 0.42 fl oz Mertect 340-F per 2000 lb of tubers in sufficient water for complete coverage. Additional treatment may be made before shipping by misting the tubers at the same rate or dipping the tubers for 20 seconds in a solution containing 0.42 fl oz of Mertect per gallon of water. Do not treat seed potatoes after cutting.

*Restricted-use pesticide.

(continued)

Disease control in potato (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Rhizoctonia stem canker	azoxystrobin	0.4–0.8 fl oz Quadris Flowable per 1,000 row feet 0.125–0.25 oz Amistar 80WDG per 1,000 row feet	—	Apply in-furrow at planting
	PCNB (pentachloro-nitrobenzene)	1.65 lb Blocker 10 G per 1,000 row feet	45	Direct 8.5-inch band of Blocker into the furrow over the seed and cover as part of the hilling operation during planting.
	pyraclostrobin	0.6–0.8 fl oz Headline per 1,000 row feet	—	Apply in-furrow at planting
Root lesion and root knot nematodes	metam-sodium	Vapam HL, Metam, Sectagon 42		Generally double mineral soil rates for muck soils. More effective when soils are warmer than 55°F. A minimum of 3 weeks is necessary between fumigation and planting to prevent phytotoxicity.
Scab	<i>Grow scab-resistant varieties. Maintain pH between 5.2–5.8, plow down cover crops, maintain adequate soil moisture especially during tuber initiation and early growth. Early season stress favors scab.</i>			
Silver scurf (<i>Heminthosporium solani</i>) and black scurf (<i>Rhizoctonia solani</i>)	azoxystrobin	0.4–0.8 fl oz Quadris Flowable/1000 row ft 0.125–0.25 oz Amistar 80 WDG/1000 row ft	0 0	Apply at planting just before covering seedpieces with soil. Application of Amistar or Quadris at planting does not appear to control early blight or late blight on the foliage later in the season. Do not exceed 1.88 lb/a Amistar or 2.88 qt/a Quadris per season.
Tuber rot, pythium leak, and pink rot	mefenoxam	0.42 oz Ridomil Gold EC/ 1000 row ft at planting 0.84 fl oz Ultra Flourish/ 1000 row ft at planting	—	Mix Ridomil Gold EC or Ultra Flourish in a minimum of 3 gal of water per acre and apply in a 6- to 8-inch band over the potato seedpiece at planting.
	mefenoxam + chlorothalonil	2.0 lb Flouronil 2.0 lb Ridomil Gold Bravo	14 14	A total of up to three applications at 14-day intervals may be made beginning at flowering.
	mefenoxam + copper hydroxide	2.0 lb Ridomil Gold Copper	14	
	mefenoxam + mancozeb	2.5 lb Ridomil Gold MZ	3	
White mold (<i>Sclerotinia sclerotiorum</i>)	boscalid	5.5–10.0 oz Endura WDG	30	Endura belongs to the Group 7 fungicide category. Do not exceed two sequential applications of Endura before alternating to a labeled fungicide with a different mode of action. Do not exceed two applications per season for white mold control. Do not exceed 20.5 oz/a Endura per season.
	fluazinam	5.5–8.0 fl oz Omega	14	Application should begin prior to onset of disease. Do not apply more than 3.5 pt/a per season. Tank-mix with other fungicides such as chlorothalonil, maneb, or mancozeb.
	iprodione	2.0 lb Rovral 50WP 2.0 pt Rovral 4F	14 14	Treat when warm, wet weather conditions favor disease development. Up to four applications at 7- to 10-day intervals may be made. Note crop rotation information on label. All crops on the Rovral label may be grown after treated potatoes. Root crops, cereal grains, soybeans, and tomatoes may be grown the year following treated potatoes.
	thiophanate-methyl	1.0–1.5 lb Topsin M WSB 20.0–30.0 fl oz Topsin 4.5 FL	21 21	Make first application just before row closure. Subsequent applications may be made at 7- to 14-day intervals if conditions warrant. Application at peak bloom provides best control. Do not apply more than 4.0 lb/a Topsin M WSB or 80.0 fl oz/a Topsin 4.5 FL per season.

Scouting calendar for insect pests of potato

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
	Colorado potato beetle, 1st gen. only		both generations	2nd generation only	
		Potato leafhopper			
			Potato aphid		
			Tarnished plant bug		
	Aster leafhopper				
				Green peach aphid	

Insect control in potato

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
General insect control with soil-applied systemic	Aphid, leafhopper, flea beetle, and early-season suppression of Colorado potato beetle:			
	3.0 lb disulfoton	15.0–23.0 oz Di-Syston 15G/1000 ft row	75	Apply as band in row at planting or sidedress postemergence. Do not exceed two applications per season.
	Aphid, leafhopper, flea beetle, Colorado potato beetle:			
	0.2–0.3 lb imidacloprid	3.5–7.0 fl oz Admire Pro	21	Apply as band below seed furrow within 7 days before planting or spray in furrow at planting. Use higher rate on muck soils or for seed production. Do not exceed 8.7 fl oz/a per season.
	Aphid, leafhopper, flea beetle, and suppression of Colorado potato beetle:			
	broadcast rate: 2.0–3.0 lb phorate banded rate: heavy soil—0.22 lb/ 1000 ft row light soil—0.14 lb/ 1000 ft row	banded rate: heavy soil—17.3 oz *Thimet 20G, *Phorate 20G light soil—11.3 oz *Thimet 20G, *Phorate 20G	90	Apply as band in furrow at planting or apply sidedress postemergence at hilling; do not use both. Use the lower rate only on sandy soils and for all emergence applications.
	thiamethoxam	5.0–8.0 fl oz Platinum 0.11–0.16 fl oz Cruiser FS/100 lb seed pieces	30 30	For best results, spray directly on seed pieces. Or apply as an in-furrow spray at planting or at crop emergence. Irrigate within 24 hours of application to move chemical into the root zone. For Platinum, do not apply less than 5 oz/a or more than 8 oz/a per season. For Cruiser FS, do not exceed 4 fl oz/100 lb seed.
Seed piece treatment	Use a seed dusting metering applicator to assure thorough coverage. Plant seed pieces as soon as possible after treatment.			
	imidacloprid + thiophanate-methyl + zinc + manganese	0.75–1.0 lb Tops-MZ-Gaucha/ 100 lb cut seed pieces		Regardless of the type of application, do not exceed 0.31 lb ai/a imidacloprid (Admire or Provado) per year. There is a 12-month rotational plantback interval for all crops except those registered.
Colorado potato beetle (foliar sprays)	Need for control is based on percent defoliation at different plant growth stages. When plants are 6–8 inches tall and pre-flowering, plants can have 20–30% defoliation by Colorado potato beetle adults and larvae before plants should be treated. Flowering plants can have only 5–10% defoliation while tuber-forming plants can withstand up to 30% defoliation before control is needed.			
	Apply treatments for first-generation larval control at 240–250 DD ₅₂ to target third instar larvae. Use spot treatments when appropriate; beetles are often clustered near field edges. Treat adults in mid-July if needed based on percent defoliation and plant growth stage.			
	Note: A high proportion of populations are resistant to pyrethroid insecticides. Do not use esfenvalerate or permethrin if resistance is suspected.			
	abamectin	8.0–16.0 fl oz Agrimek	14	Target first-generation larvae.

*Restricted-use pesticide.

(continued)

Insect control in potato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Colorado potato beetle (foliar sprays) (<i>cont.</i>)	acetamiprid	1.5–4.0 fl oz Assail 30SG 0.6–1.7 fl oz Assail 70WP	7 7	For heavy pest pressure, use higher label rates. Do not make more than four applications or exceed 0.3 lb ai/a per season. Do not apply more than once every 7 days.
	azinphos-methyl	0.75 lb Guthion Solupak	7	Apply every 7 days as needed.
	<i>Bacillus thuringiensis</i> subsp. <i>tenebrionis</i>	Novodor, Raven	0	Make initial spray when you first observe eggs and small larvae. Rates vary with formulation.
	0.5–1.0 lb carbofuran	1.0–2.0 pt *Furadan F	14	There is a 10-month rotational plantback interval for all crops except those registered.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed six applications per year. Do not exceed 0.125 lb ai/a cyfluthrin including Baythroid and Leverage.
	0.12–0.24 lb cyromazine	2.66–5.32 oz Trigard 75WP	7	Do not apply more than 1 lb/a Trigard per crop. Repeat applications 7 days apart.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.05–0.33 lb dinotefuran	foliar: 1.0–1.5 oz Venom 70SG soil: 6.5–7.5 oz Venom 70SG	7 —	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 4.5 oz/a per year using foliar applications, or 7.5 oz/a per season using soil applications. See product label for application directions.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, Phaser EC 1.0–2.0 lb Thiodan WP	1	Do not exceed six applications per season.
	0.025–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season. CPB has developed resistance in some areas.
	0.047 lb imidacloprid	3.75 fl oz Provado 1.6	7 7	Foliar application: Use ground equipment only. Allow at least 7 days between applications. Regardless of the type of application, do not exceed 0.31 lb ai/a imidacloprid (Admire, Leverage, or Provado) per year. There is a 12-month rotational plantback interval for all crops except those registered.
	0.0792 lb imidacloprid/cyfluthrin	3.75 fl oz Leverage 2.7E		Apply every 7 days as needed. Do not exceed 15 fl oz/a (0.317 lb ai/a) per season. Do not exceed 0.31 lb ai/a imidacloprid including Admire, Provado, or Leverage. Do not exceed 0.26 lb ai/a cyfluthrin including Baythroid and Leverage.
	0.11 lb indoxcarb	6.0 oz Avaunt 30 DG	7	Wait at least 5 days between applications. Do not apply more than 24 oz/a Avaunt (0.44 lb ai/a) per crop. In areas where Colorado potato beetles are resistant to other insecticides, addition of piperonyl butoxide (PBO) as a tank mix with Avaunt may be required. Adult beetles will cease to feed following exposure to Avaunt but may not die for several days.
	0.058–0.078 lb novaluron	9.0–12.0 fl oz Rimon 0.83EC	14	Apply when population is between egg hatch and second instar. Use higher rates for larger larvae. Do not apply more than twice to a single generation of Colorado potato beetles and do not apply to successive generations. Do not apply more than 24 oz/a per season.
	0.5–1.0 lb oxamyl	2.0–4.0 pt *Vydate L	7	Treat first-generation larvae. Use low rates for light infestation; higher rates for severe infestation.

Insect control in potato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Colorado potato beetle (foliar sprays) (<i>cont.</i>)	0.05–0.2 lb permethrin	*Ambush, *Pounce	14	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per season.
	1.0 lb phosmet	1.33 lb Imidan WP	7	Use only on potatoes to be machine harvested.
	9.6–11.5 lb sodium aluminofluoride	10.0–12.0 lb Prokil Cryolite 96, Kryocide	0	Treat beginning at 20% egg hatch at a minimum of 7-day intervals. Do not exceed 96 lb per season. Mortality does not occur for 2–4 days. Does not affect beneficial insects. Cryolite can be abrasive to equipment; check the label.
	0.047–0.094 lb spinetoram	6.0–8.0 oz Radiant SC	7	Do not apply more than 32 oz/a Radiant (0.25 lb ai/a) per crop and do not make more than four applications per crop.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	7	Target application for eggs at hatching and small larvae. Use higher rates for heavier infestations and for older larvae. Do not apply more than 0.33 lb ai/a per crop.
	thiamethoxam	1.5–3.0 oz Actara	14	Apply before pests reach damaging levels. Allow at least 7 days between applications. Do not exceed 3 oz/a per season.
		0.11–0.16 fl oz Cruiser 5FS/100 lb seed pieces	0–30	Use rate chart on label to select proper application rate. Do not exceed 0.125 lb ai/a.
Cutworms, loopers	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season. May provide inadequate control in areas where CPB are resistant to other synthetic pyrethroids.
	<i>Before July 25 treat when counts exceed 4/row foot; after July 25 treat when counts exceed 8/row foot. Use spot treatments if infestations are patchy.</i>			
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Agree, Biobit, Dipel	0	Rates vary with formulations for loopers.
	1.0–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.5–2.0 lb carbaryl	Sevin	0	Several formulations; see label for rate.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed 6 applications per year.
	0.012–0.028 lb deltamethrin	1.0–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.025–0.05 lb esfenvalerate	2.8–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season.
	0.058–0.078 lb novaluron	9.0–12.0 fl oz Rimon 0.83EC	14	Apply when population is between egg hatch and second instar. Use higher rates for larger larvae. Do not make more than 2 applications or exceed 24 oz/a per season.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	14	Do not exceed 1.6 lb ai/a per season.
	0.047–0.094 lb spinetoram	6.0–8.0 oz Radiant SC	7	Do not apply more than 32 oz/a Radiant (0.25 lb ai/a) per crop and do not exceed four applications per crop.
	0.07–0.094 lb spinosad	1.25–2.0 fl oz Entrust 4.5–6.0 fl oz SpinTor 2SC	7	Target application for eggs at hatching and small larvae. Use higher rates for heavier infestations and for older larvae. Do not apply more than 0.33 lb ai/a per crop.
	0.01–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
	European corn borer	1.5–2.5 fl oz Assail 30SG	7	For heavy pest pressure, use higher label rates. Do not make more than four applications or exceed 0.3 lb ai/a per season. Do not apply more than once every 7 days.
		1.1 fl oz Assail 70WP	7	
	azinphos-methyl	1.0–1.5 lb Guthion Solupak	7	Apply every 7 days as needed.

Insect control in potato (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
European corn borer (cont.)	1.0–2.0 lb <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.5–2.0 lb carbaryl	Sevin	0	Several formulations; see label for rate.
	0.5–1.0 lb carbofuran	1.0–2.0 pt *Furadan F	14	See label for limitations on crops that follow.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed six applications per year.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season.
	0.065–0.11 lb indoxacarb	3.5–6.0 oz Avaunt	7	Do not exceed 0.26 lb ai/a per season.
	0.1–0.2 lb permethrin	*Pounce	14	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per season.
	0.047–0.094 lb spinetoram	6.0–8.0 oz Radiant SC	7	Do not apply more than 32 oz/a Radiant (0.25 lb ai/a) per crop and do not exceed four applications per crop.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	7	Target application for eggs at hatching and small larvae. Use higher rates for heavier infestations and for older larvae. Do not make more than two applications per generation. Do not apply more than 0.33 lb ai/a per crop.
	0.01–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Grasshoppers	<i>Treat when defoliation exceeds 10%.</i>			
	2.0 lb carbaryl	Sevin Bait	0	Broadcast. See label for rate.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	0	
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season.
Green peach aphid, potato aphids	<i>Control when green peach aphids exceed one per 10 leaves for seed production or three aphids per 10 leaves for table stock.</i>			
	acetamiprid	1.5–4.0 fl oz Assail 30SG 1.0–1.7 fl oz Assail 70WP	7 7	For heavy pest pressure, use higher label rates. Do not make more than four applications or exceed 0.3 lb ai/a per season. Do not apply more than once every 7 days.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed six applications per year.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.25–0.5 lb diazinon	several formulations	35	Repeat applications as necessary. Allow at least 7 days between applications. Do not use on potatoes that will be hand harvested. Limit of five applications per season.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	0	
	0.4–1.0 lb disulfoton	0.4–1.0 pt *Di-Syston EC	30	Foliar application. Do not exceed three applications per season.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, 1.0–2.0 lb Thiodan WP	1	Do not exceed six applications per season.
	0.025–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	For potato aphid only. Do not exceed 0.35 lb ai/a per season.

Insect control in potato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Green peach aphid, potato aphids (<i>cont.</i>)	0.062–0.089 lb flonicamid	2.0–2.8 oz Beleaf 50SG	7	Thorough coverage is required for optimal control. Do not apply more than 2.8 oz/a Beleaf 50SG (0.089 lb ai/a) per treatment and do not exceed 8.4 oz/a (0.267 lbai/a) per season. Allow at least 7 days between applications; rapidly growing plants often require retreatment. Limit of three applications per year.
	0.047 lb imidacloprid	3.75 fl oz Provado 1.6F	7	Foliar application: Use ground equipment only. Allow at least 7 days between applications. Regardless of the type of application, do not exceed 0.31 lb ai/a imidacloprid (Admire or Provado) per year. There is a 12-month rotational plantback interval for all crops except those registered.
	0.6–0.9 lb malathion	several formulations	0	Short residual.
	0.75–1.0 lb methamidophos	1.5–2.0 pt *Monitor 4E	14	
	0.45–0.9 lb methomyl	1.5–3.0 pt *Lannate LV 0.5–1.0 lb *Lannate SP	6	Do not exceed 10 applications per season.
	0.5–1.0 lb oxamyl	2.0–4.0 pt *Vydate L	7	Foliar application. Do not exceed six applications per season.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	14	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per season.
	pymetrozine	2.75 oz Fulfill 50WDG	14	Apply according to label directions when aphids first appear. May repeat treatment in 7 days. Do not exceed two applications per crop or 5.5 oz ai/a per season. May be applied through chemigation.
	thiamethoxam	3.0 oz Actara	14	Apply every 7–10 days as needed. Do not exceed 6 oz/a per season.
		0.11–0.16 fl oz Cruiser 5FS/100 lb seed pieces	0–30	Use rate chart on label to select proper application rate. Do not exceed 0.125 lb ai/a.
Potato flea beetle	0.02–0.025 lb zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply Mustang Max only after populations have exceeded thresholds. Do not apply more than 24 oz/a per season.
	acetamiprid	1.5–2.5 fl oz Assail 30SG	7	For heavy pest pressure, use higher label rates. Do not make more than four applications or exceed 0.3 lb ai/a per season. Do not apply more than once every 7 days.
		0.6–1.1 fl oz Assail 70WP	7	
	azinphos-methyl	1.0–1.5 lb Guthion Solupak	7	Apply every 7 days as needed.
	0.5–2.0 lb carbaryl	Sevin (several formulations)	0	See label for limitations on crops that follow.
	0.5–1.0 lb carbofuran	1.0–2.0 pt *Furadan F	14	
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed six applications per year.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.25–0.5 lb diazinon	several formulations	35	Repeat applications as necessary. Allow at least 7 days between applications. Do not use on potatoes that will be hand harvested.

Insect control in potato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Potato flea beetle (<i>cont.</i>)	0.05–0.33 lb dinotefuran	<i>foliar</i> : 1.0–1.5 oz Venom 70SG <i>soil</i> : 6.5–7.5 oz Venom 70SG	7 —	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 4.5 oz/a per year using foliar applications, or 7.5 oz/a per season using soil applications. See product label for directions.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, 1.0–2.0 lb Thiodan WP	1	Do not exceed six applications per season.
	0.025–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season.
	0.047 lb imidacloprid	3.75 fl oz Provado 1.6F	7	<i>Foliar application</i> : Use ground equipment only. Allow at least 7 days between applications. Regardless of the type of application, do not exceed 0.31 lb ai/a imidacloprid (Admire, Leverage, or Provado) per year. There is a 12-month rotational plantback interval for all crops except those registered.
	0.75–1.0 lb methamidophos	1.5–2.0 pt *Monitor 4S	14	
	0.05–0.2 lb permethrin	*Ambush, *Pounce	14	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per season.
	thiamethoxam	0.11–0.16 fl oz Cruiser 5FS/100 lb seed pieces	0–30	Use rate chart on label to select proper application rate. Do not exceed 0.125 lb ai/a.
	0.01–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
	Potato leafhopper <i>Sample nymphs and adults. Do not treat if fewer than 0.5 adults per sweep unless there are more than 2.5 nymphs per 25 leaves. If 0.5–1.0 adults per sweep, treat if they remain at the same level for 10–14 days or if nymphs are present. If 1.0–1.5 adults per sweep, treat within 5–7 days or immediately if nymphs are present. If more than 1.5 adults per sweep, treat immediately.</i>			
	acetamiprid	1.5–4.0 fl oz Assail 30SG 0.6–1.7 fl oz Assail 70WP	7 7	For heavy pest pressure, use higher label rates. Do not make more than four applications or exceed 0.3 lb ai/a per season. Do not apply more than once every 7 days.
	azinphos-methyl	1.0–1.5 lb Guthion Solupak	7	Apply every 7 days as needed.
	0.5–2.0 lb carbaryl	Sevin (several formulations)	0	See label for limitations on crops that follow.
	0.5–1.0 lb carbofuran	1–2 pt *Furadan F	14	
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed six applications per year.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	0	
	0.05–0.33 lb dinotefuran	<i>foliar</i> : 1.0–1.5 oz Venom 70SG <i>soil</i> : 6.5–7.5 oz Venom 70SG	7 —	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 4.5 oz/a per year using foliar applications, or 7.5 oz/a per season using soil applications. See product label for directions.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, 1.0–2.0 lb Thiodan WP	1	Do not exceed 6 applications per season.
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	7	Do not exceed 0.35 lb ai/a per season.

Insect control in potato (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Potato leafhopper (cont.)	0.047 lb imidacloprid	3.75 fl oz Provado 1.6F	7	<i>Foliar application:</i> Use ground equipment only. Allow at least 7 days between applications. Regardless of the type of application, do not exceed 0.31 lb ai/a imidacloprid (Admire or Provado) per year. There is a 12-month rotational plantback interval for all crops except those registered.
	0.6–0.9 lb malathion	several formulations	0	Short residual will protect beneficial insects.
	0.75–1.0 lb methamidophos	1.5–2.0 pt *Monitor 4S	14	
	0.45–0.9 lb methomyl	1.5–3.0 pt *Lannate LV 0.5–1.0 lb *Lannate SP	6	
	0.05–0.2 lb permethrin	*Ambush, *Pounce	14	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per season.
	1.0 lb phosmet	1.33 lb Imidan WP	7	Use only on potatoes to be machine harvested.
	thiamethoxam	1.5–3.0 oz Actara	14	Apply every 7–10 days as needed. Do not exceed 6 oz/a per season.
		0.11–0.16 fl oz Cruiser 5FS/100 lb seed pieces	0–30	Use rate chart on label to select proper application rate. Do not exceed 0.125 lb ai/a.
	0.01–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
	<i>Treat when insect sweep net counts exceed an average of 1 bug/sweep.</i>			
Tarnished plant bug	azinphos-methyl	1.0–1.5 lb Guthion Solupak	7	Apply every 7 days as needed.
	0.5–2.0 lb carbaryl	Sevin (several formulations)	0	See label for limitations on crops that follow.
	0.0125–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Apply every 5 days as needed. Do not exceed six applications per year.
	0.018–0.028 lb deltamethrin	1.5–2.4 oz *Delta Gold	3	Apply every 3 days as needed.
	0.025–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	7	Do not exceed 12 applications per season.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	14	Several formulations; see label for rate. Do not exceed 1.6 lb ai/a per season.
	0.01–0.025 lb zeta-cypermethrin	1.76–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Two-spotted spider mite	0.125–0.25 lb bifenazate	16.0–24.0 oz Acramite 4SC	14	Apply in at least 50 gallons of water to ensure uniform coverage and canopy penetration. Do not apply more than once per year.
Wireworms (soil treatment)	bifenthrin	<i>at-plant:</i> 19.2 oz *Brigade 2EC <i>lay-by:</i> 3.2–9.6 oz *Brigade 2EC		Apply as an in-furrow spray or T-band spray at planting. May be applied as a lay-by treatment as a banded spray over the drilled area.
	4–6 lb ethoprop	2.1 lb/1000 ft row *Mocap EC		Band in row at planting.
		40.0–60.0 lb *Mocap G		Preplant broadcast if severe infestation is likely.
	0.09–0.1 lb fipronil	2.9–3.2 oz Regent 4SC	90	Make only one in-furrow treatment. Apply as a 5- to 7-inch-wide band and cover thoroughly. See label for plant-back restrictions.
	banded rate: <i>heavy soil:</i> 0.22 lb/ 1000 ft row phorate <i>light soil:</i> 0.14 lb/ 1000 ft row phorate	<i>heavy soil:</i> 17.3 oz *Thimet 20G, *Phorate 20G <i>light soil:</i> 11.3 oz *Thimet 20G, *Phorate 20G	90	Apply as fertilizer band treatment at planting.

*Restricted-use pesticide.

Weed control

Control potato weeds with timely cultivation and use of herbicides. Many herbicide application options exist, including preplant, drag-off, preemergence, and post-emergence applications. If you hill early, spray-hill and hill-spray options are also available. Hill-spray refers to applying the herbicide immediately after hilling when potatoes are beginning to emerge. Any preemergence herbicide can be used. Spray-hill refers to application made at cracking but before emergence. Application is made at cracking and followed immediately by hilling. Herbicides requiring incorporation can be used in this option.

Relative effectiveness of potato herbicides

Target species	Dual pre	Eptam pre	Lorox pre	Matrix pre, post	Poast post	Prowl pre	Sencor pre, post	Treflan pre
Annual broadleaf weeds								
Black nightshade	E*	F*	G	P	N	P	P	P
Carpetweed	—	—*	—*	—	N	—	E ^a	—*
Lady's thumb	P	F	E	F	N	—	E	P
Lambsquarter	F	G*	E*	F*	N	G*	E*	G*
Pigweed, redroot	G*	G*	E*	E*	N	G*	E*	G*
Pigweed, prostrate	—	G*	—	E*	N	G*	— ^a	G*
Purslane, common	G	—*	E*	F*	N	—*	G ^b	E*
Ragweed, common	F	F	E*	F*	N	P	E*	P
Shepherd's purse	—	—*	—	E*	N	—	— ^a	—
Smartweed, Pennsylvania	F	F	E*	F*	N	P	E*	P
Velvetleaf	P	G	G	F*	N	P	E*	P
Wild buckwheat	P	F	F	F	N	—	—	P
Annual grasses								
Barnyard grass	E*	F*	G*	E*	E	G*	P	E*
Crabgrass, large	E*	E*	G*	F*	E	E*	G ^d	E*
Foxtail, green	E*	E*	G*	E*	E	E*	G*	E*
Sandbur	F	—*	—	—	E	G*	P	—*
Witchgrass	—*	E*	F	—	E	E*	P	E
Perennial grass								
Quackgrass	P	F	P	G*	G*	P	P	P

*Weeds listed as controlled on the herbicide's label.

Abbreviations: E=excellent, F=fair, G=good, N=none, P=poor, pre=preemergence treatment, post=postemergence treatment

Because the performance of herbicides is affected by many variables, these ratings can only indicate the relative effectiveness. The actual performance may be better or worse than indicated in the chart.

^a Sencor label lists carpetweed, jimsonweed, wild mustard, prostrate pigweed, and shepherd's purse as controlled by preemergence sprays only.

^b Sencor label states preemergence treatment will suppress purslane.

^c Lexone label lists purslane and cocklebur as partially controlled with preemergence treatment but controlled by postemergence spray.

^d Lexone label lists large crabgrass and foxtails as controlled by preemergence sprays and partially controlled by postemergence. Sencor label lists crabgrass, yellow foxtail, and fall panicum as controlled by preemergence treatments only.

Weed control in potato (See table of relative effectiveness of potato herbicides, previous page.)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.56–0.98 lb dimethenamid-P	<i>coarse soils:</i> 12.0–18.0 fl oz Outlook 6.0 <i>medium- and fine-textured soils:</i> 18.0–21.0 fl oz Outlook 6.0	40	Make preemergence applications after drag-off or after hilling, but before weeds emerge. In cold and wet conditions, Outlook may delay emergence or stunt potatoes.
Annual grasses and some broadleaves	3.0–6.0 lb EPTC (drag-off or spray hill)	3.5–7.0 pt Eptam 7E	45	Treat at emergence and hill immediately to avoid volatilization losses or apply through the irrigation system to clean cultivated soil after crop emergence. 'Superior' may suffer early season stunting if the crop is stressed.
	3.0 lb EPTC (after crop emergence through irrigation)	15.0–30.0 lb Eptam 20G	45	
		3.5 pt Eptam 7E or equivalent	45	
	s-metolachlor	1.0–2.0 pt Dual Magnum or Dual II Magnum		Make preemergence applications after drag-off or after hilling but before weeds emerge. Use rates vary with soil organic matter and formulation. PHI varies with type of application, so read the label carefully. Do not use on peat or muck soils. If cool wet soil conditions occur after treatment, Dual may delay maturity or reduce yield of early maturing varieties.
	0.5–1.49 lb pendimethalin	1.2–3.6 pt Prowl 3.3EC or Pendimax		Make one preemergence application after potatoes are planted but before weeds or crop emerge. Use rate is based on soil texture. Pendimethalin is most effective if adequate rainfall or irrigation occurs within 1 week of treatment. Incorporate if moisture is inadequate. May also be applied postemergence from crop emergence to 6-inch stage and through chemigation. Do not make applications to potatoes under stress from cold/wet or hot/dry weather.
	0.71–1.43 lb pendimethalin	1.5–3.0 pt Prowl H ₂ O		
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or registered equivalent		Treat after planting but before emergence, following dragoff or after potatoes have fully emerged. May also be applied through chemigation. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation, application, and incorporation procedures. May injure potatoes if improperly incorporated. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual broadleaves and some grasses	0.5–1.0 lb linuron	Sands and central sands: 1.0 lb Lorox DF 1.0 pt Linex 4L Loamy sands: 2.0 lb Lorox DF 2.0 pt Linex 4L		Apply delayed preemergence after planting but just before potatoes emerge. Linuron can be applied in a hill-spray operation. Apply before grasses are 2 inches tall and broadleaf weeds are 6 inches tall, preferably just before or when weed seedlings emerge. If weeds are present, add 1 pt surfactant/25 gal spray mixture. In irrigated areas, apply linuron to moist soil and follow with sprinkler irrigation or rainfall within 2 weeks. Do not incorporate. More effective on annual broadleaf weeds than grasses. Check label rates for heavier soils.

(continued)

Weed control in potato (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual broadleaves and some grasses (<i>cont.</i>)	0.25–1.0 lb metribuzin (drag off or hill-spray)	0.5–2.0 pt Sencor 4 0.33–1.33 lb Sencor DF	60	Apply delayed preemergence after drag-off or hilling. Do not incorporate. Early postemergence applications are labeled for white-skinned varieties that are not early maturing. Can be applied with sprinkler irrigation systems. Apply after 3 days of sunny weather and before weeds are 1 inch tall. Do not apply within 24 hours of other pesticide applications. Postemergence Sencor treatment is not recommended for red-skinned varieties or 'Atlantic', 'Shepody', 'Chip Bell', 'Bellchip', or 'Centennial.' Preemergence application to these varieties may also cause injury. Split applications (preemergence and early postemergence) at reduced rates are often effective and reduce potential for leaching.
	0.25–0.5 lb metribuzin (early postemergence)	0.5–1.0 pt Sencor 4 0.33–0.67 lb Sencor DF		
Annual weeds and some perennial weeds	0.0156–0.02 lb rimsulfuron	1.0–1.5 oz Matrix	60	Apply 1.0–1.5 oz immediately after hilling or dragoff, or postemergence to young, actively growing weeds. Depending on soil type, rainfall or irrigation of 1/3–1 inch is needed for activation. For postemergence applications, add nonionic surfactant at 1–2 pt/100 gal spray mixture. Sequential applications are allowed up to a total of 2.5 oz/a of Matrix. Matrix may be tank-mixed with other registered herbicides. Check the label for crop rotation guidelines.
Emerg ed weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, wait until they resume active growth and reach the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat (rate varies by label)	several manufacturers and formulations		Make application up to cracking. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerg ed grasses	0.094–0.25 lb clethodim	6.0–16.0 oz Select 2EC	30	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Adding AMS may improve control of quackgrass, rhizome johnsongrass, red rice, wild oats, volunteer cereals, and volunteer corn. Do not apply if rain is expected within 1 hour.
	0.068–0.24 lb clethodim	9.0–32.0 oz Select Max	30	
	0.19–0.48 lb sethoxydim	1.0–2.5 pt Poast	30	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for wild proso millet and rescue treatment rates. Do not exceed 5 pt/a Poast in one crop season. Always add 2 pt/a of crop oil concentrate.

*Restricted-use pesticide.

Pumpkin & squash

Planting Most commercial growers start pumpkin and squash from seed. Delay planting until danger of frost is past and soils have warmed to at least 60°F. Planting generally begins in southern Wisconsin around May 10, and June 1 in northern Wisconsin. Pumpkin and squash are sensitive to transplanting. Plants are typically started in individual containers 3–4 weeks before transplanting in the field—May 20 in southern Wisconsin and June 1 in northern counties. Using too small a container or allowing the plants to grow too large before transplanting can impair root growth in the field.

Bush types Rows—24–48 inches; **plants in row**—36–60 inches apart.

Vine types Rows—36–96 inches; **plants in row**—36–60 inches apart.

Pollination Pumpkins and squash have male and female flowers that are pollinated by insects, typically bees. To protect pollinators, insecticide applications should not be made during the day while they are active.

Lime and fertilizer **Lime:** Use dolomitic limestone to maintain a pH of 6.0 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P_2O_5 and K_2O according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in the table below. Increase the rates shown below by 20% for high-yielding pumpkins. Take credits for previous legume crops and manure.

Application: Broadcast lime and fertilizer and work into the soil before planting. Apply fertilizer at planting time in a band 2 inches to the side and 2 inches below seed level.

Nitrogen: Split nitrogen recommendation into two or more applications during the season. Make the first application when plants have two or more true leaves. Make a second application when vines begin to fill the rows. Subsequent applications (15–20 lb N/a each) can be made at 10- to 14-day intervals after harvest has started. Excess nitrogen can delay maturity and result in green pumpkins.

Annual nitrogen, phosphate, and potash recommendations for pumpkin and squash

			Phosphate and potash		
Crop	Nitrogen		Yield goal	Amount to apply ^a	
	Organic matter	Amount to apply		P ₂ O ₅	K ₂ O
	— % —	— lb/a —	— t/a —	— — — lb/a — — —	
Pumpkin	<2	100	15–20	50	110
	2.0–9.9	80			
	10–20	60			
	>20	30			
Squash	<2	80	12–16	40	90
	2.0–9.9	60			
	10–20	40			
	>20	20			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in pumpkin and squash

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions	
Angular leaf spot (<i>Pseudomonas</i>)	fixed copper	0.5–0.75 gal Copper-Count-N	0	Use disease-free seed and rotate crops.	
		1.3 pt Kocide 4.5 LF	0		
		1.5 lb Kocide 2000 DF	0		
Anthracnose and alternaria leaf blight	azoxystrobin	2.0–5.0 oz Amistar 80 WDG 11.0–15.4 fl. oz. Quadris Flowable	1 1	Amistar, Quadris, and Cabrio belong to the Group 11 (strobilurin) category of fungicides; Quadris Opti contains Groups 11 and M5 fungicides; and Tanos contains Groups 11 and 27 fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per year. Do not exceed 1.25 lb/a Amistar, 1.92 qt/a Quadris, 2 gal/a Quadris Opti, 32 oz/a Tanos, or 64 oz/a Cabrio per season. Tanos must be tank-mixed with a contact fungicide such as mancozeb, chlorothalonil, or a copper-containing fungicide. Do not tank-mix Amistar, Quadris, Quadris Opti, or Cabrio with additives or adjuvants.	
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1		
	famoxadone + cymoxanil	8.0 oz Tanos	3		
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0		
	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Groups 7 (anilide) and 11 (strobilurin) fungicide categories. Do not exceed one application of Pristine before alternating to a labeled fungicide with a different mode of action not in Group 7 or 11. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.	
	chlorothalonil	<i>Rates for anthracnose:</i>			
		1.5–2.0 pt Bravo Weather Stik, Echo 720, Equus 720	0		
		1.4–1.8 lb Bravo Ultrex 82.5WDG, Equus DF	0		
		1.3–1.6 lb Echo 90DF	0		
		2.25–2.75 pt Bravo Zn, Echo Zn, Equus 500 Zn	0		
		<i>Rates for alternaria:</i>			
	2.0–3.0 pt Bravo Weather Stik, Echo 720, Equus 720	0			
	1.8–2.7 pt Bravo Ultrex WDG, Equus DF	0			
	1.6–2.5 lb Echo 90DF	0			
	2.75–4.25 pt Bravo Zn, Echo Zn, Equus 500 Zn	0			
fenamidone	5.5 fl oz Reason 500 SC	14	For alternaria leaf blight only. Reason belongs to the Group 11 (strobilurin) fungicide category. Do not exceed one application of Reason or other Group 11 materials before alternating with a fungicide having a different mode of action. Do not exceed four applications of Group 11 fungicides per year. Do not exceed 22 fl oz/a Reason per season. Following the last application of Reason 500 SC, wait 30 days before planting wheat and 1 year for all other crops.		
thiophanate methyl	0.25–0.5 lb Topsin M 70WSB	0			
maneb	1.5 lb Maneb 80WP	7	Consult label for product use limits. Spray every 5–10 days depending on disease and weather pressures.		
	1.2 qt Maneb plus Zinc F4	7			
	1.2 qt Manex F4	7			

(continued)

Disease control in pumpkin and squash (cont.)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Anthracnose and alternaria leaf blight (cont.)	mancozeb	1.2 qt Dithane F-45	7	For use on summer squash only. Consult label for product use limits. Spray every 5–10 days depending on disease and weather pressures.
		1.5 lb Dithane 75DF	7	
		Rainshield NT	7	
		1.5 lb Manzate 200 75DF	7	
		1.5 lb Penncozeb 80WP, 75DF	7	
Bacterial wilt (<i>Erwinia</i>)				Control the cucumber beetles that carry this pathogen (see Insect Control).
Black rot (<i>Didymella</i>)	See chemical recommendations for anthracnose.			Use disease-free seed and practice long rotations with crops other than cucurbits. Destroy infected plant refuse at the end of the growing season. Handle storage squash and pumpkins carefully to avoid scratches or injuries to the rind.
Downy mildew	cyazofamid	2.1–2.75 fl oz Ranman	0	Ranman belongs to Group 21 fungicide category. Do not apply more than six sprays of Ranman per crop. Alternate Ranman sprays with a fungicide having a different mode of action. Do not apply more than 16.5 fl oz/a per year.
	dimethomorph	6.0 fl oz Forum	0	See Phytophthora blight.
	famoxadone + cymoxanil	8.0 oz Tanos	3	See Phytophthora blight.
	propamocarb hydrochloride	1.2 fl oz Previcur Flex or 0.6 fl oz Previcur Flex plus chlorothalonil	2	Do not apply more than 6 pt/a Previcur Flex per season
Mosaic				Plant resistant varieties.
Phytophthora blight or crown rot (<i>Phytophthora capsici</i>)	cyazofamid	2.75 fl oz Ranman 400SC	0	Do not apply more than six sprays or 16.5 fl oz/a per year. Alternate Ranman (Group 21) sprays with a fungicide having a different mode of action. Crops not listed on the label should not be planted within 30 days after the last application.
	dimethomorph	6.0 oz Forum	0	Do not exceed 30 oz/a or five applications per season. Do not make more than two sequential applications of Forum before alternating to another effective fungicide with a different mode of action for at least one application.
	famoxadone + cymoxanil	8.0 oz Tanos	3	Do not make more than one application of Tanos before alternating with a fungicide having a different mode of action. Do not make more than four applications of Tanos or other Group 11 fungicides per season and do not alternate Tanos with other Group 11 fungicides. Do not exceed 32 oz/a Tanos per crop per season. Tanos is helpful for suppressing Phytophthora blight. Tanos must be tank-mixed with a contact fungicide such as mancozeb, chlorothalonil, or a copper-containing fungicide.
	zoxamide + mancozeb	1.5–2.0 lb Gavel 75DF	5	Do not exceed 8 applications or more than 16 lb/a product per season.
Powdery mildew	azoxystrobin	11.0–15.4 fl. oz. Quadris Flowable	1	Amistar, Cabrio, Flint, and Quadris belong to the Group 11 (strobilurin) category of fungicides. Quadris Opti contains a combination of Groups 11 and M5 fungicides. Do not exceed one application of any of these products before alternating with a fungicide having a different mode of action. Do not exceed four applications of strobilurin fungicides per year. Do not exceed 1.25 lb/a Amistar, 64 oz/a Cabrio, 8 oz/a Flint, 1.92 qt/a Quadris, or 2 gal/a Quadris Opti per season. Do not tank-mix Amistar, Cabrio, Flint, Quadris, or Quadris Opti, with additives or adjuvants.
		2.0–5.0 oz Amistar 80 WDG	1	
	azoxystrobin + chlorothalonil	3.2 pt Quadris Opti	1	
	pyraclostrobin	12.0–16.0 oz Cabrio EG	0	
	trifloxystrobin	1.5–2.0 oz Flint	0	

(continued)

Disease control in pumpkin and squash *(cont.)*

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Powdery mildew (<i>cont.</i>)	boscalid + pyraclostrobin	12.5–18.5 oz Pristine WDG	0	Pristine belongs to Group 7 and Group 11 (strobilurin) fungicide categories. Do not exceed two sequential applications of Pristine before alternating to a labeled fungicide with a different mode of action. Do not exceed four applications of Pristine or other Group 7 or Group 11 fungicides per season. Do not exceed 74 oz/a Pristine per season.
	myclobutanil	2.5–5.0 oz Nova 40W	0	Do not exceed 1.5 lb/a product (0.6 lb ai/a) per year. Observe a 30-day plantback interval between the last application and planting new crops.
	thiophanate methyl	0.25–0.5 lb Topsin-M 70W, Topsin-M WSB 10.0 fl oz Topsin 4.5 FL	0 0	Apply when disease first appears and repeat if needed every 7–14 days.
	triflumizole	4.0–8.0 oz Procure 50WS 4.0–8.0 fl oz Procure 480 SC	0	Do not exceed 40 oz/a of Procure 50WS or 40 fl oz/a of Procure 480 SC per season. See product label for plantback restrictions for leafy vegetables (30 days), root vegetables (60 days), and all other crops (1 yr).
Seed rot and damping-off	captan thiram			Plant seed that has been pre-treated with Captan or Thiram.

Scouting calendar for insect pests of pumpkin and squash

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
			Striped and spotted cucumber beetle		
			Aphids		
			Squash bugs		
		Squash vine borer			
		Mites			

Insect control in pumpkin and squash

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cucumber beetle (striped, spotted)	<i>Treat when there are more than four to five adults per 50 plants. If the plants are not touching within the row, treatment is justified if the field averages more than five beetles per plant.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Treat every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.5–1.0 lb carbaryl	Sevin (several formulations)	0	Do not apply during maximum flowering or fruit set, or when pollinating bees are in the field. Make applications after 8 p.m.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	3	Apply every 3 days as needed. Do not exceed 14.4 fl oz/a per season.
	0.045–0.268 lb dinotefuran	foliar: 1.0–4.0 oz Venom 70SG soil: 5.0–6.0 oz Venom 70SG	1 21	Do not follow soil applications with foliar application of any other neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz/a per year using foliar applications, or 12 oz/a per season using soil applications. See product label for application directions.

*Restricted-use pesticide.

(continued)

Insect control in pumpkin and squash (*cont.*)

Insect	Rate/a of active ingredient	Commercial product	Days to harvest	Remarks and suggestions
Cucumber beetle (<i>cont.</i>)	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC, 1.0–2.0 lb Thiodan WP	2	Do not exceed 3 lb ai/a per season or more than 6 applications per season.
	0.2–0.3 lb fenprothrin	10.66–16.0 oz Danitol 2.4EC	7	Do not exceed 2.66 pt/a Danitol (0.8 lb ai/a) per season. Control may be improved by the addition of a nonionic surfactant.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on plant row within 14 days before planting or as an in-furrow treatment during planting. Do not exceed 0.38 lb ai/a per season.
	0.9–1.75 lb malathion	several formulations	3 (pumpkin) 1 (squash)	Do not apply before vining or to wet plants.
	0.5–1.0 lb methomyl	1.5–3.0 pt *Lannate LV, 0.5–1.0 lb *Lannate SP		See label for days to harvest.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. Spray during the evening. No more than 1.6 lb total.
	10.0 lb rotenone	Rotenone D, WP	1	
	thiamethoxam	3.0–5.5 oz Actara 25WDG 5.0–11.0 Platinum 2SC	30	Do not follow applications of Platinum with foliar applications of any other neonicotinoid insecticide. Platinum may be applied to direct seeded crops in-furrow at the seeding or transplant depth or as a narrow surface band above the seedling and followed by irrigation. Do not apply more than 11 oz/a per season. Actara is applied as a foliar spray.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Cutworm	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Treat every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	1.0 lb carbaryl	Sevin Bait (several formulations)	0	Broadcast when cutworms are present in damaging numbers.
	0.012–0.028 lb deltamethrin	1.0–2.4 fl oz *Delta Gold	3	Apply every 3 days as needed. Do not exceed 14.4 fl oz/a per season.
	0.132–0.179 lb dinotefuran	3.0–4.0 oz Venom 70SG	1	Do not apply more than 6 oz/a per year using foliar applications. See product label for application directions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Spray when cutworms are present in damaging numbers.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. No more than 1.6 lb total.
	0.01–0.025 lb zeta-cypermethrin	1.28–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Melon aphid	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Treat every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.25–0.75 lb diazinon	several formulations	3 (winter squash) 7 (summer squash)	Apply as soon as aphids are noticed
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC 1.0–2.0 lb Thiodan WP	1 (pumpkin) 2 (squash)	Do not exceed 3 lb ai/a per season.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Apply in a narrow band centered on plant row within 14 days before planting or as an in-furrow treatment during planting. Do not exceed 0.38 lb ai/a per season.
	1.0–2.0 lb malathion	several formulations	3 (pumpkin) 1 (squash)	Do not apply before vining or when plants are wet.

*Restricted-use pesticide.

(continued)

Insect control in pumpkin and squash (*cont.*)

Insect	Rate/a of active ingredient	Commercial product	Days to harvest	Remarks and suggestions
Melon aphid (<i>cont.</i>)	0.375–0.5 oxydemeton-methyl	1.5–2.0 pt *Metasystox-R S	3 (summer squash) 14 (pumpkin, winter squash)	Summer squash only. Also suppresses spider mites. Do not make more than one application per season.
	pymetrozine	2.75 oz Fulfill 50WDG	14	Controls melon and green peach aphids. Treat when aphids first appear. May repeat in 7 days. Do not exceed 5.5 oz/a per season or more than two applications per crop.
	thiamethoxam	1.5–3.0 oz Actara, 5.0–8.0 fl oz Platinum	0 30	Apply before pests reach damaging levels. Repeat as needed every 7–10 days. Apply higher rates for heavy infestations, or for long residual with Platinum. Do not exceed 8 oz/a of either product per season. Do not apply less than 5 oz/a of Platinum per season.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Seed corn maggot	0.04–0.08 lb bifenthrin	3.4–6.8 oz Capture LFR	—	Apply as a 5- to 7-inch band over an open furrow or in-furrow with the seed. Do not apply more than 0.1 lb/a Capture LFR per season as an at-plant application.
Spider mite	0.938–1.88 lb abamectin	8.0–16.0 fl oz *Agri-Mek 0.15EC	7	May repeat after 7 days, but do not make more than two sequential treatments or exceed 5.64 lb ai/a per year.
	bifenazate	0.75–1.0 lb Acramite 50WS	3	Limit of one application per season.
	0.08–0.10 lb bifenthrin	5.12–6.4 fl oz *Brigade 2EC	3	Apply before insects reach threshold levels. May repeat after 7 days. Do not apply more than twice after bloom or exceed 0.3 lb ai/a per season.
	0.2 lb fenpropathrin	10.0–66.0 fl oz Danitol 2.4EC	7	Treat when mites first appear and repeat every 7 days as needed. Do not exceed 0.8 lb ai/a per season.
	1.5–2.0 lb malathion	several formulations	3 (pumpkin) 1 (squash)	Do not apply before vining or to wet plants.
	spiromesifen	7.0–8.5 fl oz Oberon 2SC	7	Apply every 7 days as needed. Do not exceed 25.5 fl oz/a per season.
Squash bug	<i>Check undersides of leaves for squash bug eggs laid in neat rows. Eggs hatch within 1–2 weeks. Treat when squash bugs are young; they are difficult to control as older nymphs or adults. At early flowering, treat if you find more than one egg mass per plant. Destroy crop residue in fall to reduce overwinter survival of this pest.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Treat every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.5–1.0 lb carbaryl	Sevin (several formulations)	0	Do not apply to wet foliage or when rain or high humidity is expected within 2 days of treatment.
	0.132–0.179 lb dinotefuran	3.0–4.0 oz Venom 70SG	1	Do not exceed 6 oz/a per year using foliar applications. See label for application directions.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC, 1.0–2.0 lb Thiodan WP	2	
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per year.
	0.2 lb permethrin	*Ambush, *Pounce	0	Will kill adult squash bugs. See label for rate. Do not exceed 1.6 lb ai/a per season.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.

Insect control in pumpkin and squash (cont.)

Insect	Rate/a of active ingredient	Commercial product	Days to harvest	Remarks and suggestions
Squash vine borer	<i>Treat when adults are observed (around 900DD₅₀), especially when runners are less than 2 feet long. Larvae boring in the main stem can kill the entire plant, while loss of a runner or two when the plant is larger will not cause economic damage. Look for sawdust-like excrement coming from holes in the stems, and open the stems to confirm the presence of squash vine borer larvae. Repeat applications at 5- to 7-day intervals throughout the 3-week egg-laying period. Once larvae are inside the vine, little can be done to control this pest.</i>			
	0.04–0.10 lb bifenthrin	2.6–6.4 fl oz *Brigade 2EC	3	Treat every 7 days as needed. Do not exceed 0.3 lb ai/a per season. Do not make more than two applications after bloom.
	0.5–1.5 lb carbaryl	Sevin (several formulations)	0	Do not apply to wet foliage or when rain or high humidity is expected within 2 days of treatment.
	0.5–1.0 lb endosulfan	0.66–1.33 qt Phaser EC, 1.0–2.0 lb Thiodan WP	2	Apply weekly to flower buds, stems, and vines beginning when moths first appear. Do not exceed 3 applications per season (squash) or 6 applications per season (pumpkin).
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	3	Do not exceed 0.25 lb ai/a per season
	0.1–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. Do not apply more than 1.6 lb ai/a per season.
	0.4 lb rotenone	Rotacide EC	0	Apply as late in day as possible.
	0.02–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.

*Restricted-use pesticide.

Weed control in pumpkin and squash

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.25–0.75 lb clomazone	0.67–2.0 pt Command 3ME (pumpkins and winter squash) 0.67–1.33 pt Command 3ME (summer squash)	45 (squash)	Pumpkin (processed only), winter squash, and summer squash only. For suppression and control of annual grasses and broadleaves, make a single preemergent soil application before seeding or transplanting. Place seed or roots of transplants below the chemical barrier when planting. Consult variety restrictions on label. Strictly follow all precautions and restrictions on the label to minimize offsite movement and carryover. Read and understand the vegetable disclaimer section of the label—the end user of this product assumes all liability for failure to perform and crop injury resulting from its use.
	1.1–1.7 lb ethalfluralin	3.0–4.5 pt Curbit EC		Make a single broadcast application within 2 days after seeding. Rate varies with soil texture and organic matter. A shallow cultivation or 1/2-inch of water is needed for activation. Heavy rain following application or seeding may result in crop injury. Do not incorporate or use under plastic mulch, broadcast over transplants, apply through irrigation, or use on soils with more than 10% organic matter.
	0.4–1.2 lb ethalfluralin + 0.125–0.375 lb clomazone	2.0–6.0 pt Strategy	45 (squash)	Use only as a postplant surface-applied herbicide before weed emergence. Make one application before crop emergence or apply as a banded spray between rows following emergence or transplanting. Do not make broadcast applications to transplants or use under plastic mulch. Rainfall, irrigation, or a shallow cultivation 2–5 days after application required for activation. Because of the potential for offsite movement and severe crop injury, strictly follow all precautions and restrictions listed on the label.

(continued)

Weed control in pumpkin and squash (*cont.*)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual grasses	5.0–6.0 lb bensulide	5.0–6.0 qt Prefar 4E		Summer squash, winter squash, and pumpkin only. Apply before planting and incorporate 1–2 inches deep to avoid losses due to volatilization. Use on mineral soils only.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea (rate varies by crop use and application timing—see label)	30	Sandea controls several broadleaf weeds and nutsedge. It will not control grasses. Sandea has both pre- and postemergence activity. Broadcast applications to non-processing crops should not exceed 0.75 oz/a Sandea. Application of Sandea to summer squash is limited to directed spray to row middles, avoiding contact with the crop. Do not exceed two applications or apply more than 2 oz per 12-month period. Soil or foliar applications of organophosphate insecticides to Sandea-treated crops may cause severe crop injury. Consult label for rate, maximum Sandea use per crop cycle, application timing, and other important usage information and precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Some formulations require a wait of 3 days between application and seeding. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations		Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding and transplanting should be performed with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.125 lb clethodim	6.0–8.0 oz Select 2EC	14	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.12 lb clethodim	9.0–16.0 oz Select Max	14	
	0.094–0.28 lb sethoxydim	0.5–1.5 pt Poast	14	Make postemergence applications to actively growing grasses at the sizes indicated on the label. Check the label for wild proso millet or rescue treatment rates. Do not exceed 3 pt/a Poast in one crop season. Always add 2 pt/a of oil concentrate. Check the label for additional precautions and restrictions.

*Restricted-use pesticide.

Sweet corn

Since sweet corn is harvested in the immature or milk stage, it requires a shorter growing season than other types of corn. Nonetheless, it is a warm weather crop. Average temperatures of 65°–70°F, with a minimum of 50°F, are required during June, July, and August. On the other hand, high temperatures above 80°F hasten maturity and often result in inferior quality. Temperature also greatly affects the length of time that sweet corn kernels remain sweet and tender. At high temperatures, they pass the best eating stage quickly.

The relationship of growth and maturity to temperature may be expressed more accurately by degree days than in terms of calendar days. Since sweet corn does not grow at temperatures below 50°F, daily degree days are computed by subtracting 50°F from the average daily temperature. Scheduling of planting and harvest for nearly 75 percent of the processing sweet corn in the nation is based on degree days computed by this method or modifications. For more information, see “Calculating Degree Days” at the beginning of this publication.

Sweet corn does best where annual rainfall is 30 inches or more, and April through September rainfall is 20 inches or more. The crop is especially susceptible to lack of moisture and to hot dry winds during the reproductive period. After the appearance of tassels the plants need rain every week. For this reason supplemental irrigation is increasingly important in the production of processing sweet corn. The water added may increase snapped weight by 1/2 t/a per inch of irrigation water, resulting in yields of 10–12 t/a in the humid North Central states.

Most sweet corn varieties were based on the sugary gene and had yellow kernels. Sugary hybrids have between 10 and 15% sugar at harvest time. Recently, new hybrids based on other genes have become available. The most important of these new gene types are the supersweet types based on the *shrunk-2* gene and the SE types based on the *sugary enhancer* gene. Both of these genes result in elevated sugar levels of 25–35% at harvest. The supersweet types also convert sugar to starch more slowly resulting in a longer harvest period and longer shelf life. However, the pericarp of the supersweets will toughen with increased maturity resulting in decreased quality just as it does in the other types.

White kernel and bicolor (yellow and white kernels) hybrids are also becoming increasingly common. While the kernel color does not affect taste they may be of interest to consumers due to their attractiveness or novelty.

Supersweets must be isolated from sugary enhancer and sugary hybrids. To obtain the best results, sugary enhancer hybrids should be isolated from sugary hybrids and white hybrids should be isolated from bicolor and yellow. Isolation may be either in space or time. Different gene types should be grown at least 100 feet apart or they should flower at least 10 days apart.

Planting

Rows—30–40 inches;

plants in row—7–20 inches (depends on row width and acre population).

For maximum yields, there should be 16,000–20,000 plants/a. Thus, actual seeding rates must be 18,000–22,000 plants/a—12–16 lb/a seed depending upon the grade or seed size for sugary hybrids. Supersweet seed is lighter and therefore only 5–8 lb/a seed is required.

Plant sweet corn for processing during May and June. Market gardeners may plant on light soils in mid-April. Supersweets are more sensitive to cold soils and should be planted when the soil temperature is over 60°F.

Uniform plant growth and maturity is important for processing sweet corn plantings since fields must be harvested at one time for market and processing. Plant uniform size seed using a dependable planter with plates designed for that specific seed grade.

A deep firm seedbed free of clods, trash, and surface irregularities is necessary for uniform germination, good stands, and uniform maturity. You can fall plow moderately heavy soils that are unlikely to erode and leave them rough over the winter to permit earlier spring planting. You should plow light soils early in the spring.

Plow under stubble or green manure crops that precede sweet corn, and disk the soil 3–4 weeks before planting. Disk as many times as necessary to prepare a uniform seedbed and keep weeds under control. However, a crust can form if you work the soil too much.

In heavy soils, do not plant seed deeper than 1 inch. On sandy loams, plant seed 1.5 inches deep, and plant seed 2 inches deep on light sandy soils. Deeper planting may interfere with germination and prevent emergence if packing and crusting follow hard rains. In case of packing or crusting, use a rotary hoe to break the crust.

To extend the length of harvest, you can use successive plantings of the same hybrid at intervals of a week or less; or plant early, medium, and late maturing hybrids at the same time. Late plantings of early varieties usually are less productive than early plantings of late varieties. If you plant different hybrids that will be used for processing, they should have a similar ear and similar kernel type and color because of overlap at harvest. Late plantings often have more serious problems with diseases and insects.

Continuous corn production in the same field increases the danger of corn rootworm damage. To avoid this problem, rotate crops. You can rotate sweet corn with other vegetable processing crops such as snap beans, lima beans, peas, and cabbage. You can use early hybrids in multiple cropping systems following canning peas.

Irrigation

Sweet corn is sensitive to the moisture supply, especially during the 10 days before silking and the 20 days between silking and harvest. Irrigation rates depend upon soil type, temperature, relative humidity, and rainfall. Apply 2–3 inches of water when needed.

Lime and fertilizer

Lime: Use dolomitic limestone to maintain a pH of 6.0 or higher on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply fertilizer according to soil test recommendations. Use annual nitrogen, P_2O_5 , and K_2O recommendations in the table below. Take credits for previous legume crops and manure. Sowing 1.5–2.0 bu/a of rye or wheat after the corn harvest in late August or September may help capture some mobile soil nutrients.

Application: Broadcast lime and fertilizer and disc or plow under before seeding. Apply fertilizer to the side and below the seed.

Nitrogen: Apply sidedress or split the rate into two or three applications during the growing season on sandy soils. You can apply nitrogen through the irrigation system.

Micronutrients: If the soil test is low or very low for zinc, apply 2–4 lb Zn/a with the starter fertilizer.

Annual nitrogen, phosphate, and potash recommendations for sweet corn

Nitrogen		Phosphate and potash		
Organic matter	Amount to apply	Yield goal	Amount to apply ^a	
— % —	— lb/a —	— t/a —	P_2O_5	K_2O
<2	150	2.0–4.0	10	20
2.0–9.9	130	4.1–6.0	15	30
10–20	110	6.1–8.0	25	40
>20	70	8.1–10.0	30	55

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in sweet corn

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Anthracnose	<i>Rotate crops or use deep-incorporation of debris from previous year's corn crop.</i>			
Leaf rust, foliar diseases (gray leaf spot, northern corn leaf blight, and northern corn leaf spot)	azoxystrobin	<i>leaf rust:</i> 6.2–9.2 fl oz Quadris Flowable 2.0–3.0 oz Amistar <i>other foliar diseases:</i> 9.2–15.4 fl oz Quadris Flowable 3.0–5.0 oz Amistar	7	Amistar, Headline, and Quadris belong to the Group 11 (strobilurin) fungicide category. Quilt and Stratego contain Group 11 and Group 3 fungicides. Do not exceed one application of Amistar, Headline, Quadris, Quilt, or Stratego before alternating to a labeled fungicide with a different mode of action. Do not exceed 2.5 lb/a
	azoxystrobin + propiconazole	<i>leaf rust, gray leaf spot and eyespot:</i> 10.5–14.0 fl oz Quilt	14	Amistar, 72 fl oz/a Headline, 3.75 qt/a Quadris, 56 fl oz/a Quilt, or 30 fl oz/a Stratego per season.
		<i>other foliar diseases:</i> 7.0–14.0 fl oz Quilt	14	The number of applications using Group 11 fungicides should not exceed half of the total fungicide applications per season.
	propiconazole + triflozystrobin	10 fl oz Stratego	14	Treat when disease first appears; continue fungicide applications on a 7- to 14-day interval
	pyraclostrobin	<i>leaf rust and gray leaf spot:</i> 6.0–9.0 fl oz Headline	7	if conditions favorable for disease development persist.
		<i>other foliar diseases:</i> 9.0–12.0 fl oz Headline	7	
	chlorothalonil	0.75–2 pt Bravo Weather Stik, Echo 720, Equus 720	14 (fresh market only)	Plant tolerant or resistant varieties. Early detection is critical for fungicide use. Early plantings are less susceptible to these diseases. Do not exceed 9 lb ai/a chlorothalonil per season. Spray at 4- to 7-day intervals when symptoms first appear. Do not graze treated fields or use treated corn for livestock feed.
		0.7–1.8 lb Bravo Ultrex 82.5WDG, Equus DF	14 (fresh market only)	
		0.65–1.6 lb Echo 90DF	14 (fresh market only)	
	maneb	1.5 lb Maneb 80WP	7	Consult label for product use limits. Spray every 5–10 days depending on disease and weather pressures. Do not feed treated forage to livestock.
		1.2 qt Maneb plus Zinc F4	7	
		1.2 qt Manex F4	7	
	mancozeb	1.2 qt Dithane F-45	7	Consult label for product use limits. Spray every 5–10 days depending on disease and weather pressures. Do not feed treated forage to livestock.
		1.5 lb Dithane 75DF	7	
		1.5 lb Manzate 200 75DF	7	
		1.5 lb Penncozeb 80WP, 75DF	7	
	propiconazole	4 fl oz Tilt	14	Apply when disease first appears and continue at 7- to 14-day intervals. Do not apply more than 16 fl oz/a per season. Do not harvest sweet corn for forage within 14 days of application.
	Maize dwarf mosaic	<i>Plant tolerant or resistant varieties. Early plantings generally are less susceptible to this disease.</i>		
Northern corn leaf blight (<i>Helminthosporium turcicum</i>)	<i>This disease seldom develops on Wisconsin sweet corn to the point where control is needed. Fungicide sprays recommended for leaf rust will also control this disease.</i>			
Seed rot and damping-off	captan thiram			Seed corn should always be treated with a fungicide. Follow manufacturer's directions for rate and use. Do not use treated seed for feed or food.
Smut	<i>There is no satisfactory control for smut. Later, larger-growing varieties tend to have less infection than early, small varieties. Avoid excessive nitrogen or manure. Not poisonous to livestock or people.</i>			
White line mosaic	<i>Occurs more in soils that have high moisture content. Varieties resistant to this virus have not been identified.</i>			

Scouting calendar for insect pests of sweet corn

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
Armyworms					
Cutworms					
Flea beetles					
	European corn borer, 1st gen.		European corn borer, 2nd gen.		
	Corn leaf aphids				
	Stalk borer larvae				
	Hop vine borer larvae				
	Corn rootworm, larvae		adults	←egg laying begins	
			Corn earworm		
			Fall armyworm		

Spray schedule for corn borers and corn earworm moths based on nightly trap catches when temperatures are below 85°F

Corn borers	Corn earworm moths				
	<2/night	2–5/night	5–10/night	10–50/night	>50/night
<5/night	do nothing	do nothing	do nothing	4-day interval	3-day interval
5–10/night	6-day interval	6-day interval	5-day interval	4-day interval	3-day interval
10–20/night	5-day interval	5-day interval	5-day interval	4-day interval	3-day interval
>20/night	4-day interval	4-day interval	4-day interval	4-day interval	3-day interval

Adapted from Foster and Flood, *Vegetable Insect Management with Emphasis on the Midwest*, 1995.

Insect control in sweet corn

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	<i>Plant resistant hybrids. Early planted corn suffers less from aphids. Make a single insecticide application if 50% of corn plants have more than 50 aphids per plant just before tassel emergence. Apply sprays before tassels have emerged but not before upper whorl leaves open to expose tassels.</i>			
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use treated crops for feed within 1 day of last application.
	0.5–1.0 lb chlorpyrifos	1–2 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a Lorsban (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.
	0.25 mg clothianidin /kernel	1.13 fl oz Poncho 600/80,000 seeds	seed treatment	Early-season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold 1.5EC	1	For suppression only. Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 fl oz *Proaxis	1	Suppression only. Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for resistance statement plus grazing and forage feed restrictions.

*Restricted-use pesticide.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids (<i>cont.</i>)	3.2–6.4 fl oz imidacloprid /100 lb seed	16–20 fl oz Gaucho 600 /100 lb seed	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Suppression only. Do not exceed 0.48 lb ai/a. See label for resistance statement plus grazing and forage feed restrictions.
	methyl parathion	2.0–3.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Do not apply if bees are foraging in the areas to be treated. Do not exceed 12 pt/a per year.
	0.0175–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	3	Do not exceed 24 fl oz/a Mustang Max (0.15 lb ai/a) per season.
Armyworms	<i>Treat when there are two or more armyworms (3/4 inch or longer) per plant on 25% of plants or there is one per plant on 75% of the plants. When armyworms migrate from adjoining areas treat only border rows.</i>			
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use treated crops for feed within 1 day of last application.
	carbaryl	1.0–2.0 qt Sevin XLR Plus	2 (ears) 14 (forage) 48 (fodder)	Highly toxic to bees; see label for details on protecting them. Do not exceed 16 qt/a per season.
	0.5–1.0 lb chlorpyrifos	1.0–2.0 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a Lorsban (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.
	0.013–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	For control of first and second instar larvae. Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold 1.5EC	1	Apply to early instar larvae. Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 fl oz *Proaxis	1	For control of first and second instars only. Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage feed restrictions.
	0.045–0.065 lb indoxacarb	2.5–3.5 fl oz Avaunt	3 (food) 35 (forage)	For use on fall armyworm. Apply from whorl stage through tassel emergence (before silking). Do not apply more than 14 oz/a (0.26 lb ai/a) per crop. Do not exceed four applications per season. Allow at least 3 days between sprays. Re-entry interval is 12 hours; 14 days for hand harvesting. See label for grazing and forage use restrictions.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Use higher rates for large larvae. Do not apply more than 0.48 lb ai/a per crop. See label for grazing and forage feed restrictions.
	0.225–0.45 lb methomyl	0.75–1.5 pt *Lannate LV	0 (ears) 3 (forage) 21 (stover)	Certain hybrids are susceptible to methomyl injury. Treat a small area to determine crop safety before full-scale spraying. Do not apply more than 21 pt/a or make more than 28 applications per crop. Allow at least 1 day between treatments.

*Restricted-use pesticide.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Armyworms (<i>cont.</i>)	0.06–0.12 lb methoxyfenozide	4.0–8.0 fl oz Intrepid 2F	3 (ears, green chop) 21 (fodder)	Apply when infestations have reached economic threshold. For heavy infestations, reapply at 5- to 10-day intervals. Do not exceed 16 fl oz/a per application or 64 fl oz/a (1.0 lb ai/a) per season.
	methyl parathion	2.0–3.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Do not apply if bees are foraging in areas to be treated. Do not apply more than 12 pt/a per year.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Do not exceed 1.2 lb ai/a per season.
	0.023–0.047 lb spinetoram	3.0–6.0 fl oz Radiant	1	Do not make more than six applications per crop or exceed 0.281 lb ai/a per season. Wait at least 4 days between treatments and 3 days before harvesting for forage or fodder.
	spinosad	0.5–2.0 fl oz Entrust 1.5–6.0 fl oz SpinTor 2SC	1 1	Do not apply more than 0.45 lb ai/a per year.
	0.0175–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.
	Corn borers <i>Scout every 5–7 days and sample at least five consecutive plants in 10 areas of a field. Treat if there is an average of one egg mass (hatched plus unhatched) per 10 plants. Check traps at least every 2–3 days when moths are present. Refer to the spray schedule table above for treatment frequency based on trap catches.</i>			
	<i>Bacillus thuringiensis</i> (granular formulations)	Biobit, Dipel (see label rates)	0	First generation larvae. Larvae must be actively feeding on treated, exposed plant surfaces. Thorough spray coverage is needed. Repeat as needed every 3–14 days, depending on plant growth rate, moth activity, rainfall, and other factors.
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use crops for feed within 1 day of last treatment.
	carbaryl	1.5–2.0 qt Sevin XLR Plus	2 (ears) 14 (forage) 48 (fodder)	Highly toxic to bees; see label for details on protecting them. Do not exceed 16 qt/a per season.
	carbofuran	1.0 pt *Furadan F	7 (machine-harvested only)	Second generation only. Furadan F is limited to two applications per season or one application if Furadan 4F was used as a soil application. Do not graze or harvest stalks within 21 days of last application. There is a 10-month rotational plantback period for all crops except those registered.
	chlorpyrifos	Lorsban 15G	21	Recommended for first generation. See label for rates. Do not make more than three applications of any product containing chlorpyrifos per season, including the maximum allowed of two granular applications, at the 1 lb ai/a chlorpyrifos rate. Do not exceed 3 lb ai/a chlorpyrifos per season.
		1.0–2.0 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a Lorsban (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.

*Restricted-use pesticide.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Corn borers (<i>cont.</i>)	0.013–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Application must be made before larvae bore into plants. Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold 1.5EC	1	Application must be made before larvae bore into plants. Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Second generation only. Do not exceed 0.5 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage feed restrictions.
	0.045–0.065 lb indoxacarb	2.5–3.5 fl oz Avaunt	3 (food) 35 (forage)	Apply from whorl stage through tassel emergence (before silking). Do not apply more than 14 oz/a (0.26 lb ai/a) per crop. Do not exceed four applications per season. Allow at least 3 days between sprays. Re-entry interval is 12 hours; 14 days for hand harvesting. See label for grazing and forage use restrictions.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Treat if populations reach economic threshold and before larvae enter the stalk or ear. Do not apply more than 0.48 lb ai/a per crop. See label for grazing and forage feed restrictions.
	0.22–0.45 lb methomyl	0.75–1.5 pt *Lannate LV	0 (ears) 3 (forage) 21 (stover)	Certain hybrids are susceptible to methomyl injury. Treat a small area to determine crop safety before full-scale spraying. Do not apply more than 21 pt/a or make more than 28 applications per crop. Allow at least 1 day between treatments.
	0.06–0.12 lb methoxyfenozide	4.0–8.0 fl oz Intrepid 2F	3 (ears, green chop) 21 (fodder)	Apply at egg hatch when infestations reach economic threshold levels. For early season (first-generation) infestations, direct application at the whorl. For mid- and late-season (second-generation) infestations, broadcast over the row. Do not exceed 16 fl oz/a per application or 64 fl oz/a (1.0 lb ai/a) per season.
	methyl parathion	2.0–3.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Do not apply if bees are foraging in areas to be treated. Do not apply more than 12 pt/a per year.
	0.1–0.2 lb permethrin	6.7–13.3 lb *Pounce 1.5G	1	Apply when eggs begin to hatch. Do not apply more than 1.2 lb ai/a per season.
	0.1–0.25 lb permethrin	*Ambush, *Pounce	1	Second generation only. Several formulations; see label for rate. Do not exceed 1.2 lb ai/a per season.
	0.023–0.047 lb spinetoram	3.0–6.0 fl oz Radiant	1 (food) 3 (forage, fodder)	Do not make more than six applications per crop. Do not exceed 0.281 lb ai/a per season. Wait at least 4 days between treatments.
	spinosad	0.5–2.0 fl oz Entrust 1.5–6.0 fl oz SpinTor 2SC	1 1	Do not apply more than 0.45 lb ai/a.
	0.0175–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.

*Restricted-use pesticide.

(continued)

Insect control in sweet corn (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Corn flea beetle	<p><i>These tiny (less than 1/16 inch), black beetles transmit the bacterial disease Stewart's wilt. The pathogen overwinters in beetles, plant residue, and soil. During mild winters, enough flea beetles may survive in Wisconsin to lead to significant incidence of Stewart's wilt in the southern tier or two of counties.</i></p> <p><i>To predict disease risk—and the need to scout for beetles—add the monthly average temperatures for December, January, and February. Scout seedling corn intensively if the total is greater than 90°F. Treatment may be warranted if you find an average of six or more beetles per 100 plants. Beetles readily jump from plants when disturbed.</i></p>			
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use crops for feed within 1 day of last treatment.
	carbaryl	1.0–2.0 qt Sevin XLR Plus	2 (ears) 14 (forage) 48 (fodder)	Highly toxic to bees; see label for details on protecting them. Do not exceed 16 qt/a per season.
	0.5–1.0 lb chlorpyrifos	1.0–2.0 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a Lorsban (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.
	0.25 mg clothianidin /kernel	1.13 fl oz Poncho 600 /80,000 seeds	seed treatment	Early-season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.007–0.013 lb cyfluthrin	0.8–1.6 fl oz *Baythroid XL	0	Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.012–0.018 lb deltamethrin	1.0–1.5 fl oz *Delta Gold 1.5EC	1	Do not exceed 38.4 fl oz/a per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.5 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage use restrictions.
	3.2–6.4 fl oz imidacloprid /100 lb seed	16–20 fl oz Gaucho 600 /100 lb seed	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Do not exceed 0.48 lb ai/a per season. See label for grazing and forage feed restrictions.
	methyl parathion	2.0–3.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Do not apply if bees are foraging in the areas to be treated. Do not exceed 12 pt/a per year.
	0.125–0.80 mg thiamethoxam/kernel	Cruiser	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 fl oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.

*Restricted use.

(continued)

Insect control in sweet corn (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Cutworm	<p><i>Treat when more than 5% of plants are severely damaged.</i></p> <p><i>Lorsban 15G, *Counter 15G, and *Mocap 15G soil insecticides are labeled for planting-time application for cutworm control. These products are relatively effective in controlling light to moderate infestations. However, data for heavy infestations are limited and reports of unacceptable levels of damage from heavy infestations have occurred. Because of these factors and the difficulty of predicting cutworm outbreaks, do not use the "preventive approach." Field scouting and application of the pelleted bait or banded sprays is a better approach. Lorsban 4E is labeled for cutworm control at 1–2 pt/a (0.5–1.0 lb ai/a) as a preplant-incorporated, at-plant, or preemergence broadcast spray.</i></p>			
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use treated crops for feed within 1 day of last application.
	0.5–1.0 lb chlorpyrifos	1.0–2.0 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.
	0.26–0.76 lb chlorpyrifos + gamma-cyhalothrin	13.0–38.0 fl oz *Cobalt	21	Apply as broadcast spray preplant, at-plant, or preemergence. Do not apply more than 126 fl oz/a per season. Do not make more than three applications of any product containing chlorpyrifos per season.
	0.25 mg clothianidin /kernel	1.13 fl oz Poncho 600 /80,000 seeds	seed treatment	Early-season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.007–0.013 lb cyfluthrin	0.8–1.6 fl oz *Baythroid XL	0	Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.010–0.018 lb deltamethrin	0.8–1.5 fl oz *Delta Gold 1.5EC	1	Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Broadcast spray. Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage use restrictions.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Do not apply more than 0.48 lb ai/a per crop. See label for grazing and forage feed restrictions.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Broadcast spray. Do not exceed 1.2 lb ai/a per season.
	0.125–0.80 mg thiamethoxam/kernel	Cruiser	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 fl oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.
Earworms	<p><i>Treat as soon as silks begin to appear and pheromone trap catches indicate threshold levels have been exceeded. Check traps at least every other day when moths are present. Refer to spray schedule on previous page for timing recommendations. Make ground application in 25 gal of water/a with at least 100 psi. Direct two "wetttable powder" nozzles at silks from each side of the row. Make aerial applications in 4–5 gal/a water.</i></p>			
	<i>Bacillus thuringiensis</i> (granular formulations)	Biobit, Dipel (see label rates)	0	First generation larvae. Larvae must be actively feeding on treated, exposed plant surfaces. Thorough spray coverage is needed. Repeat as needed every 3–14 days, depending on plant growth rate, moth activity, rainfall, and other factors.

*Restricted use.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Earworms (<i>cont.</i>)	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use treated crops for feed within 1 day of last application.
	0.013–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Application must be made before larvae bore into plants. Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold 1.5EC	1	Apply to early instar before larvae bore into plants. Apply as needed from tassel emergence to silk dry down. Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage feed restrictions.
	0.045–0.065 lb indoxacarb	2.5–3.5 fl oz Avaunt	3 (ears) 35 (forage)	Do not exceed four applications per season. Apply from whorl stage through tassel push (prior to silking) only. Do not apply more than 14 oz/a (0.26 lb ai/a) per crop. Allow at least 3 days between sprays.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Treat if populations reach economic threshold and before larvae enter the stalk or ear. Do not apply more than 0.48 lb ai/a per crop. See label for grazing and forage feed restrictions.
	0.225–0.45 lb methomyl	0.75–1.5 pt *Lannate LV	0 (ears) 3 (forage) 21 (stover)	Certain hybrids are susceptible to methomyl injury. Treat a small area to determine crop safety before full-scale spraying. Do not apply more than 21 pt/a or make more than 28 applications per crop. Allow at least 1 day between treatments.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	1	Several formulations; see label for rate. Do not exceed 1.2 lb ai/a per season.
	0.023–0.047 lb spinetoram	3.0–6.0 fl oz Radiant	1 (food) 3 (forage, fodder)	Do not make more than six applications per crop. Do not exceed 0.281 lb ai/a per season. Wait at least 4 days between treatments.
	spinosad	1.0–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	1 1	Do not apply more than 0.45 lb ai/a.
	0.0175–0.025 lb zeta-cypermethrin	2.8–4.0 oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.
Grasshoppers	<i>Treat fencerows adjacent to corn fields to prevent injury.</i>			
	0.25–0.50 lb chlorpyrifos	0.5–1.0 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a Lorsban (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.
	0.012–0.018 lb deltamethrin	1.0–1.5 fl oz *Delta Gold 1.5EC	1	Do not exceed 38.4 fl oz/a per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.

*Restricted use.

(continued)

Insect control in sweet corn (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Grasshoppers (cont.)	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage use restrictions.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Do not exceed 0.48 lb ai/a. See label for grazing and forage feed restrictions.
	methyl parathion	2.0–3.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Use higher rates if the majority of grasshoppers are large or the weather is cool. Do not apply if bees are foraging in the areas to be treated. Do not exceed 12 pt/a per year.
	0.0175–0.025 lb zeta-cypermethrin	2.8–4.0 fl oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.
Rootworm larvae	<i>Spread insecticide granules or spray in a 7-inch band over the corn row in front of the packing wheel. Only chlorethoxyfos, chlorpyrifos, tebupirimphos, and terbufos may be placed in the seed furrows. Cover spilled granules with soil to reduce chance of birds and mammals being poisoned.</i>			
	<i>For postemergence row treatment, *Counter, Lorsban, or *Thimet granules can be applied at the base of stalks with a cultivator applicator at labeled rates and covered lightly with soil. This treatment should be made by mid-June and is suggested only as an emergency treatment because dry weather following application can limit insecticide activation giving marginal control. Planting time treatments are preferred.</i>			
	0.0046 lb bifenthrin /1000 ft row	0.3 fl oz/1000 ft row *Brigade 2EC *Discipline 2EC	30	Apply as a 5- to 7-inch T-band treatment over open seed furrow.
	0.0046–0.0057 lb bifenthrin /1000 ft row	0.39–0.49 fl oz *Capture LFR	30	Apply as a 5- to 7-inch T-band treatment over open seed furrow.
	1.0–1.3 lb chlorpyrifos	6.0–8.0 oz Lorsban 15G/1000 ft row	21	Do not exceed 8 oz/1,000 ft of row (1.3 lb ai/a) at planting. Do not make more than three applications of any product containing chlorpyrifos per season. Do not exceed 3 lb/a chlorpyrifos per season.
	phorate	4.5–6.0 oz *Thimet 20-G/1,000 ft row	30	Apply in a 7-inch band in seed furrow.
	tebupirimphos	6.7 oz *Aztec 2.1G /1000 ft row		Apply in 7-inch band or seed furrow. Within 20 yards of aquatic areas, make in-furrow applications only.
	tefluthrin	4.0–5.0 oz *Force 3G /1000 ft row		Apply in 7-inch band or seed furrow.
	terbufos	8.0 oz *Counter 15G /1,000 ft row	60	Do not exceed 8.7 lb/a Counter per season. If application is made at planting, do not apply postemergence or at cultivation. Do not use ALS-inhibiting herbicides if using Counter at planting.
Rootworm beetle	<i>Treat if five or more beetles per plant (check silks) before 75% silking, and silks are being pruned to within 1/2 inch of the husk.</i>			
	0.033–0.10 lb bifenthrin	2.1–6.4 fl oz *Brigade 2EC *Discipline 2EC	1	Do not exceed 12.8 fl oz/a (0.2 lb ai/a) per season. Do not graze or use crops for feed within 1 day of last treatment.
	carbaryl	1.0–2.0 qt Sevin XLR Plus	2 (ears) 14 (forage) 48 (fodder)	Highly toxic to bees; see label for details on protecting them. Do not exceed 16 qt/a per season.

*Restricted use.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Rootworm beetle (<i>cont.</i>)	1.0 lb chlorpyrifos	2.0 pt *Lorsban 4E	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 6 pt/a (3 lb ai/a) per season. Do not make a sequential application of a chlorpyrifos-containing product within 10 days of previous application.
	0.26–0.52 lb chlorpyrifos + gamma-cyhalothrin	13.0–26.0 fl oz *Cobalt	21	Do not apply more than 126 fl oz/a per season. Do not make more than three applications of any product containing chlorpyrifos per season.
	0.013–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold 1.5EC	1	For suppression only. Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not exceed 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage use restrictions.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Apply as required by scouting and insect populations reaching economic threshold. Do not exceed 0.48 lb ai/a. See label for grazing and forage feed restrictions.
	0.22–0.45 lb methomyl	0.75–1.5 pt *Lannate LV	0 (ears) 3 (forage) 21 (stover)	Certain hybrids are susceptible to methomyl injury. Treat a small area to determine crop safety before full-scale spraying. Do not apply more than 21 pt/a or make more than 28 applications per crop. Allow at least 1 day between treatments.
	0.25–0.5 lb methyl parathion	1.0–2.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Do not apply if bees are foraging in areas to be treated. Do not apply more than 12 pt/a per year.
	0.1–0.2 lb permethrin	*Ambush EC, *Pounce EC	1	Several formulations; see label for rate. Do not exceed 1.2 lb ai/a per season
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 fl oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.
Sap (picnic) beetles	carbaryl	1.0–2.0 qt Sevin XLR Plus	2 (ears) 14 (forage) 48 (fodder)	Highly toxic to bees; see label for details on protecting them. Do not exceed 16 qt/a per season.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not apply more than 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage use restrictions.
	0.02–0.03 lb lambda-cyhalothrin	2.56–3.84 fl oz *Warrior	1	Apply when insect populations reach economic thresholds and before larvae enter the plant. Do not exceed 0.48 lb ai/a. See label for grazing and forage feed restrictions.

*Restricted use.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Sap (picnic) beetles (<i>cont.</i>)	0.22–0.45 lb methomyl	0.75–1.5 pt *Lannate LV	0 (ears) 3 (forage) 21 (stover)	Certain hybrids are susceptible to methomyl injury. Treat a small area to determine crop safety before full-scale spraying. Do not apply more than 21 pt/a or make more than 28 applications per crop. Allow at least 1 day between treatments.
	methyl parathion	2.0–3.0 pt *PennCap-M 2FL	4 (ears) 12 (forage)	Do not apply if bees are foraging in areas to be treated. Do not apply more than 12 pt/a per year.
	0.014–0.025 lb zeta-cypermethrin	2.24–4.0 fl oz *Mustang Max	3	Do not exceed 24 oz/a Mustang Max (0.15 lb ai/a) per season.
	0.04–0.10 lb zeta-cypermethrin + bifenthrin	4.0–10.3 fl oz *Hero	3	Do not exceed 0.266 lb ai/a per season.
Seed beetles	1.3 lb chlorpyrifos	8.0 oz Lorsban 15G /1,000 ft row	21	Do not exceed 8 oz/1000 ft row or 1.3 lb ai/a at-plant. Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 3 lb/a chlorpyrifos per season.
	permethrin	1.5 oz Kernel Guard Supreme/42 lb seed	0	Planter box treatment.
	phorate	4.5–6.0 oz *Thimet 20-G/1,000 ft row	30	Apply in 7-inch band.
	tebupirimphos	6.7 oz *Aztec 2.1G /1,000 ft row		Apply in 7-inch band or seed furrow. Within 20 yards of aquatic areas, make in-furrow applications only.
	terbufos	8.0 oz *Counter 15G /1,000 ft row	60	Do not exceed 8.7 lb/a per season. If application is made at planting, do not apply postemergence or at cultivation. DO NOT use ALS-inhibiting herbicides if Counter has been applied at planting.
Seed maggots	1.3 lb chlorpyrifos	8.0 oz Lorsban 15G /1,000 ft row	21	Do not exceed 8.0 oz/1000 ft row (1.3 lb ai/a) at-plant. Do not make more than three applications of a chlorpyrifos-containing product/season. Do not exceed 3 lb ai/a chlorpyrifos per season.
	0.25 mg clothianidin /kernel	1.13 fl oz Poncho 600 /80,000 seeds	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	2.0–2.8 oz cyfluthrin	0.12–0.16 oz *Baythroid XL/1,000 ft row	0	Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	3.2–6.4 fl oz imidacloprid /100 lb seed	16–20 fl oz Gaucho 600 /100 lb seed	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	permethrin	1.5 oz Kernel Guard Supreme/42 lb seed	seed treatment	Planter box treatment.
	phorate	4.5–6.0 oz *Thimet 20-G/1,000 ft row	30	Apply in 7-inch band over the row. Do not use in-furrow application.
	tebupirimphos	6.7 oz *Aztec 2.1G /1,000 ft row		Apply in 7-inch band or seed furrow. Within 20 yards of aquatic areas, make in-furrow applications only.
	tefluthrin	4.0–5.0 oz *Force 3G /1,000 ft row		Apply in 7-inch band or seed furrow.
	terbufos	8.0 oz *Counter 15G /1,000 ft row	60	Do not exceed 8.7 lb/a of Counter per season. If application is made at planting, do not apply postemergence or at cultivation. ALS-inhibiting herbicides should not be used if Counter has been applied to corn at the time of planting.
	0.125–0.80 mg thiamethoxam/kernel	Cruiser 5FS	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.

*Restricted use.

(continued)

Insect control in sweet corn (cont.)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Stalk borers	<i>Small corn is most susceptible to injury. Control is most effective when larvae are small and before wilted plants are common. Begin scouting border rows at 1300–1400 degree days (DD). The Wisconsin Crop Manager newsletter and DATCP's Pest Survey Bulletin provide degree day information (base 41°F) during the stalk borer season. Iowa State University studies indicate that 10% of the larvae move into corn from adjacent host weeds by 1400 DD and 50% will have migrated by 1700 DD. Larvae originating within the field from last year's weed patches will damage corn earlier. Map weedy areas during fall harvest so that you can check them the following year, starting at about 900–1000 DD.</i>			
	1.0 lb chlorpyrifos	2.0 pt *Lorsban 4E	21	Do not apply more than 6 pt/a (3 lb ai/a) per season. Do not make more than three applications of any chlorpyrifos-containing product per season, including granular application of chlorpyrifos at-plant.
	0.38–0.84 lb chlorpyrifos + gamma-cyhalothrin	19.0–42.0 fl oz *Cobalt	21	Do not apply more than 126 fl oz/a per season. Do not make more than three applications of any product containing chlorpyrifos per season. Use 19–38 fl oz for stalk borer and 38–42 fl oz for common stalk borer. See label for details.
	0.013–0.022 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Application must be made before larvae bore into the plant. Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold 1.5EC	1	Apply to early instar larvae before they bore into stalks. Do not exceed 38.4 fl oz/a (0.45 lb ai/a) per season. See label for grazing and feed restrictions.
	0.03–0.05 lb esfenvalerate	5.8–9.6 fl oz *Asana XL	1	Do not exceed 0.50 lb ai/a per season.
	0.01–0.015 lb gamma-cyhalothrin	2.56–3.84 oz *Proaxis	1	Do not exceed 3.84 pt/a (0.24 lb ai/a) per season. See label for grazing and forage use restrictions.
	0.1–0.2 lb permethrin	*Ambush, *Pounce	1	See label for rate. Do not exceed 1.2 lb ai/a per season.
White grubs	1.3 lb chlorpyrifos	8.0 oz Lorsban 15G /1,000 ft row	21	Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 8 oz/1,000 ft row or 1.3 lb ai/a at-plant. Do not exceed 3 lb/a chlorpyrifos per season.
	0.25 mg clothianidin /kernel	1.13 fl oz Poncho 600 /80,000 seeds	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	2.5–2.8 oz cyfluthrin	0.14–0.16 oz *Baythroid XL /1,000 ft row	0	Apply in 7-inch band or in seed furrow. Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	3.2–6.4 fl oz imidacloprid /100 lb seed	16–20 fl oz Gaucho 600/100 lb seed	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	phorate	4.5–6.0 oz *Thimet 20-G/1,000 ft row	30	Apply in 7-inch band over the row. Do not use in furrow application.
	tebupirimphos	6.7 oz *Aztec 2.1G /1,000 ft row		Apply in 7-inch band over the row. Do not use in furrow application.
	tefluthrin	4.0–5.0 oz *Force 3G /1,000 ft row		Apply in 7-inch band or seed furrow.
	terbufos	8.0 oz/1,000 ft row *Counter 15G	60	Do not exceed 8.7 lb/a of Counter per season. If application is made at planting, do not apply postemergence or at cultivation. ALS-inhibiting herbicides should not be used if Counter has been applied to corn at the time of planting.
	0.125–0.80 mg thiamethoxam/kernel	Cruiser 5FS	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.

*Restricted use.

(continued)

Insect control in sweet corn (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Wireworms	1.3 lb chlorpyrifos	8.0 oz Lorsban 15G /1,000 ft row	21	Do not exceed 8 oz/1000 ft row (1.3 lb ai/a) at-plant. Do not make more than three applications of any product containing chlorpyrifos per season. Do not apply more than 3 lb/a chlorpyrifos per season.
	0.25 mg clothianidin /kernel	1.13 fl oz Poncho 600/ 80,000 seeds	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	2.0–2.8 oz cyfluthrin	0.12–0.16 oz/1,000 ft row *Baythroid XL	0	Apply in 7-inch band or in seed furrow. Do not exceed 28.0 fl oz/a (0.22 lb ai/a) per season.
	3.2–6.4 fl oz imidacloprid /100 lb seed	16–20 fl oz Gaucho 600/100 lb seed	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.
	phorate	4.5–6.0 oz *Thimet 20-G/1,000 ft row	30	Apply in 7-inch band over the row. Do not use in furrow application.
	tebupirimphos	6.7 oz *Aztec 2.1G /1,000 ft row		Apply in 7-inch band or seed furrow. Within 20 yards of aquatic areas, make in-furrow applications only.
	tefluthrin	4.0–5.0 oz *Force G /1,000 ft row		Apply in 7-inch band or seed furrow.
	terbufos	8.0 oz *Counter 15G /1,000 ft row		Do not exceed 8.7 lb/a of Counter per season. If application is made at planting, do not apply postemergence or at cultivation. ALS-inhibiting herbicides should not be used if Counter has been applied to corn at the time of planting.
	0.125–0.80 mg thiamethoxam/kernel	Cruiser 5FS	seed treatment	Early season protection. Purchase treated seed from seed dealer or seed treatment representative.

*Restricted use.

Weed control

Due to concern about groundwater contamination, Wisconsin has enacted atrazine rate restrictions based on surface soil texture, prior atrazine use and geographic location relative to atrazine detections in groundwater. Wisconsin's Atrazine Rule (ATCP 30) imposes a 0.75–1.5 lb/a rate limit on atrazine use statewide. An exception is allowed for growers who find it necessary to use atrazine postemergence to "rescue" seed or sweet corn from weed competition. This exception applies only to seed and sweet corn and the total amount of atrazine used at planting and postemergence may not exceed 1.5 lb/a on coarse soils and 2 lb/a on medium or fine soil. In addition, atrazine use is prohibited in extensive areas of Dane county and the entire Lower Wisconsin River valley extending downstream from the Highway 60 bridge at Prairie du Sac to the confluence of the Wisconsin and Mississippi Rivers. Localized areas of Adams, Brown, Calumet, Chippewa, Columbia, Dodge, Eau Claire, Grant, Green, Green Lake, Iowa, Jackson, Juneau, Lafayette, Manitowoc, Marathon, Marinette, Marquette, Monroe, Outagamie, Pierce, Portage, Richland, Rock, St. Croix, Sauk, Trempealeau, Vernon, Walworth, Waupaca, Waushara, Winnebago, and Wood counties have a total prohibition on atrazine use. Contact your county Extension office for detailed maps of atrazine prohibition areas or visit <http://datcp.state.wi.us/arm/agriculture/pest-fert/pesticides/atrazine/index.jsp>.

The following table lists atrazine active ingredient rate limits for various management situations in Wisconsin. Be certain to reduce the use rates of atrazine and atrazine containing products according to the Wisconsin Atrazine Rule. Wisconsin ATCP 30 also specifies that atrazine can be applied only from April 1 through July 31. It also prohibits atrazine application through irrigation systems and prohibits irrigation for two years after atrazine application unless such irrigation is practiced via an irrigation scheduling program that does not allow the water content of the soil in the crop root zone to exceed field moisture capacity.

Atrazine active ingredient rate limits

Surface soil texture	Statewide atrazine limits	
	Atrazine used last year	No atrazine used last year
	— — — — — lb ai/a — — — — —	
Coarse	0.75	0.75
Medium and fine	1.0	1.5

State and federal rules have also established setbacks for mixing, loading, and applying atrazine and atrazine-containing herbicides. Heed the following guidelines to minimize ground and surface water contamination by atrazine.

- No mixing or loading within 100 feet of wells, sinkholes, streams, lakes, or reservoirs unless such mixing or loading occurs over a spill containment pad constructed in compliance with Wisconsin ATCP 29. (Note: In Wisconsin, this rule applies for all pesticides. Federal rules require a 50-foot setback for atrazine only.)
- No application within 50 feet of a well or sinkhole or within 200 feet of the shoreline of natural or impounded lakes or reservoirs.
- No application within 66 feet of where field runoff enters streams (perennial or intermittent) and rivers.

Weed control in sweet corn

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Annual weeds:	<i>Even where you use herbicides, shallow cultivation will help control weeds. Cultivate while both weeds and sweet corn are small. Do not cultivate when sweet corn is more than 24 inches tall or you may prune roots.</i>		
soil-applied herbicides	safened acetochlor	1.25–2.75 pt Harness 1.25–3.0 pt Surpass (or equivalent)	Acetochlor provides good to excellent control of foxtails, crabgrass, and fall panicum, but will only suppress wild proso millet and has no effect on quackgrass. It controls nightshade and pigweed, suppresses lambsquarters, but several other broadleaf weeds escape control. Do not use on sands with less than 3% organic matter, on loamy sands with less than 2% organic matter, or on sandy loams with less than 1% organic matter when depth to ground water is less than 30 feet. Alfalfa, barley, potato, oat, soybeans, and tobacco may be planted the following spring and wheat may be planted after 4 months, but peas and snap bean are not allowed as rotational crops. Preplant-incorporated: Apply to dry soil within 2 weeks before planting and incorporate into the top 1–2 inches of soil. Preemergence: Apply after planting but before weed emergence.
	safened acetochlor + atrazine	1.8–2.3 qt Harness Xtra 1.6–3.0 qt Keystone LA (or equivalent)	These premixes provide good to excellent control of foxtails, crabgrass, fall panicum, and several annual broadleaf weeds, but will only suppress wild proso millet and have no effect on quackgrass. Some velvetleaf may escape. Do not use on sands with less than 3% organic matter, on loamy sands with less than 2% organic matter, or on sandy loams with less than 1% organic matter when depth to ground water is less than 30 feet. Only corn, soybean, or sorghum may be planted the spring after application. Certain labels allow other rotational crops after 15 months. Preplant-incorporated: Apply to dry soil within 2 weeks before planting and incorporate into the top 1–2 inches of soil. Preemergence: Apply after planting but before weed emergence.

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Annual weeds: soil-applied herbicides (<i>cont.</i>)	*alachlor	<i>Preplant-incorporated</i> 2.5–3.5 qt Alachlor 4EC or Micro-Tech	Alachlor provides good to excellent control of foxtails, crabgrass, and fall panicum, but will only suppress wild proso millet and has no effect on quackgrass. It also does not control velvetleaf and several other broadleaf weeds. Up to 4 qt/a may be applied to soils with greater than 10% organic matter.
		<i>Preemergence</i> 2.0–3.25 pt Alachlor 4EC or Micro-Tech	Preplant-incorporated: Apply to dry soil within the 7 days before planting and blend into the top 1–2 inches of soil. Provides reasonable yellow nutsedge control at 3–4 qt/a alachlor. Preemergence: Apply after planting but within 5 days after the last tillage for weed control. Provides only limited control of yellow nutsedge.
	*alachlor + atrazine	2.5–4.0 qt Bullet or Lariat	These premixes provide good to excellent control of foxtails, crabgrass, fall panicum, and several broadleaf weeds, but they will only suppress wild proso millet and will have little effect on quackgrass. Some velvetleaf may escape. They are ineffective on peat or muck soils. Only corn, soybean, dry bean, or sorghum may be planted the year after application. Preplant-incorporated: Apply to dry soil within the 7 days before planting, blending it into the top 1–2 inches of soil. Gives reasonable yellow nutsedge control at the higher rate. Preemergence: Apply after planting but within 5 days after last tillage for weed control. Provides only limited control of yellow nutsedge.
	*atrazine	1.5–3.0 pt Atrazine 4L (or equivalent)	Many annual broadleaf weeds are controlled but permissible rates are generally inadequate for annual grass control except on very coarse-textured, low organic matter soils and when combined with rotary hoeing and/or row cultivation. Atrazine can be tank-mixed with Alachlor 4EC, Dual II Magnum, Eradicane, Micro-Tech, Outlook, or Prowl/Pendimax to improve control of annual grasses. Triazine-resistant velvetleaf, common lambsquarters, smooth pigweed, and kochia are not controlled. Only corn, soybean, or sorghum may be planted the year after application. Preplant-incorporated: Work into soil within the 2 weeks before planting. Ineffective on peat or muck soils. Preemergence: Apply after planting but before annual weeds emerge. Ineffective on peat or muck soils.
	dimethenamid-P	10.0–21.0 fl oz Outlook 6.0	Outlook provides good to excellent control of foxtails, crabgrass, and fall panicum but will only suppress wild proso millet and has no effect on quackgrass. It also does not control velvetleaf and several other broadleaf weeds. Preplant-incorporated: Apply to dry soil within 14 days before planting and blend into the top 1–2 inches of soil. Provides reasonable yellow nutsedge control at the highest rate recommended by soil type. Preemergence: Apply after planting but before weed emergence. Provides only limited control of yellow nutsedge. Postemergence: Although Outlook will not control emerged grasses, it can be applied to sweet corn up to 12 inches tall in single or sequential treatments. Do not harvest within 50 days or feed to livestock within 40 days after application.

*Restricted-use pesticide

(continued)

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Annual weeds: soil-applied herbicides (<i>cont.</i>)	*dimethenamid + atrazine	2.0–3.5 pt G-Max Lite	<p>This premix provides good to excellent control of foxtails, crabgrass, fall panicum, and several annual broadleaves but will only suppress wild proso millet and has little effect on quackgrass. Some velvetleaf may escape. It is not recommended on soils with more than 20% organic matter. Only corn, soybean, or sorghum may be planted the year after application.</p> <p>Preplant-incorporated: Apply to dry soil within 14 days before planting and blend into the top 1–2 inches of soil. Provides reasonable yellow nutsedge control at the higher rate for a soil type.</p> <p>Preemergence: Apply after planting but before weed emergence. Provides only limited control of yellow nutsedge.</p> <p>Postemergence: This premix can be applied to sweet corn up to 12 inches tall. Apply while broadleaf weeds are less than 1.5 inches tall and before grasses emerge. Best results are obtained when rainfall occurs within 5–7 days after this delayed application.</p>
	EPTC + safener	4.75–7.33 pt Eradicane	<p>Preplant-incorporated: Apply to dry soil within 2 weeks before planting and incorporate 2–3 inches deep within 4 hours of application. If possible, application and incorporation should be done together. This treatment provides excellent control of foxtails, crabgrass, and fall panicum. Follow-up treatment for broadleaf control is usually necessary. Do not use on peat or muck soils. The highest rates are labeled specifically for quackgrass, yellow nutsedge, woolly cupgrass, and wild proso millet suppression. Rotate Eradicane-treated fields to another herbicide annually or Eradicane will lose efficacy.</p>
	flufenacet	15.0–25.0 oz Define SC	<p>Provides good to excellent control of foxtails, crabgrass, and fall panicum, but will only suppress wild proso millet and has no effect on quackgrass. It also does not control velvetleaf and several other broadleaf weeds. Define can be tank-mixed with atrazine or Princep to increase the spectrum of weed control. Plant sweet corn at least 1.5 inches deep when using Define.</p> <p>Preplant-incorporated: Apply to dry soil within 2 weeks before planting and incorporate into the top 1–2 inches of soil.</p> <p>Preemergence: Apply after planting but before weed emergence.</p> <p>Postemergence: Although Define will not control emerged grasses, it can be applied to sweet corn through the 5-collar stage for residual grass control.</p>
	mesotrione	6.0–7.7 oz Callisto	<p>Preemergence: Controls many annual broadleaf weeds including lambsquarters, nightshade, pigweed, common ragweed, and velvetleaf, but not annual grasses. Callisto can be tank-mixed with a preemergence grass herbicide for annual grass control. If tank-mixed with a herbicide containing atrazine, the Callisto rate can be reduced to 5–6 oz/a. To avoid injury, do not apply with emulsifiable concentrate grass herbicides after corn has spiked. Do not apply if wind speed exceeds 10 mph. Small grains can be planted after 120 days; and alfalfa, soybeans, and potatoes can be planted after 10 months. Most other crops can be planted after 18 months.</p>

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Annual weeds: soil-applied herbicides (<i>cont.</i>)	safened s-metolachlor	1.0–2.0 pt Dual II Magnum or Cinch	<p>S-metolachlor provides good to excellent control of foxtails, crabgrass, and fall panicum but will only suppress wild proso millet and has no effect on quackgrass. It does not control velvetleaf and several other annual broadleaf weeds. Ineffective on peat or muck soils.</p> <p>Preplant-incorporated: Apply within 2 weeks before planting and blend into the top 2 inches. Treatment at 2 pt/a will control yellow nutsedge.</p> <p>Preemergence: Apply after planting but before weeds or sweet corn emerge. Offers limited control of yellow nutsedge.</p> <p>Postemergence: Although s-metolachlor will not control emerged grasses, it can be applied on sweet corn up to 40 inches tall for residual grass control. Do not harvest ears for 30 days after application.</p>
	*safened s-metolachlor + atrazine	0.9–2.2 qt Bicep Lite II or Cinch ATZ Lite	<p>Provides good to excellent control of foxtails, crabgrass, fall panicum, and several broadleaf weeds, but will only suppress wild proso millet and has little effect on quackgrass. Some velvetleaf may escape. Ineffective on peat or muck soils. Only corn, soybean, or sorghum may be planted the year after application.</p> <p>Preplant-incorporated: Apply within the 2 weeks before planting and blend into top 2 inches of soil. Gives reasonable nutsedge control at the higher rate.</p> <p>Preemergence: Apply after planting but before weeds emerge. Provides limited control of yellow nutsedge.</p> <p>Early postemergence: Apply before weeds reach the two-leaf stage and before sweet corn is 5 inches tall. Best results when rain occurs 5–7 days after this application.</p>
	safened s-metolachlor + mesotrione	2.0–2.4 qt Camix	<p>Camix provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but will only suppress wild proso millet and has no effect on quackgrass. The mesotrione in this premix improves velvetleaf control compared to Bicep Lite II Magnum or similar premixes. Camix can be tank-mixed with Princep in atrazine prohibition areas. Yellow nutsedge will be suppressed. Do not apply if wind speed exceeds 10 mph. Winter wheat can be planted 4.5 months after application; potatoes, small grains, and soybeans can be planted the year after application. Other crops should not be planted for 18 months. Only corn and sorghum can be planted the following year if applied after June 1.</p> <p>Preplant: Apply up to 14 days before planting.</p> <p>Preemergence: Apply after planting but before sweet corn and grass weeds emerge.</p>

*Restricted-use pesticide

(continued)

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Annual weeds: soil-applied herbicides (<i>cont.</i>)	safened s-metolachlor + mesotrione + atrazine	2.5–3.0 qt Lumax	Lumax provides good to excellent control of foxtails, crabgrass, fall panicum, and most annual broadleaf weeds, but will only suppress wild proso millet and has no effect on quackgrass. The mesotrione in this premix improves velvetleaf control compared to Bicep Lite II Magnum or similar premixes. Lumax is similar to Camix except it also contains atrazine, which increases the consistency of control of some broadleaf weeds. Do not apply if wind speed exceeds 10 mph. Winter wheat can be planted 4.5 months after application and small grains and soybeans can be planted the following year. Other crops should not be planted the year after application. If applied after June 1, only corn or sorghum can be planted the following year. Preplant: Apply up to 14 days before planting. Preemergence: Apply after planting but before sweet corn and grass weeds emerge.
	pendimethalin	% organic matter: less than 1.5% 2.0–3.0 pt Prowl H ₂ O or 1.8–3.6 pt Prowl 3.3EC/ Pendimax more than 1.5% 3.0–4.0 pt Prowl H ₂ O or 2.4–4.8 pt Prowl 3.3EC/ Pendimax	Preemergence: Apply after planting and before weeds emerge. Do not soil incorporate. Provides excellent control of foxtails, crabgrass, and fall panicum, but has no effect on quackgrass, ragweeds, and mustards. Do not use on peat or muck soils. Plant sweet corn at least 1.5 inches deep. Postemergence: Will not control emerged grasses, but it can be applied postemergence for residual grass control before sweet corn reaches 24 inches tall or the 8-collar stage. Do not plant winter wheat or barley within 120 days of application.
	simazine	4.0–6.0 pt Princep 4L (or equivalent)	Princep controls many annual broadleaf weeds, but grasses will only be controlled at higher rates. Quackgrass will not be controlled. Use 8 pt/a on peat or muck soils. Princep will persist and injure crops other than corn the next year; only plant corn the year after application or soybeans if 6 pt/a or less was applied. Preplant-incorporated: Apply within 2 weeks before planting and blend into the top 2 inches. Preemergence: Apply after planting but before sweet corn and weeds emerge. Princep requires more rainfall than atrazine to make it effective. Preplant-incorporated applications will be more effective in dry springs.
Emerged annual broadleaves	*atrazine	1.5–3.0 pt Atrazine 4L (or equivalent) <i>plus</i> 2 pt oil concentrate	Early postemergence: Use after earlier annual grass control treatment before redroot pigweed and common lambsquarters are 6 inches tall and before all other broadleaf weeds reach 4 inches but before corn is more than 12 inches tall. Check Wisconsin atrazine rate limits before using this treatment. Triazine-resistant velvetleaf, common lambsquarters, smooth pigweed, and kochia are not controlled. Only corn, soybean, or sorghum may be planted the year after application.
	bentazon	1.5–2.0 pt Basagran <i>plus</i> 2 pt oil concentrate	Postemergence: Apply when broadleaf weeds are small and sweet corn has one to five leaves. If velvetleaf is the primary problem, substitute 1 gal/a of 28% nitrogen solution or 2.5 lb/a of spray grade ammonium sulfate for the oil concentrate. If both velvetleaf and common lambsquarters and/or common ragweed are a problem, include both oil concentrate and nitrogen solution or ammonium sulfate. Use a minimum of 20 gal/a of water and 40 psi. Rain within 4 hours reduces effectiveness. Also provides good control of yellow nutsedge; treat when 6–8 inches tall. There are no rotational restrictions following a Basagran application.

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Emerged annual broadleaves (<i>cont.</i>)	*bentazon + atrazine	1.33–2.33 pt Laddok S-12 plus 2 pt oil concentrate	Early postemergence: Apply when broadleaf weeds are small and sweet corn has one to five leaves but before it is more than 12 inches tall. Rain within 4 hours reduces effectiveness. Broadens the spectrum of broadleaf weed control as compared to Basagran alone. Maximum rate provides good yellow nutsedge control.
	carfentrazone-ethyl	0.5 fl oz Aim EW plus a nonionic surfactant at 0.25% v/v or, during dry conditions, a crop oil concentrate.	Postemergence: Aim is a contact herbicide with little residual activity. It may be applied up to the 8-leaf collar stage. Do not apply if winds exceed 10 mph. Apply in a minimum of 10 gal/a spray volume. Aim provides excellent control of velvetleaf and good control of lambsquarters, pigweed, and nightshade. Aim can be tank-mixed with atrazine to improve weed spectrum. Aim will cause temporary leaf speckling. Avoid spraying within 6–8 hours of rain or irrigation or spraying excessive rates into the whorl because excessive leaf burn may occur. Rain within 1 hour reduces effectiveness. Treated fields can be planted to corn, beans, peas, potatoes, small grains, and soybeans anytime; and to crops not listed on the label after 12 months.
	carfentrazone-ethyl + halosulfuron	1.0 oz Priority plus 0.25% nonionic surfactant	Postemergence: Priority is a premix of Aim and Permit. It provides excellent velvetleaf control plus good control of several broadleaf weeds and yellow nutsedge. It may be applied up to the 8-leaf collar stage. Apply before smartweed exceeds 2 inches, before lambsquarters and giant ragweed exceed 3 inches, before nightshade and pigweed exceed 4 inches, before cocklebur and common ragweed exceed 9 inches, and before velvetleaf exceeds 18 inches. The Aim component will cause speckling of corn leaves. Spraying within 6–8 hours of rain or irrigation and spraying excessive rates in the whorl may cause excessive leaf burn. Treated fields can be planted to field corn after 1 month; small grains after 2 months; sweet corn after 3 months; soybean after 9 months; and alfalfa, dry and snap beans, peas, and potatoes after 12 months.
	clopyralid	0.33–0.66 pt Stinger	Postemergence: Stinger has good activity on weeds in the legume and sunflower families, including Canada thistle, common and giant ragweed, and cocklebur. For Canada thistle, apply when most plants have emerged and are 6–8 inches tall but before the pre-bud stage. For annual weeds, apply before weeds exceed the 5-leaf stage. Apply before sweet corn exceeds 18 inches in height as a broadcast or directed spray in 10–20 gpa. Stinger may be tank-mixed with other herbicides labeled for use on sweet corn. Rain within 6 hours reduces effectiveness. Do not harvest ears or forage within 30 days after application, or stover within 60 days. Stinger-treated fields can be planted to corn, small grains, and beets anytime after application. Do not plant alfalfa, dry beans, or soybeans for 10.5 months, or peas, potatoes, or snap beans for 18 months after application.

*Restricted-use pesticide

(continued)

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Emerged annual broadleaves (<i>cont.</i>)	fluroxypyr	0.66 pt Starane	Postemergence: Starane controls cocklebur, ragweeds, velvetleaf, hemp dogbane, and suppresses volunteer potato. It is poor on lambsquarters and pigweed when used alone. Starane can be tank-mixed with atrazine to control these and other broadleaf weeds. Apply before annual weeds are 8 inches tall. Apply to sweet corn through the 4-leaf collar stage in broadcast or directed spray in 10–20 gpa. Drop nozzle applications can be made after this stage. Rain within 1 hour reduces effectiveness. Apply at least 31 days before harvesting ears or feeding forage to livestock. Small grains and corn can be planted anytime after application and other crops can be planted after 120 days.
	halosulfuron	0.66 oz Permit/Sandea plus 0.25% surfactant	Halosulfuron controls several broadleaf weeds and yellow nutsedge, but has no grass activity. It is poor on lambsquarters and will not control nightshade. Postemergence: Treat redroot pigweed, giant ragweed, and smartweed at 1–3 inches. Velvetleaf and common ragweed may be controlled at up to 9 inches. May be applied over-the-top or with drop nozzles from the spike to layby growth stage. Fields may be cultivated 7 days after treatment. Use drop nozzles if making a second application. Do not exceed two applications per year. Rain within 4 hours reduces effectiveness. Halosulfuron has not been evaluated on all sweet corn varieties and should not be used unless crop safety is known. Hybrids that are approved for Accent use may have the least risk of injury. Do not use on Jubilee sweet corn. Do not apply to sweet corn treated with a soil-applied organophosphate insecticide. Do not apply a foliar organophosphate insecticide within 7 days after or 3 days before halosulfuron treatment. Treated fields can be planted to field corn after 1 month; to small grains after 2 months; or to alfalfa, beans, peas, soybeans, or potatoes after 9 months.
	mesotrione	3 oz Callisto plus 0.25% nonionic surfactant	Postemergence: Callisto controls many annual broadleaf weeds, but will not control most grasses. Callisto may cause bleaching of sweet corn leaves, but the injury generally does not affect sweet corn growth. Hybrid tolerance ratings to Callisto are available at ipcm.wisc.edu (search the publications for “sweet corn”). To minimize the risk of injury, nonionic surfactant is the recommended adjuvant. Crop oil concentrate at 1% may be used, but the risk of injury increases. Do not add ammonium sulfate or a liquid nitrogen fertilizer. Because less-active adjuvants are used in sweet corn versus field corn, broadleaf weeds should be sprayed before 5 inches tall. Tank-mixing 0.25 lb/a atrazine with Callisto is synergistic and will compensate for the less-active adjuvants in general and will specifically improve common ragweed control. Callisto plus atrazine must be applied before the sweet corn exceeds 12 inches. Callisto alone must be applied before sweet corn exceeds 30 inches or the V8 stage. Rain within 1 hour may reduce effectiveness. Do not apply Callisto if Counter or Lorsban were applied. Do not apply if wind speed exceeds 10 mph. Treated fields can be planted to corn anytime; small grains can be planted after 120 days; and alfalfa, soybeans, and potatoes can be planted after 10 months. Most other crops can be planted after 18 months.

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Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Emerged annual broadleaves (<i>cont.</i>)	safened tembotrione	3 oz Laudis <i>plus</i> 1% methylated seed oil (preferred) <i>or</i> 1% crop oil concentrate <i>plus</i> 1.5 qt 28% nitrogen solution <i>or</i> 1.5 lb ammonium sulfate	Postemergence: Laudis controls many annual broadleaf weeds including lambsquarters, nightshade, pigweed, ragweeds, and velvetleaf, as well as several annual grasses including large crabgrass, giant and yellow foxtail, and wild proso millet. Broadleaf weeds should be treated before they are 6-inches tall. Grass weed heights are shorter and vary by species. Tank-mixing with 0.5 lb/a atrazine is synergistic and will improve control of broadleaf weeds and will control larger grass weeds. Laudis can be applied to sweet corn up to the 7-collar growth stage, except for atrazine tank mixtures which must be applied before corn exceeds 12 inches. Most hybrids have excellent tolerance to Laudis; however, a few hybrids, like Merit, are highly sensitive and will be killed. Rain within 1 hour may reduce effectiveness. Treated fields can be planted to corn anytime; small grains can be planted after 4 months; soybeans can be planted after 8 months; and alfalfa, peas, potatoes, snap beans can be planted after 10 months. Most other crops can be planted after 18 months.
	topramazone	0.5–0.75 oz Impact <i>plus</i> 1.0–1.5% crop oil concentrate <i>or</i> methylated seed oil <i>plus</i> 1.25–2.5% of 28% nitrogen solution <i>or</i> 8.5 lb/100 gal of ammonium sulfate	At the 0.5 oz/a rate, Impact controls smartweeds up to 2 inches; common lambsquarters, nightshades, common ragweed, and pigweeds up to 4 inches; and giant ragweed and velvetleaf up to 5 inches. It also suppresses giant foxtail, wild proso millet, and crabgrasses. Larger weeds and certain grasses can be controlled at 0.75 oz/a, but soybeans cannot be planted for 18 months at this rate. Impact is synergized by atrazine, so tank mixtures with 0.25–1.0 lb/a atrazine are recommended. Apply from emergence until 45 days before harvest, although Impact plus atrazine must be applied before corn exceeds 12 inches. Do not apply if winds exceed 10 mph. Impact is rainfast in 1 hour. Corn can be planted anytime after application; small grains after 3 months; alfalfa, peas, potatoes, and sorghum after 9 months; and other crops after 18 months. If the 0.5 oz/a rate is used, soybeans can be planted after 9 months.
Emerged annual grasses	nicosulfuron	0.66 oz/a Accent <i>plus</i> 1.0% oil concentrate <i>or</i> 0.25% surfactant <i>plus</i> 2–4 qt 28% nitrogen fertilizer <i>or</i> 2–4 lb ammonium sulfate	Postemergence: Apply broadcast to processing or fresh-market sweet corn up to 12 inches tall or with drop nozzles to sweet corn up to 18 inches tall. Do not treat if sweet corn has 6 or more collars (V6 stage). DuPont has previously approved use on: ABCO 610, Bonus, Challenger, Chase, Climax, Cornucopia, Crisp'N'Sweet 710, Crisp'N'Sweet 710A, DMC 20-04, DMC 20-35, Dynamo, Eliminator, Empire, Excalibur, Excellency, GG 8, GG 22, GG 43, GG 57, GG 202, GG 214, GG 246, GG 255, GG 435, GG 445, GH 0937, GH 2547, GH 2690, GH 9589, GSS 8357, GSS 8388, GSS 9299, Harvest Gold, HM701, Kokanee, Legacy, Lumina, Reward, Sheba, Sockeye, Spirit, Sprint, Stetson, Suregold, Wht 2801, Zenith, and 781 Ultra. Hybrid tolerance ratings to Accent are available at ipcm.wisc.edu (search the publications for "sweet corn"). Accent will kill highly sensitive hybrids. Apply before foxtails, barnyardgrass, fall panicum, and wild proso millet exceed 4 inches or quackgrass exceeds 10 inches. Accent will not control crabgrass. Rain within 4 hours reduces effectiveness. Do not cultivate 10 days before or 7 days after application. Accent can be tank-mixed with atrazine. Do not apply Accent if Counter has been used. Accent's interaction with other organophosphate soil insecticides may

(continued)

Weed control in sweet corn (*cont.*)

Weed	Active ingredient	Rate/a of commercial product	Remarks and suggestions
Emerged annual grasses (<i>cont.</i>)	nicosulfuron (<i>cont.</i>)		cause unacceptable injury. Do not apply an organophosphate insecticide within 7 days before or 3 days after applying Accent. Treated fields can be planted to field corn anytime; to soybeans after 15 days; to winter cereals after 4 months; to spring cereals after 8 months; or to alfalfa, beans, peas, potatoes, or sweet corn after 10 months.
	sethoxydim	0.75–2.25 pt Poast Plus plus 1 qt/a crop oil concentrate 0.5–1.5 pt Poast plus 1 qt/a crop oil concentrate	Poast/Poast Plus can only be applied to Poast-protected sweet corn; other hybrids will be severely injured. Postemergence: Poast Plus will control annual grass weeds and suppress quackgrass. Apply Poast Plus at 0.75 pt/a to control wild proso millet up to 10 inches tall, 1.5 pt/a for crabgrass up to 6 inches tall and foxtails up to 8 inches tall, and 2.25 pt/a for quackgrass when 8 inches tall. (Equivalent rates of Poast are 67% of the Poast Plus rate.) The addition of 2.5 lb/a ammonium sulfate or 2–4 qt/a 28% nitrogen solution may improve control of certain grass weeds. Tank mixtures with atrazine, Basagran, or Laddok S-12 are labeled to control emerged broadleaf weeds. Poast has minimal residual activity on grass weeds. Labeled tank mixtures with Outlook or G-Max Lite would provide residual weed control. Poast applications can be made until before pollen shed. Up to two applications can be made at an interval of 10 days. Rain within 1 hour may reduce effectiveness. Sweet corn can be harvested 30 days after application. Crops on which Poast is labeled can be planted anytime after application; other crops can be planted 30 days after application.
Emerged annual and perennial broadleaves	2,4-D	<i>Broadcast</i> 0.5–1.0 pt 2,4-D amine or 0.33–0.66 pt 2,4-D low volatile ester	Sweet corn may be injured by 2,4-D; use only when essential. Do not cultivate for 8–10 days to allow sweet corn to recover from stalk brittleness. Smartweeds and wild buckwheat are tolerant to 2,4-D, especially the amine form.
		<i>Drop nozzle</i> 1.0 pt 2,4-D amine or low volatile ester	Broadcast early postemergence: Apply when sweet corn is 4–6 inches tall. Use the lower rate in hot, humid weather. Drop nozzle postemergence: Apply when sweet corn is at least 8 inches tall. Direct spray toward base of sweet corn. Do not apply 2,4-D from a week before tassel emergence until after silks turn brown.
Directed applications	*paraquat	1.0–2.0 pt Gramoxone Inteon	Apply as directed spray when corn is at least 10 inches tall and before weeds reach 6 inches tall. Corn plants shorter than 10 inches may be injured beyond recovery. Add 1 qt of nonionic surfactant per 100 gal of final spray mixture. Arrange nozzles to spray no higher than the lower 3 inches of corn stalks to provide maximum weed contact with minimum corn contact. Do not spray over the top of corn. Do not mix this herbicide with liquid fertilizer for simultaneous application. For improved control of broadleaf annual weeds include 1 to 2 pt/a of the atrazine 4L formulation or an equivalent in the spray mixture. Use Gramoxone only when there is enough height difference between the corn and weeds to thoroughly spray the weed foliage without contacting the upper corn leaves by spray or drift. Such contact may cause crop injury. This treatment provides excellent annual weed control and temporary burn on the topgrowth of perennial weeds. However, an earlier herbicide treatment, rotary hoeing, or row cultivation is usually necessary to establish the proper height differential between corn and weeds.

*Restricted-use pesticide.

Tomato

Planting

Don't grow tomatoes in the same spot 2 years in succession, rotate them with other crops except pepper, eggplant, and potato. Prepare bed 7–8 inches deep. The bed should be smoothed and free of weeds. Wisconsin's growing season is too short to allow direct planting of tomato seed. Instead, seed should be planted indoors around March 25 and transferred to a cold frame or hotbed May 1. Transplant after all danger of frost—about May 20–25 in southern Wisconsin and after June 1 in northern Wisconsin. Cultivate or hoe to control weeds. Do not cultivate after vines cover the ground. To avoid spreading plant diseases, do not hoe or cultivate when plants are wet. Alternatively, plastic mulch can be used to suppress weeds in the row. In addition, mulches increase tomato yield as compared to plants grown in bare soil.

Should plants be staked, caged or left to sprawl? If cultivars are indeterminate (the terminal bud is vegetative), they should be caged or staked. If they are determinate (the terminal bud is a flower bud), you can cage them or let them sprawl. Each method has advantages and disadvantages.

Staked plants give a slightly earlier harvest, are cleaner, have somewhat larger fruit and are easier to harvest. However, extra labor is needed for weekly pruning and tying; fruit is more prone to cracking and sunscald; and more plants are needed to give the same yield.

Caged plants give higher quality, cleaner and more abundant fruit compared to ordinary ground-type culture. They ripen later but are less susceptible to sunscald than staked plants. Caged plants do not need to be pruned.

Ground plants are the easiest to care for. However, they occupy the most space and fruit quality is compromised, especially for fruit touching the soil.

Pruned and staked Rows—36–48 inches; plants in row—12–24 inches apart.

Caged Rows—36–48 inches; plants in row—36 inches apart.

Use 10–12 ft² per plant for early varieties; use 15–20 ft² per plant for late or main crop varieties. Set 8-week-old plants 5–7 inches deep. Trench-in plants with long stems. Water plants several hours before they are set to ensure that a “ball” of soil adheres to the roots at transplanting.

Lime and fertilizer

Lime: Apply aglime to maintain a pH of 6.0 on mineral soils and 5.6 on organic soils.

Fertilizer rates: Apply P₂O₅ and K₂O according to soil test recommendations. Use annual nitrogen, P₂O₅, and K₂O recommendations in table below. Take credits for previous legume crops and manure. Adequate K₂O fertilization is important for prevention of gray wall.

Application: Broadcast lime, P₂O₅, and K₂O and work into soil before planting.

Nitrogen: On heavier soils, broadcast and incorporate with fertilizer before planting. On sandy soils, apply 20–40 lb N/a before setting plants and sidedress the balance of the N recommended in one or more applications after the first fruits set. Overapplication of nitrogen can lead to excess vegetative growth, delaying maturity and reducing yield.

Micronutrients: Tomato has relatively high requirements for most micronutrients. Use plant analysis to confirm if these nutrients may be in short supply.

Annual nitrogen, phosphate, and potash recommendations for tomato

Nitrogen		Phosphate and potash		
		Yield goal	Amount to apply ^a	
Organic matter	Amount to apply		P ₂ O ₅	K ₂ O
— % —	— lb/a —	— t/a —	— — — lb/a — — —	— — —
<2	140	20–25	40	180
2.0–9.9	120			
10–20	100			
>20	50			

^a Amounts shown are for optimum (O) soil test levels. Apply 50% of this rate if soil test is high (H) and omit if soil test is excessively high (EH). If soil test is low (L) or very low (VL), increase rates according to soil test recommendations.

Disease control in tomato

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Bacterial spot	<i>A hot water seed treatment will help prevent bacterial spot. Place the seed in a mesh bag and dip it into water heated to 122°F. Treat seed for 25 minutes. Immediately transfer the bag to cold water to cool the seed. There will be some reduction in the germination rate of treated seed. You may wish to sow additional seed to compensate.</i>			
	fixed copper	3.0–4.0 lb Tri-Basic Copper Sulfate	0	Use disease-free plants. Only certified disease-free transplants should be used.
		2.0 qt Top Cop Tri-Basic	0	Spray every 7 days in the plant bed and
		2.0–4.0 lb Kocide 101 77WP	0	continue to spray in the field. Before
		2.0–4.0 lb Champion 77WP	0	transplanting, examine transplants carefully
		1.3–2.6 pt Champ Formula 2 4.6F	0	for bacterial spot lesions on the leaves and
		2.0–4.0 lb Kocide DF	0	stems, especially when using southern-grown
		2.6–5.3 pt Kocide LF 2.4F	0	transplants.
		1.3–2.6 pt Kocide 4.5 LF	0	
		1.5–3.0 lb Kocide 2000 DF	0	
	streptomycin sulfate	200 ppm streptomycin	0	Spray every 4–5 days in the seedbed up to transplanting.
Blossom-end rot	<i>Maintain uniform moisture supply by mulching and irrigating. Avoid excessive use of ammonia nitrogen and highly soluble potassium salts. Also work a superphosphate fertilizer or hydrated lime into the soil before planting. Do not cultivate too close to plants.</i>			
Botrytis (gray mold)	<i>Cultural management in greenhouses: keep ventilators partly open while the outside temperature is at least 45°F. This practice reduces relative humidity and the duration of periods favorable to spread of the fungus.</i>			
Early blight + botrytis (gray mold)	boscalid	<i>Early blight:</i> 2.5–3.5 oz Endura <i>Botrytis (gray mold):</i> 9.0–12.5 oz Endura	0	Endura belongs to the Group 7 fungicide category. If used alone, Endura does not control late blight. Use only in a tank mix with a broad-spectrum fungicide. Do not make more than two sequential applications of Endura before switching to a fungicide having a different mode of action. Do not make more than six applications of Endura per growing season. Do not exceed 21 oz/a per season when treating for early blight or 25 oz/a per season when treating for gray mold.
	pyrimethanil	7.0 fl oz Scala SC in combination with a broad-spectrum fungicide	7	Scala SC belongs to the Group 9 fungicide category. Use only in a tank mix with a broad-spectrum fungicide. Alternating the tank-mix combination with a broad-spectrum fungicide is a resistance management strategy. Scala SC can be used in a well-ventilated plastic tunnel house or glass house. Ventilate for at least 2 hours after application.
Fruit anthracnose	See Septoria leaf blight for chemical recommendations. <i>When conditions are favorable for fruit anthracnose use higher label rates of chlorothalonil formulations.</i>			
Fusarium + Verticillium wilts	<i>Plant only wilt-resistant varieties and follow a rotation that does not include wilt-susceptible crops.</i>			
	metam-sodium	Vapam HL		
Late blight	cyazofamid	2.1–2.75 fl oz Ranman 400SC	0	Do not apply more than six sprays or 16.5 fl oz/a per year. Alternate Ranman (Group 21) sprays with a fungicide having a different mode of action. Crops not listed on the label should not be planted within 30 days after the last application.

(continued)

Disease control in tomato (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Late blight (<i>cont.</i>)	dimethomorph	6.0 oz Forum	0	Begin treatment before the onset of late blight. Apply every 7–10 days; when cool, wet conditions are conducive for disease or when late blight has been detected in a field or nearby, apply every 5–7 days. Forum must be used in a tank mix with other protectant fungicides other than mefenoxam or metalaxyl. Do not apply more than 30 oz/a Forum per season.
	fixed copper	2.0–3.0 lb Kocide 101, DF	0	Begin treatment before symptoms appear.
		2.6–4.0 pt Kocide LF 2.4F	0	
		1.3–2.0 pt Kocide 4.5 LF	0	
		1.5–3.0 lb Kocide 2000 DF	0	
		3.0–4.0 lb Tri-Basic Copper Sulfate	0	
	propamocarb hydrochloride	0.7–1.5 pt Previcur Flex	5	Begin treatment before the onset of late blight. Tank-mix with other fungicides such as chlorothalonil, maneb, or mancozeb. Adjust rates and timing according to late blight conditions. Do not exceed 7.5 pt/a Previcur Flex per growing season.
Seed rot + damping-off	captan thiram			Plant seed treated with Captan or Thiram fungicide.
Septoria leaf blight + early blight + late blight	azoxystrobin	1.6–2.0 oz Amistar 80 WDG	14	Amistar, Cabrio, Evito, Quadris, Reason, and Tanos belong to the Group 11 (strobilurin) fungicide category. Quadris Opti contains a combination of Groups 11 and M5 fungicides. Do not exceed one application of any of these Group 11 products before alternating with a fungicide having a different mode of action. Do not exceed four applications of Evito or six applications of other Group 11 fungicides per year. Do not exceed 0.75 lb/a Amistar, 96 oz/a Cabrio, 22.8 fl oz/a Evito, 1.0 qt/a Quadris, 1 gal/a Quadris Opti, 24.6 fl oz/a Reason, or 72 oz/a Tanos per season. Following the last application of Reason 500 SC, wait 30 days before rotating to wheat and 1 year for all other crops. Do not apply Amistar, Quadris, or Tanos with an adjuvant. Do not apply Amistar, Quadris, or Tanos until 21 days after transplanting or 35 days after seeding. Do not apply Amistar, Quadris, or Tanos within 6 days before or after a postemergence application of Sencor herbicide. Tanos must be tank-mixed with a contact fungicide having a different mode of action.
		5.0–6.2 fl oz Quadris Flowable	14	
	azoxystrobin + chlorothalonil	1.6 pt Quadris Opti	14	
	cymoxanil + famoxadone	6.0–8.0 oz Tanos 50DF (early blight) or	3	
		8.0 oz Tanos 50DF (late blight, fruit anthracnose)	3	
	fenamidone	5.5–8.2 fl oz Reason 500 SC	14	
	fluoxastrobin	3.8 fl oz Evito 480 SC	3	
	pyraclostrobin	8.0–12.0 oz Cabrio EG (early blight, fruit anthracnose and Septoria leaf blight)	0	
		8.0–16.0 oz Cabrio EG (late blight)	0	
	chlorothalonil	1.3–1.8 lb Bravo Ultrex 82.5WDG, Equus DF	0	
		1.5–2.0 pt Bravo Weather Stik, Echo 720, Equus 720	0	
		1.2–1.7 lb Echo 90DF	0	
		2.0–3.0 pt Echo Zn	0	
		2.0–2.75 pt Bravo Zn	0	
		1.9–2.8 pt Equus 500 Zn	0	

(continued)

Disease control in tomato (*cont.*)

Disease	Active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Septoria leaf blight + early blight + late blight (<i>cont.</i>)	maneb	1.5–3.0 lb Maneb 80WP	5	Consult label for product use limits. Spray every 5–10 days depending on disease and weather pressures.
		1.2–2.4 qt Maneb plus Zinc F4	5	
		1.2–2.4 qt Manex F4	5	
	mancozeb	1.2–2.4 qt Dithane F-45	5	Consult label for product use limits. Spray every 5–10 days depending on disease and weather pressures.
		1.5–3.0 lb Dithane 75DF	5	
		Rainshield NT		
		1.5–3.0 lb Manzate 200 75DF	5	
		1.5–3.0 lb Penncozeb 80WP, 75DF	5	
Soil rot	<i>Avoid by staking or mulching plants.</i>			
Walnut wilt	<i>Symptoms are similar to Fusarium wilt. Plant tomatoes at a distance from the base of black walnut trees that is greater than the tree height.</i>			

Scouting calendar for insect pests of tomato

April	May	June	July	August	September
early mid late	early mid late	early mid late	early mid late	early mid late	early mid late
	Black cutworm				
	Flea beetles				
			Variegated cutworm		
			Tomato hornworm (European corn borer)		

Insect control in tomato

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids	acetamiprid	0.8–1.2 oz Assail 70WP	7	Begin treatment when thresholds are reached. Apply every 7 days as needed. Do not exceed 6.8 oz/a Assail 70WP or 16 oz/a Assail 30SG per season.
		2.0–4.0 oz Assail 30SG	7	
	0.033–0.08 lb bifenthrin	2.1–5.2 fl oz *Brigade 2EC	1	Do not exceed 4 applications per season.
	0.025–0.044 lb cyfluthrin	1.6–2.8 fl oz *Baythroid 2EC	0	Ground applications only.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a Delta Gold.
	0.25–0.5 lb dimethoate	0.5–1.0 pt Dimethoate EC	7	
	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, 1.0–2.0 lb Thiodan WP	2	Do not exceed 6 applications per season.
	0.2 lb fenpropathrin	10.67 oz Danitol 2.4EC	3	Do not exceed 2.66 pt/a Danitol (0.8 lb ai/a) per season. Control may be improved by the addition of a nonionic surfactant.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Systemic at planting. Do not exceed 24 fl oz/a Admire per season.
	0.05 lb imidacloprid	Provado 1.6	0	Foliar spray. Also controls whitefly. Do not exceed 18.75 fl oz/a Provado per season.
	0.9–1.5 lb malathion	several formulations	1	
	0.75–1.0 lb methamidophos	1.5–2.0 pt Monitor 4E	7	
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV	1	
		0.25–1.0 lb *Lannate SP		

*Restricted-use pesticide.

(continued)

Insect control in tomato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Aphids (<i>cont.</i>)	pymetrozine	2.75 oz Fulfill 50WDG	14	Controls melon and green peach aphids. Treat when aphids first appear. May repeat in 7 days. Do not exceed 5.5 oz/a per season or more than two applications per crop.
	thiamethoxam	2.0–3.0 oz Actara, 5.0–11.0 fl oz Platinum	0 30	Apply before pests reach damaging levels. Repeat as needed every 7–10 days. Apply higher rates for heavy infestations, or for long residual with Platinum. Do not exceed 8 oz/a of either product per season. Do not apply less than 11 oz/a of Platinum per season.
	zeta-cypermethrin	3.2–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.
Cutworms and loopers	<i>Treat when larvae exceed 1 per 10 plants.</i>			
	0.033–0.08 lb bifenthrin	2.1–5.2 fl oz *Brigade 2EC	1	Do not exceed 4 applications per season.
	0.033–0.044 lb cyfluthrin	2.1–2.8 fl oz *Baythroid XL	0	Ground applications only. Apply every 7 days as needed. Do not apply more than 16.8 fl oz/a of Baythroid per season.
	1.0–2.0 lb carbaryl	Sevin (several formulations)	0	Broadcast bait formulation. Can only be used with mechanical harvest.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a Delta Gold.
	0.0075–0.015 lb emamectin benzoate	2.4–4.8 oz Proclaim 5 WDG	7	
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	1	Do not exceed 0.5 lb ai/a per season.
	0.2 lb fenpropathrin	10.67 oz Danitol 2.4EC	3	Do not exceed 2.66 pt/a Danitol (0.8 lb ai/a) per season. Control may be improved by the addition of a nonionic surfactant.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	5	Do not use on cherry tomatoes.
	0.06–0.16 lb methoxyfenozide	4.0–10.0 fl oz Intrepid 2F	1	Do not exceed 64 fl oz/a per season. Use the higher rates with higher populations or when spray coverage is difficult. See label for use restrictions in some Wisconsin counties.
	0.039–0.063 lb spinetoram	5.0–8.0 oz Radiant SC	7	Do not apply more than 34 oz/a Radiant (0.266 lb ai/a) per crop and do not make more than six applications per crop.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust	1	Use higher rate for larger insects. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent. Spray thoroughly for control.
	tebufenozide	6.0–16.0 fl oz Confirm 2F	7	Apply per label directions when populations reach threshold levels. Do not exceed 64 fl oz ai/a per season. There is a 1–12 month plantback restriction depending on crop.
	0.01–0.025 lb zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply at thresholds and do not exceed 24 oz/a Mustang Max per season.
Flea beetle	<i>Treat when numbers exceed 2 beetles per 10 leaves.</i>			
	0.033–0.08 lb bifenthrin	2.1–5.2 fl oz *Brigade 2EC	1	Do not exceed four applications per season.
	0.8 lb carbaryl	Sevin	0	Several formulations; see label for rate. Can only be used with mechanical harvest.
	0.018–0.028 lb deltamethrin	1.5–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a Delta Gold.

*Restricted-use pesticide.

(continued)

Insect control in tomato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Flea beetle (<i>cont.</i>)	0.5–1.0 lb endosulfan	0.66–1.33 qt Thiodan EC, 1.0–2.0 lb Thiodan WP	1	
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	1	Do not exceed 0.5 lb ai/a per season.
	0.01–0.015 lb gamma cyhalothrin	2.56–3.84 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	imidacloprid	7.0–10.5 fl oz Admire Pro	21	Systemic at planting.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	5	
	thiamethoxam	2.0–3.0 oz Actara	0	Apply before pests reach damaging levels. Repeat as needed every 5 days. Do not exceed 8 oz/a of product per season.
	thiamethoxam	5.0–11.0 fl oz Platinum	30	Apply as an in-furrow spray at planting or as a post-seeding transplant or hill drench. Irrigate sufficiently to move the chemical into the root zone. Use the higher rate for long residual control. Do not apply less than 5 fl oz/a or more than 11 fl oz/a of Platinum per season.
	zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.
Hornworm and tomato fruitworm	<i>Treat when there is an average of at least two hornworms per plant.</i>			
	<i>Bacillus thuringiensis</i>	Dipel DF, Javelin, MVP	0	Rates vary with formulation. Apply when larvae are small.
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	1.0–2.0 lb Lepinox WDG	0	Treat early instar larvae before noticeable feeding damage occurs. Repeat as needed.
	0.033–0.08 lb bifenthrin	2.1–5.2 fl oz *Brigade 2EC	1	Do not exceed 4 applications per season.
	0.5–2.0 lb carbaryl	Sevin (several formulations)	0	Can only be used with mechanical harvest.
	0.025–0.044 lb cyfluthrin	1.6–2.8 fl oz *Baythroid XL	0	Ground applications only. Apply every 7 days as needed. Do not apply more than 16.8 fl oz/a of Baythroid 2 per season.
	0.012–0.028 lb deltamethrin	1.0–2.4 fl oz *Delta Gold	1	Apply every 5 days as needed. Do not exceed 14.4 fl oz/a Delta Gold.
	0.0075–0.015 lb emamectin benzoate	2.4–4.8 oz Proclaim 5 WDG	7	
	0.015–0.05 lb esfenvalerate	2.9–9.6 fl oz *Asana XL	1	Do not exceed 0.5 lb ai/a per season.
	0.2 lb fenpropathrin	10.67 oz Danitol 2.4EC	3	Do not exceed 2.66 pt/a Danitol (0.8 lb ai/a) per season. Control may be improved by the addition of a nonionic surfactant.
	0.0075–0.0125 lb gamma cyhalothrin	1.92–3.20 oz Proaxis	5	Apply every 5 days as needed. Do not apply more than 2.88 pt/a (0.18 lb ai/a) per season.
	0.045–0.065 lb indoxacarb	2.5–3.5 oz Avaunt	3	Apply when insect populations reach threshold levels. May repeat treatment every 5 days. Do not apply more than 0.26 lb ai/a per crop. Apply higher rate for tomato fruitworm control.
	0.015–0.03 lb lambda-cyhalothrin	1.92–3.84 fl oz *Warrior EC	5	Use 0.015–0.025 lb ai/a on hornworms.
	0.225–0.9 lb methomyl	0.75–3.0 pt *Lannate LV 0.25–1.0 lb *Lannate SP	1	

*Restricted-use pesticide.

(continued)

Insect control in tomato (*cont.*)

Insect	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Hornworm and tomato fruitworm (<i>cont.</i>)	0.16–0.25 lb methoxyfenozide	10.0–16.0 fl oz Intrepid 2F	1	Do not exceed 64 fl oz/a per season. Use the higher rates with higher populations or when spray coverage is difficult. See label for use restrictions in some Wisconsin counties. May only provide partial control of fruitworms in heavy infestations.
	0.05–0.2 lb permethrin	*Ambush, *Pounce	0	Several formulations; see label for rate. Do not apply to cherry tomatoes. Do not exceed 1–2 lb ai/a per season.
	0.039–0.063 lb spinetoram	5.0–8.0 oz Radiant SC	7	Do not apply more than 34 oz/a Radiant (0.266 lb ai/a) per crop and do not make more than six applications per crop.
	0.047–0.094 lb spinosad	1.0–2.0 fl oz Entrust 3.0–6.0 fl oz SpinTor 2SC	1 1	Use higher rate for larger insects. Apply adequate spray to get good coverage for best control. Do not exceed 0.45 lb ai/a per season. Do not use a buffering agent.
	0.09–0.25 lb tebufenozide	6.0–16.0 fl oz Confirm 2F	7	Apply per label directions when populations reach threshold levels. Do not exceed 64 fl oz ai/a per season. There is a 1–12 month plantback restriction depending on crop.
	zeta-cypermethrin	2.24–4.0 oz *Mustang Max	1	Apply every 7 days as needed. Use higher rate for heavy infestations. Do not exceed 24 oz/a Mustang Max per season.
Spider mite	0.938–1.88 lb abamectin	8.0–16.0 fl oz *Agri-Mek 0.15EC	7	May repeat after 7 days, but do not make more than two sequential treatments or exceed 5.64 lb ai/a per year.
	bifenazate	0.75–1.0 lb Acramite 50WS	3	Limit one application per season.
	0.033–0.08 lb bifenthrin	2.1–5.2 fl oz *Brigade 2EC	1	Do not exceed four applications per season.
	0.2 lb fenpropathrin	10.66 fl oz Danitol 2.4EC	3	Treat when mites first appear and repeat every 7 days as needed. Do not exceed 0.8 lb ai/a per season.
	1.5–2.0 lb malathion	several formulations	1–5	
	spiromesifen	7.0–8.5 fl oz Oberon 2SC	7	Apply every 7 days as needed. Do not exceed 25.5 fl oz/a per season.

*Restricted-use pesticide.

Weed control in tomato

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds	0.48–1.43 lb pendimethalin	1.0–3.0 pt Prowl H ₂ O	70	Apply as a broadcast preplant-incorporated application, or as a broadcast preplant surface application before transplanting, or as a post-directed application to transplanted or established direct-seeded tomatoes. Do not apply postemergence over the top of or to foliage of tomatoes. Use rate varies by soil type. Do not apply more than 3.0 pt/a per season. Do not allow treated soil to come in contact with the transplant area. Do not apply if row will later be covered with plastic.
	0.95–1.9 lb s-metolachlor	1.0–2.0 pt Dual Magnum	90	Transplanted tomatoes: Apply as a preplant incorporated, preplant before transplanting, or post-directed following the first settling rain or irrigation. Dual Magnum may also be used under plastic mulch or to treat row middles in bedded tomatoes. Dual Magnum will not control emerged weeds. Adjust rate according to soil texture and expected weed pressure. Do not apply to cultivars with unknown tolerance. See label for additional directions and precautions.
Annual grasses and some broadleaves	4.5–10.5 lb DCPA	6.0–14.0 lb Dacthal W-75 6.0–14.0 pt Dacthal FL		Make preemergence applications to weed-free soil 4–6 weeks after transplanting and to seeded tomatoes when they are 4–6 inches tall. seeding. Use only on soils with 5% or less organic matter.
	1.0–2.0 lb napropamide	2.0–4.0 lb Devrinol 50-WP 2.0–4.0 qt Devrinol 2-E		Apply before planting to a weed-free soil surface. Incorporate 1–2 inches deep the same day. Napropamide can be applied to direct-seeded or transplanted tomatoes.
	0.5–1.0 lb trifluralin	1.0–2.0 pt Treflan HFP or registered equivalent		For transplants, apply and incorporate before transplanting. On direct-seeded tomatoes, apply as a directed spray between rows and under plants at thinning. May cause early stunting of tomatoes, especially under poor growing conditions. Controls annual grasses and some broadleaf weeds, but is weak on wild mustard, smartweed, common ragweed, velvetleaf, and black nightshade. Rate varies with soil texture and organic matter. Follow recommended soil preparation application, and incorporation procedures. Must be incorporated within 24 hours. See label for plantback restrictions. Ineffective on peat and muck soils.
Annual broadleaves and some grasses	0.25–1.0 lb metribuzin	Preplant-incorporated:		Incorporate 2–4 inches deep before transplanting.
		0.5–1.0 pt Sencor 4	7	
		0.33–0.67 lb Sencor DF	7	
		Postemergence broadcast:		
		0.5–0.75 pt Sencor 4	7	For postemergence broadcast spray to established tomatoes, apply before weeds are 1 inch tall. Minimum of 14 days between applications. Do not treat seeded tomatoes until they have five to six leaves. Do not apply within 14 days of transplanting. Do not apply within 3 days after cool, wet, or cloudy weather, or injury may result. Do not apply within 24 hours of other chemical treatments.
		0.33–0.5 lb Sencor DF	7	
		Postemergence directed:		
		1.0–2.0 pt Sencor 4	7	Use postemergence directed spray application on fields with a history of severe weed pressure or fields infested with hard-to-kill weeds. Use in limited trials on new varieties. If making multiple applications, do not exceed the maximum annual rate.
		0.67–1.33 lb Sencor DF	7	

(continued)

Weed control in tomato (cont.)

Weed	Rate/a of active ingredient	Rate/a of commercial product	Days to harvest	Remarks and suggestions
Annual weeds and some perennial weeds	0.0156–0.312 lb rimsulfuron	1.0–2.0 oz Matrix		Requires rainfall or irrigation (0.5 inches for sandy soils, 1 inch for clay soils) for activation. For postemergence applications, use 1–2 oz product to control young, actively growing weeds. Add crop oil concentrate or nonionic surfactant to the spray mixture. Do not exceed 4 oz/a Matrix per season.
Nutsedge and some broadleaves	0.023–0.047 lb halosulfuron	0.5–1.0 oz Sandea <i>(rate varies by crop use and application timing—see label)</i>	30	Sandea controls several broadleaf weeds and nutsedge, but no grasses. Sandea has both pre- and postemergence activity and can be used under plastic mulch. A broadcast postemergent treatment can be sprayed 14 days after transplanting but before first bloom, or directed between rows of a seeded or transplanted crop at any time. If plastic is used on the planted row, adjust equipment to keep spray off the plastic. Do not exceed two applications or apply more than 2 oz/a per crop cycle or 12-month period. Soil or foliar applications of organophosphate insecticides to Sandea-treated crops may cause severe crop injury. Consult label for additional usage information and other precautions.
Emerged weeds	glyphosate	several manufacturers and formulations		See manufacturer's label to assure that the formulation is labeled for this crop and for specific instructions. Some formulations require a wait of 3 days between application and seeding. Glyphosate may be applied any time before crop emerges. If weeds have been mowed or tilled, do not treat until they have resumed active growth and reached the recommended stage on the label. Unless otherwise stated, allow 7 or more days before tilling treated fields. Do not tank-mix with soil-residual herbicides unless otherwise specified.
	*paraquat	several manufacturers and formulations	30	Prepare seedbed early to allow for maximum weed emergence. Application can be made as a banded or broadcast treatment before, during, or after planting, but before crop emergence. Use the higher rate for heavy weed infestations. Seeding and transplanting should be performed with minimal soil disturbance. Always add crop oil concentrate or nonionic surfactant to spray mixture. Follow precautions on label.
Emerged grasses	0.094–0.25 lb clethodim	6.0–16.0 oz Select 2EC	20	Apply to actively growing grasses. Repeat treatments may be made at 14-day intervals up to the maximum annual use rate. Do not cultivate grasses within 7 days before or after application. Include appropriate surfactant as required by product label. Do not apply if rain is expected within 1 hour.
	0.068–0.24 lb clethodim	9.0–32.0 oz Select Max	20	
	0.19–0.28 lb sethoxydim	1.0–1.5 pt Poast	20	Make postemergence applications to actively growing grasses within the size ranges indicated on the label. Check the label for other (wild proso millet, rescue) treatment rates. Do not apply more than 4.5 pt/a Poast in one crop season. Always add 2 pt/a of oil concentrate. Follow precautions on label.

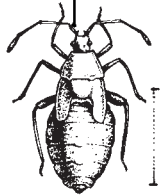
*Restricted-use pesticide.

Immature key

Nymphs

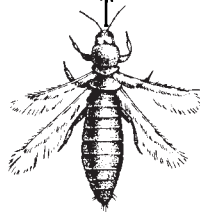
Not worm-shaped (without wings)

No tail pipe extending from rear of body.



Squash bug and leaf-footed bug

½-inch long. Oblong, greenish brown body often has two black spots on abdomen.



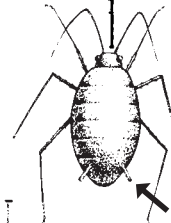
Onion thrips

Thrips about the size and shape of the exclamation mark "!"; yellow to brown in color.



Leafhopper

⅛-inch, green, wedge-shaped nymph. Like adults but smaller.



Plant lice (aphids)

Tail pipes extending from rear of body.

6 true legs (3 pairs) prolegs present; caterpillars.



White grub

Fat, soft, C-shaped, white grubworms.

Green, brown or black larvae without horn at rear of body



Cabbage looper

2 pairs of prolegs. Light-green larvae up to 1½ inches long, body makes a looping motion while moving.



Diamond moth caterpillar

3 pairs of prolegs. Light green, cigar-shaped larvae less than ¾-inch long.

4 pairs of prolegs



European corn borer

Without cross stripes; not brown at each end; flesh-colored caterpillars up to 1-inch long with small donut-shaped brown spots over the body.



Common stalk borer

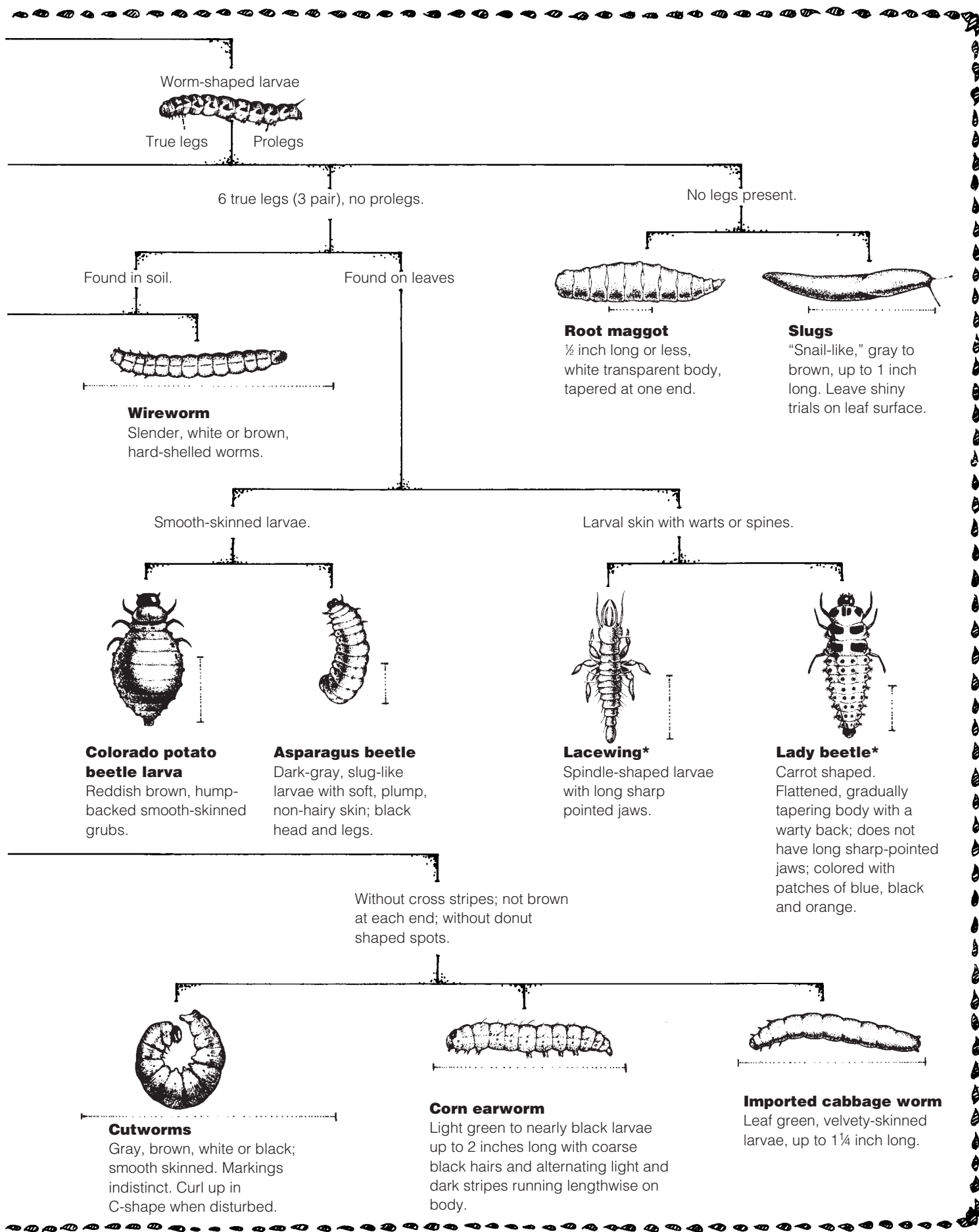
Brown and white stripes run lengthwise on body. Yellow head. Bores into stems of many vegetables.



Hornworms

Red or black horn at rear of body.

* Beneficial insect



Adult key

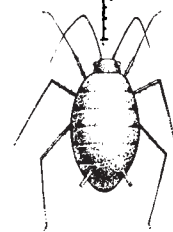
Spider mites

Barely visible—about the size of a period. Adults have 8 legs.



Aphids

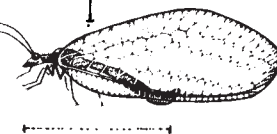
$\frac{1}{8}$ – $\frac{1}{10}$ inch long, small, soft bodied, 2 tail pipes, usually no wings, pear-shaped bodies.



Wings overlap on back, base of front wing may be leathery; Not hard shelled.

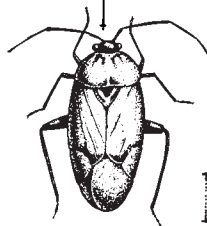
Lacewing*

Front wings entirely membrane-like. Finely netted, held tent-like over body. Green in color. Hair-like antenna.



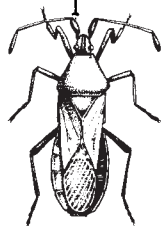
Leafhopper

$\frac{1}{8}$ inch long, wedge shaped. Hop when disturbed.



Plant bug

$\frac{1}{4}$ inch long, actively fly.



Squash bug

1 inch long, dark brown.

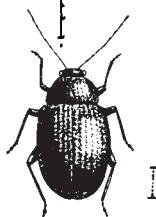
Antenna longer than length of head and thorax



Asparagus beetle

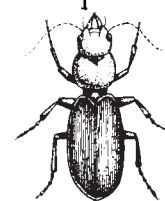
Metallic blue to back, orange to yellow marking.

Usually entirely one color—black, brown, blue or green



Flea beetle

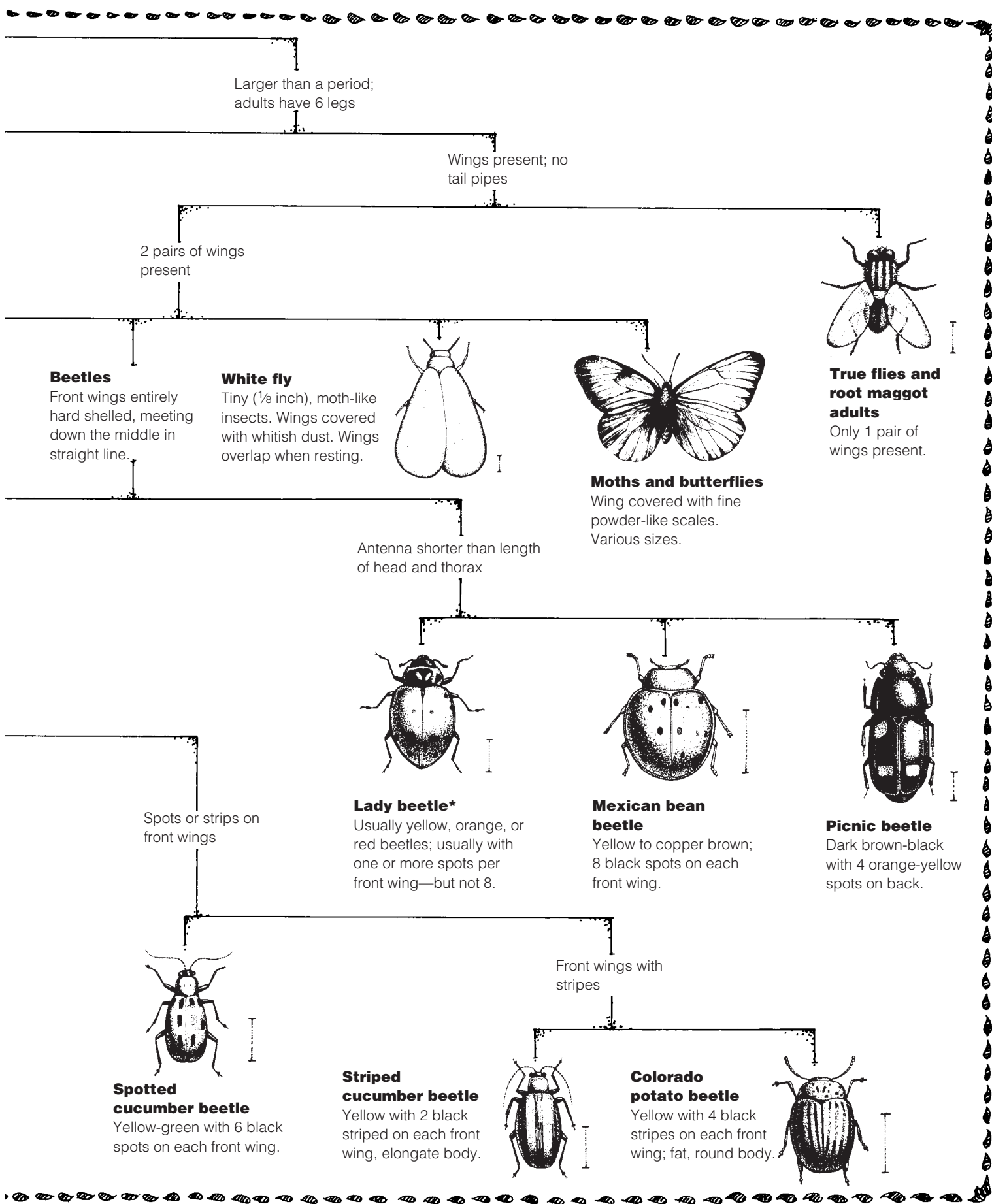
About $\frac{1}{8}$ – $\frac{1}{4}$ inch long.



Ground beetle*

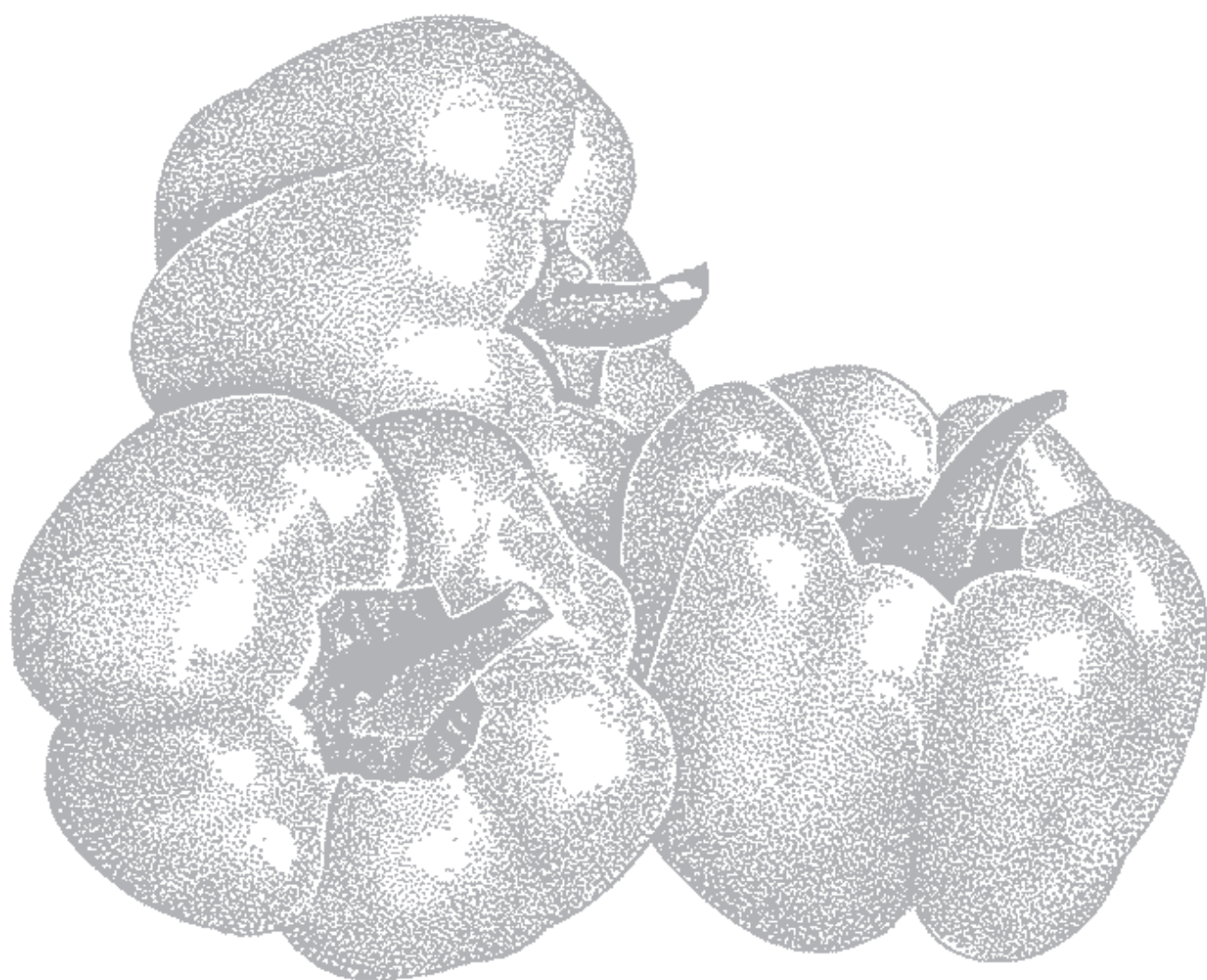
$\frac{1}{4}$ inch or longer.

* Beneficial insect



Abbreviations

a = acre
AD = allowable depletion
ai = active ingredient
BMP = best management practices
bu = bushel
Ca = calcium
CS = capsule suspension
CT = conservation tillage
CWT = hundredweight (100 lb)
D = dust
DF = dry flowable
DG = dispersible granule
DS = dry soluble
EC = emulsifiable concentrate
ET = evapotranspiration
F = flowable
FC = flowable concentrate
ft = foot
G = granular
gal = gallon
IPM = integrated pest management
K₂O = potash
K = potassium
L = liquid
lb = pound
LC = liquid concentrate
LS = liquid sprayable
Mg = magnesium
N = nitrogen
oz = ounce
P₂O₅ = phosphate
P = phosphorus
pH = a measure of acidity and alkalinity
ppm = parts per million
psi = pounds per square inch
pt = pint
qt = quart
S = sulfur
SC = soluble concentrate
SP = soluble powder
t = ton
ULV = ultra low volume
W or WP = wettable powder
WDG = wettable dispersible granule
WISP = Wisconsin Irrigation Scheduling Program
WSB = water-soluble bag
WSP = water-soluble pouch



Related web sites

Extension publications— learningstore.uwex.edu

Pesticide labels— www.cdms.net

Pesticide resistance management—

fungicides: www.frac.info

insecticides: www.irac-online.org

herbicides: www.plantprotection.org/HRAC/

Vegetable diseases—

www.plantpath.wisc.edu/wivegdis

Weed profiles—

ipcm.wisc.edu/uw_weeds/extension/

weedprofiles.htm



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